REPORT

OF THE

SECRETARY OF AGRICULTURE

1892

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1893

[PUBLIC RESOLUTION—No. 5.]

Joint resolution providing for the printing of the Agricultural Report for eighteen hundred and ninety-two.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed five hundred thousand copies of the Annual Report of the Secretary of Agriculture for the year eighteen hundred and ninety-two; one hundred and ten thousand copies for the use of the Senate; three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture.

SEC. 2. That the sum of three hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to defray the cost of printing said report.

Approved, January 16, 1893.

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REPORT

OF THE

SECRETARY OF AGRICULTURE.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., November 15, 1892.

To the PRESIDENT:

I have the honor to submit my fourth annual report as Secretary of Agriculture. If I was able to express gratification a year ago at the improved condition of our agricultural industry since my first report as Secretary of Agriculture was submitted to you, I am assuredly still more justified in feeling gratified by the general condition of the agricultural interest in this country to-day.

In every report which I have had the honor to present to you I have sought to emphasize as forcibly as possible, and in such a manner as would impress my fellow-citizens, the vast importance of agriculture as a factor in this country's prosperity. The fact that agriculture is the only industry in this country having an individual representation in the National Government, possessing, as it does, an executive department devoted exclusively to its service, and represented in the Cabinet by one of the eight persons who are known as the advisers of the Chief Executive, needs no further justification, in my opinion, than the facts in reference to it which I have had the honor to submit in former reports, and those which I have the honor to present herewith. Most truthfully can it be asserted that the agricultural industry in this country underlies the entire system of the body politic: not a single individual in the country but what is dependent directly or indirectly upon this industry.

I shall dwell for the present upon one feature only as sufficiently illustrative of the relation borne by agriculture to all other industries and to the national prosperity. I refer to the place of agriculture in our foreign trade. For many years, and during the few years of the present administration especially, the question of our foreign trade, both as to exports and imports, has been most prominent in the mind of the entire country. To it has been assigned the largest place in national legislation, while at all recent elections involving a possible change of administration from the domination of one great party to that of the other, it has been one of the leading questions, if not the leading question. I can make no mistake, then, in appealing for an earnest consideration of the following figures representing the relative proportions of agricultural products in both our export and import trade.

OUR FOREIGN TRADE—EXPORTS.

Reviewing the fiscal year which closed June 30, 1892, we find that our foreign trade in that year far surpassed that of any previous year in the history of the country, aggregating a grand total of $1,857,679,603, or more by one hundred and twenty-eight millions than ever before. Of this great sum $1,030,278,030 represented our exports, and of these all but fourteen and one-half millions represented domestic products, which amounted, for the first time in our history, to more than a billion dollars. By a brief comparison with former years we find that during the past fiscal year the balance of trade in our favor was over two hundred and two millions against less than forty millions last year, and an adverse balance of nearly three millions in 1889, and of over twenty-eight millions in 1888. Moreover, the increase in trade over the figures of the previous year was entirely in our exports, the imports showing a slight falling off from the record of 1891.

Having thus briefly presented a few figures showing the magnitude of this foreign trade, and especially of our exports, I will now show what share our agriculture had in this most important phase of our national prosperity. Of the vast sum representing exports of our domestic products, nearly 80 per cent, or, to be very exact, 78.1 per cent, consisted of agricultural products, the same being $793,717,676, a sum which exceeds by more than one hundred and fifty millions the shipments of agricultural products in any previous year, while it surpasses the record of 1889, when this administration undertook the direction of affairs, by more than two hundred and sixty millions. Indeed, it is actually greater by sixty-three millions than our total exports of all products in that year, while it exceeds the value of our total foreign trade, imports and exports included, prior to 1870. Surely, nothing more is needed to emphasize the relations which agriculture bears to our foreign trade; but it may be necessary, in order that the importance of our foreign trade may be properly understood, and that the part which this Department has been able to take in this extraordinary development may be appreciated, that I should present a few considerations suggested by these wonderful figures. Ordinarily, the first thought that will suggest itself in studying them will be that by this foreign trade and the abundance of our own domestic production the United States has been made the creditor of the world for a sum exceeding $200,000,000. But great as this may seem, the importance of this fact is but slight compared with the extent of the benefits conferred upon the entire country by the removal of these domestic products from our home markets, thus relieving these of a surplus which must have resulted in a reduction in prices to a point below the cost of production. In all considerations of our foreign trade this feature of relieving the home market from a glut of production must always be the most important.

Later on in this report I shall have occasion to show, by reference to some of the work undertaken and accomplished by this Department, what part it has been able to take in the development of this important trade with foreign countries, and shall also say a few words in regard to what part it might have taken and ought to take were its facilities sufficiently enlarged. In the mean time, as having a most important bearing upon the work of this Department and its duty in the future, I will call your attention to some features of our import trade, in which the agricultural industry is also deeply interested.

IMPORTS.

The total import trade for the fiscal year under consideration exceeded eight hundred and twenty-seven millions, of which it appears that 51.6 per cent was made up of agricultural products, an increase of eighteen millions over similar imports in 1891 and of fifty-three millions over imports of 1890. I am glad to be able to state that an examination of the items making up these agricultural imports shows this increase to be mainly confined to products that do not compete with our own producers. In fact, a comparison of the year under consideration with the fiscal year ending in 1889 shows that, while in the last-named year our imports embraced 54 per cent of agricultural products coming into competition with our own, a similar division for 1892 shows but 44 per cent of such products. This is highly encouraging as an evidence ot the value to our agricultural interests of the policy of this administration. At the same time, this gratifying result must not cause us to ignore the fact that of our total agricultural imports so large a proportion still consists of products competing with the American farmer in our own markets. It must be borne in mind, further, that in a certain sense the competition is greater than appears on the surface; that is, the estimated value being the value at port of shipment, both as regards exports and imports, the cost of transportation and distribution must be added to the valuation of imports at port of shipment in order to represent accurately what our consumers pay for agricultural products. We still import over $40,000,000 worth of animal products, exclusive of wools, which are included in the fibers, and of these last, the fibers, we imported in the past fiscal year over $67,000,000 worth, the far greater part of which, or substitutes for the greater part of which, could certainly, with proper encouragement, be grown in our own country.

In this connection I would call attention to the fact emphasized in my last annual report, namely, the large import of hides which are admitted into this country duty free. Our annual imports of this class of goods for the past two years have averaged over $27,000,000, thus necessarily causing a great depreciation in the prices realized for hides of domestic production. I must, therefore, renew most earnestly the recommendation made in my last report, namely, "That the duty provided for in section 3 of 'An act to reduce the revenue and equalize duties on imports, and for other purposes,' approved October 1, 1890, be imposed in all cases where the countries from which such hides are shipped have not granted equal concessions in regard to the admission of the agricultural products of the United States." Our imports of raw silk, also admitted free, have greatly exceeded those of the previous year, while they have been greater than even the very large imports of 1890. The difficulties attending the domestication of silk production in this country have been fully set forth in previous reports. At the same time, so long as we continue to be the largest consumers of raw silk in the world and to pay over $25,000,000 a year to foreign producers therefor, we ought, in my opinion, not to relax our efforts to introduce this industry among our own people.

Of fruits and wines we import yearly $30,000,000 worth or over, and of this class of products there can be no question that, with our great variety of soil and climate, all could be produced in the United States.

The brief review which I have thus given of the relations of our agriculture to our foreign trade, both export and import, very clearly emphasizes the main, ultimate object of all the work of this Department, namely, the closest study of all markets abroad which may be reached by our own agricultural products, accompanied by persistent and intelligent efforts to extend them, and the substitution in our own markets of home-grown for foreign-grown products. It has been my duty to express this view in former reports, but every year brings before me so much additional evidence to justify and confirm it that it is impossible for me to make an intelligent report upon this Department and our agricultural interests without reiterating and emphasizing it.

LIVE-STOCK EXPORTS—PRICES.

It affords me great gratification to be able to confirm, by the experience of the past year, the anticipations formed as to the good results which would be brought about by the efforts of this Department under the extension of its powers afforded by then recent legislation. When I submitted my report last year, indeed, that legislation was for the most part so recent that it was impossible to speak very fully as to the results, encouraging as were the indications then observable. The inspection laws by which this Department has been afforded so wide and thorough a control of the animal industry of the country, especially as regards its export trade, have now been in operation, I think, a sufficiently long time to give to the facts which I am able to lay before you in this report very great weight in estimating their benefits.

"THE AMERICAN HOG."

When I submitted my last report the prohibitions existing against American pork had been withdrawn by the Governments of Germany, Denmark, and Italy. Since that time similar action has been taken by the Governments of France, Austria, Spain, and Belgium, so that in fact there exists to-day no prohibition whatever in any country against the admission of American pork products bearing the certificate of inspection of this Department. Since these prohibitions have been removed more than 40,000,000 pounds of inspected pork have been shipped to Europe, none of which, presumably, without inspection would have found a market abroad; while, comparing the total trade in hog products with Europe for corresponding periods in 1891 and 1892, we find that in May of this year there were shipped 82,000,000 pounds, against 46,900,000 pounds in the same month of 1891. In June the exports for 1892 aggregated 85,700,000 pounds, against 46,500,000 pounds the previous year. July showed an increase of 41 per cent and August of 55 per cent over the corresponding months of 1891.

Taking, as a period in which the effects of inspection can be clearly noted, the four months of May, June, July, and August together, we find an increase in that period this year of 62 per cent in quantity of hog products shipped to Europe, as compared with the same period last year, and we find, moreover, and this is particularly noteworthy, that this enormous increase has been accompanied by an increase in the price of the exported articles, making the increase in values in the same period 66½ per cent. A comparison of prices for September, 1892, with prices for September, 1890, the year before inspection was put in force, shows an increase of 80 cents per 100 pounds in the prices received by farmers for their hogs, an increase in value of 18¾ per cent. To make the benefit secured to the farmer definitely clear, I may state that such an increase adds an average of $2 per head to the selling price of every hog sold in the United States.

I have noted above the great increase in shipments and the increase in value per head of every animal sold. There remains still one more important fact to be noted in regard to this trade, and that is, that accompanying this great increase in price there has occurred the heaviest marketing of hogs known in the history of the country, the effect of which, under ordinary circumstances, would be to greatly depreciate prices. Taking the two years ending March 1, 1892, we find that there were marketed in the United States nearly 45,000,000 hogs, as against less than 36,000,000 in the two years preceding. These figures are especially commended to the consideration of those persons who have been disposed to smile at the great prominence given to the "American hog" in recent years.

CATTLE.

The effects of our meat-inspection laws, together with the control of animal diseases and the better condition of ocean transportation, have brought about results no less gratifying in regard to the cattle industry.

THE COUNTRY FREE FROM PLEURO-PNEUMONIA.

The 26th day of September last marked an epoch in the cattle industry of this country, for on that day I was able to proclaim the country absolutely free from contagious pleuro-pneumonia, the dreaded disease which, introduced into this country from Great Britain, has been for so many years made the ground by the British Government for enforcing most grievous restrictions upon the cattle trade of the United States so far as exports to that country are concerned. This proclamation will appear in its proper place further on in this report in reviewing in greater detail the work of the Bureau of Animal Industry; but I will state here, with the utmost emphasis, that that proclamation was issued only after the most thorough investigation and inspection of all sections in which the disease has existed during the past few years, an inspection in no way relaxed for months, and in some cases for years, after the occurrence of the last case of disease, and under conditions which make it absolutely impossible that this proclamation should have been premature.

It must be borne in mind that, accompanying a gradual and justifiable relaxation in the inspection for contagious pleuro-pneumonia in certain districts, there has been a wide extension, under the cattle and meat inspection laws, of the inspection force of the Bureau of Animal Industry of this Department, so that to-day it would be absolutely impossible for a case of this disease to occur without its prompt discovery by the officers of this Department. The number of animals inspected both before and after slaughter, at the great slaughtering centers of the country, by officers of this Department, aggregates over 3,000,000 head a year. Add to this the fact that every live animal crossing our borders is now, under the law of August 30, 1890, made the subject of veterinary inspection; that animals imported from Europe are made the subject of a ninety-days' quarantine, during which they are constantly inspected; and finally that, as has been before remarked, in the few isolated and restricted sections in which pleuro-pneumonia has existed in this country during the past few years, the most drastic measures of eradication have been followed by a thorough and watchful inspection, lasting from six months to a year and more after the occurrence of the last case, and there is certainly an accumulation of evidence sufficient to satisfy every reasonable person, not only as to the complete justification for the proclamation of immunity of the 26th day of September, but as to our ability to absolutely exclude from our soil forever this dreaded disease, which can only be propagated by actual contact with infected animals or premises.

REGULATIONS ON TEXAS FEVER.

By the regulations imposed by the Department for the prevention of Texas fever—regulations which it becomes more easy every year to enforce—this disease has been almost entirely prevented. Not only have our regulations guarded against the direct losses from the disease, but they have greatly facilitated the transportation of cattle, and have been the principal factor in securing a reduction in insurance rates, by which $5 has been saved in that item alone upon every steer exported. In a word, I may say advisedly that the regulations for the prevention of Texas fever have saved three times as much money to the cattle-growers of this country yearly as is required to run the whole Department of Agriculture.

RESULTS OF INSPECTION LAWS.

One of the results of the more rigid inspection enforced by this Department under the laws of 1890 and 1891 has been the withdrawal by Great Britain of the prohibition formerly existing in that country against sheep from the United States. I deeply regret to say, however, that there are no indications on the part of the British Government ot an intention to modify the restrictions now imposed on our cattle export trade to that country, as the result of the freedom of this country from contagious pleuro-pneumonia and of the control exercised by this Department by which danger to export cattle from Texas fever is absolutely avoided. Notwithstanding, however, the continuance of this restrictive legislation, the success attained by this Department in its efforts for the prevention and control of cattle disease has been recognized in the foreign trade.

In 1889, the year in which I assumed the direction of the Department, we exported 205,786 head of cattle, while in 1892 we exported 394,607 head. Moreover, this increase in the quantity of cattle exported was accompanied by an increase in value per head. Thus, while the total value of export cattle in 1889 was $16,600,000, it was in 1892 over $35,000,000, the increase in value showing the animals to be worth $8 per head more than in 1889. The exports of dressed beef continue to increase, exceeding considerably in quantity, and still more in value, the exports of last year, while they exceed the exports of 1889 by about 60 per cent.

BENEFITS TO THE CATTLE-GROWERS.

As regards the benefits to our cattle-growers, I will, as in the case of hogs, make a comparison between the prices for cattle in Chicago for the month of September, 1892 and 1889. In September, 1892, there was 37 per cent more cattle marketed than in the corresponding month of 1889, and, in spite of this great increase, there was also an increase in prices, ranging from 24½ cents per hundred on common steers to 78 cents per hundred on second-quality steers. Even on the common butcher steers, marketed in such enormous numbers that it is wonderful they have held their own in price, we find that the selling price increased 8½ per cent, the increase in second quality and good to choice being 18 per cent. The average increase all around can not be less than 15 per cent, and amounts to from $4 to $15 per head, according to the weight of each steer sold. Putting the average increase on the selling price of cattle at $8 per head—a moderate estimate from the figures just given—the aggregate benefit to cattle-growers of this country would be about $40,000,000.

INDIAN CORN IN EUROPE.

At the same time that these most desirable results have been obtained in reference to our live-stock products, the attempt, undertaken two years ago, to extend the use of our Indian corn in Europe has been continued. During the past twelve months the special agent of the Department charged with this work has been prosecuting his mission in Germany, that country seeming to offer for several reasons the most desirable, if not the most promising, field of labor. In the first place, the bulk of the German people are not accustomed to the use of wheaten bread, their principal bread supply being rye. Secondly, the experience in that country—which is obliged to import yearly a large proportion of its cereal food supply, as the result of the deficiency in Russia, which led to the entire prohibition of cereal exports from that country, whence Germany had ordinarily drawn its chief supply—seemed to offer a favorable opportunity to acquaint the German people with the merits of Indian corn, it being more likely that they would test the merits of a new cereal food at a time when that to which they were accustomed was scarce and dear. In this I have not been disappointed, and I feel that we have reason to be well satisfied with the results of our agent's efforts in that country. He had necessarily to encounter many difficulties. It is not an easy thing to induce people at any time to try new kinds of food, especially where the kind of food in question is one which has been quite generally regarded, as has been the case with corn in Europe, as not suitable for human consumption.

Again, the channels through which our agent had sought principally to accomplish his work in Great Britain are not as available in Germany, and, lastly, the domestic customs of the people do not lend themselves as readily as with us to a corn diet. Home-made bread is rare, and hot bread is almost unknown, all bread being made by the bakers and sold by them to all classes, including the poorest. This necessitates that the bread in common use should have keeping qualities. The best solution to these difficulties was found in the manufacture of a mixed bread, composed of rye and corn, which was found to considerably cheapen the cost by comparison with bread made entirely of rye, to be palatable, and to possess the keeping qualities necessary among people who oftentimes purchase their bread supply once a week. Samples of this mixed bread were baked under the instructions of our agent and distributed widely. The conditions to which I have already referred induced many people to try these samples who would otherwise not have been induced to do so, and quite a number of the bakeries in Berlin and in some of the other leading cities undertook the making of this mixed bread, submitting it to their customers, as the price lists forwarded by our special agent show, at a considerable reduction from the price of rye bread alone. The attention of health officers was directed to the subject and, as is usual in European countries, the new bread was subjected to rigid tests, with a view to establishing its comparative healthfulness. So far as we can ascertain, the results of these investigations have been generally in its favor; in some cases, markedly so. Investigations have also been undertaken by direction of the military authorities with a view to testing the value and availability of Indian corn, in the form of such a mixed bread as I have described, as an army ration. I need hardly say that every facility has been afforded the authorities by our agent to make the fullest tests as to the value and keeping qualities of the bread, and it is hoped that ere long some report as to the result of these investigations will be made public. It can not, I think—and all Americans will agree with me—be otherwise than favorable.

Some allegations were made in opposition to the use of Indian corn, to the effect that in some sections of southern Europe a disease known as "pellagra" was occasioned among the peasantry by its use, and it was even said that this disease had been found to exist in the armies of France, of Italy, and of Mexico, as the result of a bread ration of Indian corn. Through the courtesy of our consular officers, through whom Col. Murphy instituted immediate inquiries, he was enabled to refute this charge promptly and effectually. It was found that such a disease did, indeed, occur occasionally among the peasanty in some sections of southern Europe, which was attributed to eating preparations of Indian corn insufficiently cooked. As regards the disease among soldiers, it was learned that corn meal or corn bread forms no part of the ration of a French soldier, consequently, whatever diseases might be common in the French army, they could not possibly be attributed to this cause; while from Mexico it was learned that although Indian corn formed a part of the regular ration of every soldier, no such disease was known among them.

Some of the good results accomplished by the agitation of this corn question in Germany are to be found in the introduction, in a considerable number of mills throughout the country, including Berlin, Hamburg, Magdeburg, and other important places, of corn-grinding machinery purchased in this country. This is due, no doubt, to the fact that the rate of duty imposed upon ground corn and other corn preparations by the German Government is very high as compared with that levied upon the whole corn.

The good results of the corn propaganda, conducted at a comparatively slight expense by this Department, are most readily shown by reference to the figures of our export trade. So long as corn was used in Europe exclusively as cattle feed, its export from this country depended entirely upon the abundance of the crop and the corresponding depreciation in price, which made it cheap, even for that purpose only. Whenever the price was high, corn exports practically ceased. But if we compare the exports for the past fiscal year with those of 1890, the only year in which corn exports have been as great as in the year just elapsed, we find that whereas in that year the price at port of shipment was less than 42 cents, the price this year has been maintained at an average of over 55 cents, an advance of about 33 per cent. While it is possible that other causes may have had a part in effecting this result, still, unquestionably, it is very largely due to the earnest efforts made in recent years to introduce this cereal to the people of Europe as a suitable food for human beings, and the money value to the corn-growers of the United States, represented by this enhancement in the price of export corn, represents on the exports of the past fiscal year over $10,000,000.

I am gratified to be able to state that a very large interest has been awakened in other countries of northern Europe in regard to our Indian corn, the result no doubt of the discussion of the subject had in Great Britain and in Germany, and I shall hope, at an early date, to be able to carry on the propaganda in other countries as well as to maintain it in Germany and in Great Britain.

Congress has now awarded a more liberal, though still a very moderate, sum "to enable the Secretary of Agriculture to continue investigations concerning the feasibility of extending the demands of foreign markets for agricultural products of the United States," and I hope, therefore, to be able to push this branch of our work energetically during the present fiscal year.

REDUCTION IN COTTON AREA.

One of the gratifying features of our agricultural industry during the past year has been the marked reduction in the cotton area throughout the cotton States. One of the most difficult things to control in the agricultural industry is a fair ratio of product to demand. Every year of good prices tends to an overproduction the subsequent year, with the natural result of depression in prices, unless this be fortunately prevented by fortuitous conditions which no one can foresee or control. For the past few years the price of cotton has been extraordinarily low and the production so great that each year leaving a surplus over consumption produced finally such a plethoric condition in the market as to greatly discourage the cotton-growers. This unsatisfactory condition of affairs, however, was not without salutary effects; for it is evident now that a very considerable reduction in the area planted to cotton has taken place, the result of a determined effort on the part of the growers to limit production and to turn a portion of their land to other crops. Anything which leads to a diversification of crops throughout the country, but especially in a section devoted for many years almost exclusively to the raising of one staple crop, is to be greatly commended.

IMPORTS OF RAW COTTON.

In connection with this subject, it is well that I should call attention to the great increase which has taken place of late years in our imports of raw cotton, imports which but a few years ago were hardly known. During the past fiscal year raw cotton was imported free of duty to the amount of $3,215,303, as against $2,825,004 for the year previous and $1,392,728 for the fiscal year ending in 1890. The most of our imported cotton comes to us from Egypt, and is demanded by our manufacturers on account of the peculiar characteristics which it possesses and which are not to be found in our home-grown cottons. Some imports of cotton are also made from Peru, and I am informed, on good authority, that the entire supply of Peruvian cotton imported finds its way not into the cotton factories, but into the manufactories of woolen goods, its character being such as to make it specially available for mixing with woolen goods without detection. With a view to checking our imports of foreign cottons, especially the Egyptian, I have taken measures to undertake, with the coöperation of some of the experiment stations in the cotton States, experiments with a view to producing a cotton of home growth which shall serve as an efficient substitute for the Egyptian. I trust that in this we may be successful before the import-cotton trade increases to such an extent as to seriously affect our own cotton-growers.

CEREAL PRODUCTION AND PRICES.

As the time of the wheat harvest of 1891 approached it became apparent that there would be a heavy deficiency in the crop of certain European countries of large production and equally apparent that this country would be blessed by bountiful nature with a crop of exceptional proportions. These facts were seized upon and their importance so magnified by ordinary observers of commercial affairs that a large section of the people was led into the belief that an era of abnormally high prices for wheat was at hand. Under the effect of this belief, aided by a tendency among growers in this country to hold their wheat back, on the advice of superficial observers, there was an advance in price. The values reached were not maintained, because the wheat supply of the world did not justify them, and when the decline began it was accelerated by the increased receipts in our markets from garners which had been stored up to await the promised rise. The effort to enforce an advance injured those engaged in it and resulted in further breaking prices when the movement began.

The error which misled our producers, by inducing the expectation of a rapid advance of their wheat to a high value, arose from a failure to appreciate the changed conditions which now surround the production and marketing of the world's wheat crop. The commercial supply does not depend entirely upon the crops of a few large countries. The ramifications of commerce are so extended and the facilities for internal communication so improved in the various countries of the world that a demand will draw a supply from sources little recognized a few years since in summing up countries of production. Again, improved commercial facilities make it possible to draw heavily upon the ordinary reserves without imperiling future supplies, reducing the amount which each country must hold on hand to meet possible future domestic requirements. By this improvement India and Russia are enabled to dispose of a large part of the grain which a few years ago was stored or pitted for years of scarcity. Thirdly, the wheat crop of the world is continuous, being harvested in every month of the year. There is no absolute line of demarkation of crop years, the production of one year lapping into the distribution of another, tending to an equalization of distribution and steadying of values.

Taking the world throughout, the fat crops more than equaled the lean crops, and there was actually more wheat grown in 1891 than in 1890. Superficial observers saw only the facts in a few leading countries where the crop was deficient, but the surplus in countries which they did not take into account was large enough to overthrow their theories. Even in Russia, where famine excited our sympathies and drew from the charities of this country enormous supplies, delivered free and distributed to the starving, the exports of wheat last year were 105,000,000 bushels, nearly as much as the average of the four preceding years and decidedly more than the average for ten years, and this in spite of the period when exports of wheat from that country were entirely suspended.

Wheat values did not advance to the figures which some predicted and many expected, because the world's supply was in proportion to the world's demands. The only abnormal condition was the unequal distribution. Neither the United States nor any other single country of however great importance can absolutely command the wheat market of the world. It is a staple production in too many countries easily accessible to modern commerce.

The time has arrived when the American farmer must cease his efforts to neutralize the low price of his wheat by producing a larger quantity. He is going from bad to worse, and each effort to extricate himself by that means sinks him deeper in the mire of failure. The only proper course lies in a reduction of acreage and production to meet the demand of domestic consumption and a normal requirement for exportation. The conditions which have at last overwhelmed cotton-growers now threaten wheat-growers, and unless there is a speedy reduction by choice there will be a further parallel in a reduction by force of circumstances. But for the unusual conditions which last year prevailed in Europe our crop of over 600,000,000 bushels would have precipitated the crisis which is yet impending. So far as our own wheat-growers are concerned, the remedy is in their own hands.

The beneficial effect of customs legislation affecting barley is apparent. Our acreage and production have largely increased, and our increased crops are disposed of at prices more remunerative than have prevailed during recent years. The domestic market, which has heretofore absorbed 10,000,000 bushels of foreign barley, is now reserved for the domestic product. The crop failure in eastern Europe resulted in a demand for our rye unprecedented in the history of our foreign trade. The demand was unusual and due to causes not likely soon to recur, but a trade was initiated which might be fostered and perhaps prove the nucleus for a permanent extension in our rye exports to proportions in harmony with our capability for the production of that grain.

The American farmer's hope of remunerative prices depends upon his gauging his areas in cultivation more closely to the normal demand, and not vieing in competition with the peasant and serf labor of the entire world. Something else is wanted besides wheat and corn, or cotton and tobacco. The farmer must find other outlets for his labor, or stop his plow and rest his hoe upon the border line of production which limits living prices.

DOMESTIC SUGAR INDUSTRY.

In regard to the sugar industry and its domestication in this country, there is nothing to add to what I had to offer a year ago on this subject beyond the fact that all the experiments conducted by the Department, both in the laboratory and in the field, and at the special experiment stations established for that purpose, confirm the hopeful anticipations I then expressed as to the possibility of this country, in course of time, supplying its own sugar. Enough has been done to show clearly that in various sections of this country either beet, sorghum, or cane sugar can be produced with profit to the grower of the crop and to the manufacturer, provided the conditions of culture and manufacture indicated in the special reports made by this Department on the subject shall be observed. The difficulties that exist are those of an economic character—difficulties which it seems evident that time and necessity will gradually remove. I shall submit further on, in a detailed review of the work of the Division of Chemistry, some interesting particulars in regard to this subject.

SCOPE OF THE DEPARTMENT'S WORK.

Before proceeding to a detailed account of the work of the several branches composing this Department, I desire to present for your consideration some observations regarding the general character, scope, and object of the work of this Department, which I conceive to be not thoroughly understood, or at least not fully appreciated, by many people in this country. In order to fulfill its mission, this Department must be prepared to do with reference to agriculture all that our individual farmers are unable to do for themselves. The great blessing which this country enjoys from the fact that it is far less than some other countries the home of large landed proprietors presents to us certain difficulties which it is the province of this Department to remove. The absence of large land-owners, commanding extensive capital in our agricultural industries, necessarily limits the lines of individual experiment and investigation into those agricultural problems upon the solution of which the future prosperity of agriculture depends.

It is the duty of this Department to investigate all these problems, and in this work it is entitled to receive the heartiest coöperation on the part of the experiment stations in the various States which are recipients of the national bounty. But while the work of these must necessarily be differentiated, that of the Department must be broad enough to meet the wants of the entire country. Not only must the diseases of animals and plants and the ravages of their insect enemies be studied and investigated with a view to prevention or remedy, but the condition of soil and climate, rendering various sections specially adapted to this or that crop, must be thoroughly studied and understood. This Department must be prepared to encourage agriculture on certain lines in certain sections which are especially adapted to them, and, on the other hand, to discourage certain lines in other sections. Again, the farmer must always depend upon this Department for information in regard to what may be termed the commercial side of agriculture, the condition of crops at home and abroad, the question of the demand, and the question of the supply of all great staple crops, not only as to extent, but as to character. Only a thoughtful man, familiar with the conditions of agriculture in the country, can fully appreciate the vast breadth and scope of the work required to enable this Department to adequately fulfill the mission I have indicated.

The commission of this Department, as I may call the law under which it was originally established, is broad enough to cover any work which in the judgment of its Chief may have a bearing upon agriculture in this country; but in its practical application its work is necessarily limited by the extent of the appropriations made for its use, as well as by their distribution to special objects. While the appropriations which I have estimated for have been estimated upon the most economical basis adequate to carrying on the work already undertaken with reasonable efficiency, I desire to state emphatically that a much larger sum could be spent to the very great advantage of agriculture in this country, and I will add that I know of no way in which the people of the United States can make a more profitable investment than by supplying the funds necessary to an ample enlargement of our work, and an extension of our facilities for the work already undertaken.

NEED OF ADEQUATE COMPENSATION.

In this connection I wish to point out that the Department labors under serious disadvantage from the inadequate compensation which it is authorized to offer to the men of talent, scientific education, and experience which it needs to carry on its most responsible duties. In this respect the Department's facilities will be found to compare very unfavorably with those of the other Departments of the Government.

There are in other Departments single bureaus commanding the services of a dozen men drawing salaries exceeding by $500 to $1,500 those paid to persons performing corresponding duties or having corresponding responsibilities in this Department. In all matters pertaining to agriculture this Department should lead and not follow in the footsteps of State or private enterprise, and I submit that without greater liberality in this respect, which will enable the Secretary of Agriculture to command the services of the best-equipped men in the country for his purpose, the Department will inevitably be relegated eventually to a second place unworthy of a National Department, and which will be sure to cripple its usefulness.

AGRICULTURAL GATHERINGS.

As I have had occasion to say in former reports, one of the objects which I have sought persistently to accomplish, but only with moderate success, has been the freer and larger intercourse between the Department and the farmers, by means of adequate representation at the principal gatherings of agricultural, horticultural, live stock, and kindred industries throughout the country. It is largely due to a lack of this representation that the coöperation in the interest of agriculture which ought to exist between the various bodies representing the several agricultural industries and the State boards and colleges, etc., does not obtain. What I have been able to do in this direction with the limited facilities at my disposal has brought about results most gratifying, and, at the same time, such as afford an earnest of what might be accomplished were the Department properly equipped with an adequate force of intelligent, energetic special agents, well acquainted with the agricultural interests in their own section of country, and qualified to represent the Department creditably on all public occasions. To reach its full measure of usefulness, it is essential that the Department be brought home to the farmers in such a manner that they will be made to realize that it is their Department, and that they are acquainted with it and it with them.

REPRESENTATION ABROAD.

What has been done abroad in the interest of Indian corn shows very clearly the importance and desirability of having this Department represented in foreign countries. These representatives should be charged not only with the duty of spreading information abroad in regard to our own agricultural resources and the availability of our agricultural products for foreign use, but they should also keep this Department thoroughly informed in regard to all matters relating to agriculture and to the markets for agricultural products in foreign countries, by which our own producers could be enabled to compete with the foreign producers. To afford such representatives all the facilities they ought to have, and to secure harmonious coöperation between themselves and our diplomatic representatives abroad, they ought to be, on the recommendation of the head of this Department and with the concurrence of the Secretary of State, attached in a semiofficial character to our foreign legations in those countries where it may be found necessary to station them. Such a course has already been pursued with most satisfactory results in the case of the agent of this Department in London.

A RETROSPECT.

I shall offer no apology, in presenting to you this my fourth and last report as Secretary of Agriculture, for submitting for your consideration a brief retrospect of the work accomplished in the Department under the present administration. The passage of the law making the Department one of the Executive Departments of the Government antedated by but a few weeks your own inauguration and my assumption of the duties of Secretary of Agriculture. In consequence, the entire work of reorganizing the Department in accordance with its new dignity, and to meet the enlarged field of labor which I assume to be the most practical result of its elevation, devolved upon myself, with the assistance of the distinguished gentleman whom you selected to serve as Assistant Secretary.

In my first report I said: "It is to be assumed that when Congress in its wisdom raised this Department to its present dignity and made its chief a Cabinet officer the intention of our law-makers was not simply to add the luster of official dignity to an industry already dignified by the labor of its votaries, but to give it added influence and power for good in their behalf." It is with that sentiment ever in mind that I have proceeded in the discharge of the responsible duties imposed upon me. I may venture to recall the fact that the work of reorganization was made none the less arduous for the reason that the appropriations at my disposal, not only for the fiscal year in which I assumed office, but for the fiscal year following, had been made for the Department under its old régime, no further provision being made for it as an Executive Department than the appropriation for the salaries of the Secretary and Assistant Secretary in lieu of the salary formerly paid to its Commissioner. A brief enumeration of the practical features added to the work of the Department since March, 1889, can not fail, I think, to satisfy the most exacting friend of agriculture of the earnestness with which I have sought to increase the utility of the Department and promote the interests of American agriculture.

My first step in the work of reorganization was to divide the Department into two grand divisions, one embracing all branches which involved administrative and executive features, which I retained under my personal supervision, the other embracing those branches engaged purely in scientific investigations, the immediate supervision of which I assigned to the Assistant Secretary. In accordance with this division my personal attention was devoted to the enlargement of the scope of work in the interest of practical agriculture, and particularly to three principal objects: The extension of the market for the disposal of the surplus of our great staple crops and of our vast animal products; the enlargement of our productive capacity with a view to substituting as far as possible home-grown for imported products; and to bringing the Department into such close relations with the farmers as would make them acquainted with our work, inspire them with confidence in our ability to serve them, and impress more forcibly upon the responsible officers of the Department themselves the wants and conditions of the tiller of the soil.

The great enlargement of the scope of work assigned to the Bureau of Animal Industry, which resulted in compelling me to thoroughly reorganize it administratively a little over a year ago, has been especially marked along the lines of the first of these objects. The thorough control of contagious and other cattle diseases, involving a careful and systematic regulation of our cattle traffic, and achieving, I am glad to say, the complete eradication of the most serious of the diseases with which our cattle industry was threatened; the comparative immunity obtained from the ravages of Texas fever among Northern cattle, and the establishment of a great system of national cattle and meat inspection with the twofold object of guarding our cattle from the possible introduction of communicable diseases and of opening the markets of the world to our meat products—these of themselves furnish sufficient cause for congratulation as the work of one administration. The great results of this work and the benefits secured to our cattle-growers and the live-stock interests generally I have already sufficiently emphasized in this report.

The extension of our Division of Statistics so as to cover the agricultural resources of other lands, and the demand of foreign markets for products which it was in the power of the American farmer to produce, marks another and important step in the same direction; and to this I may add the establishment of an efficient agency in Europe for the investigation of the feasibility of extending markets abroad for American agricultural products, which, for obvious reasons, as already explained, has been directed chiefly to the introduction of our Indian corn to the people of Europe as a cheap and economic substitute for other cereal foods. In the efforts for the substitution of home grown for foreign products in our own markets the development of a domestic sugar holds an important place, and it is, I am gratified to say, the work of the past three years in this direction which has placed our domestic sugar industry upon a footing which justifies and invites the extension of private capital and individual enterprise to its development.

The development of the fiber investigation from the point of simply gathering information in relation thereto to the extent of practical investigation and experiment has been accomplished, and affords marked encouragement for the hope that the time is not far distant when a large proportion of the enormous sum now paid to foreign producers for vegetable fibers and their manufactures may be diverted to the pockets of our own farmers.

Investigations into the resources of the Rocky Mountain region, together with the vast amount of information collected and published in regard to our facilities for irrigation both from surface and subterranean supplies, and extensive experiments in the production of grasses and fodder plants within the limits of the vast territory, embracing not less than 300,000,000 acres, outside of irrigable limits, and which, as I have shown, promise a reasonable degree of success, the value of which to the country can hardly be overestimated, and the important and highly satisfactory efforts made in the prevention or remedy for plant diseases and in checking the ravages of the insect enemies of plant and animal life—these represent fairly some of the more important work accomplished towards the development and extension of our own domestic production.

Of the twelve divisions of the work which I found in existence on assuming control of the Department, one which was then but a section of another division, Vegetable Pathology, has become a separate and distinct division, the importance and value of which has been widely recognized by horticulturists throughout the country, while one, the Silk Division, has been discontinued owing to the refusal of Congress to make the necessary appropriations therefor. Many new divisions have, however, been organized. One of these, it is true, the Office of Experiment Stations, had been called into being a short time before my assumption of office, under section 3 of the act of March 2, 1887, which established the State experiment stations. It had, however, practically just begun its work, and its entire organization and development has been a part of the work of this administration. Its utility as the connecting link between this Department and the stations and on behalf of the stations has been shown by the unanimity with which the directors and officers of the various stations have sought to have its appropriations increased; and while this has been done, so that to-day the appropriation for this branch of our work is twice what it was in 1889, its labors have been so far extended that the sum devoted from the printing fund of the Department to its work in the line of publications alone exceeds the original appropriations made for it.

The Division of Records and Editing is an entirely new division, and one which has had a large share in increasing the influence and the efficiency of the Department and at the same time in effecting much needed modification in its publications and exercising general supervision over its publishing interests so as to promote in a marked degree the advantageous and economic use of the printing fund. The increased appreciation of the character and utility of the Department publications has most fortunately led, in accordance with my repeated representations, to a large increase in our printing fund, the careful and economic administration of which, however, has been such as to secure a far more than corresponding increase in the number of our publications, to say nothing of the general improvement in their character, an improvement which has been especially directed to subserve the needs of the practical farmers of the country.

The work of the Division of Forestry has been so systematized and extended as to largely extend both the influence of the division itself and to awaken widespread and most gratifying interest among the people of this country in regard to the important subject of our forest resources, the preservation of our forest supplies, their condition and character, and the climatic influences of our forests, while, thanks to the enlightened initiative of the Chief Executive, important steps have been taken in the direction of administering many of the forest lands of the Government in accordance with the principles of economic forestry.

One of the most important additions to the work of the Department has been made in the transfer to it of the Weather Bureau, a transfer calculated to greatly extend the work of the Bureau itself for the benefit of agriculture and supplying opportunities for the much-needed coöperation of this branch of the service with the work of several of the other divisions of the Department—a transfer, indeed, which was absolutely essential in order to successfully conjoin studies of animal and plant life with that of the soil and climatic conditions, and, I may add further, a transfer which has elicited most gratifying evidences of general approval in all sections of the country.

To enumerate even a small proportion of the valuable publications issued during the past three years would be impossible within the limits of this report. They have been many, varied, and most useful to the agricultural interests, and, while the information to the practical farmer has been, as I believe it ought to be, my chief care, the interests of scientists and the students of agricultural science have been by no means forgotten. Congress itself has shown a high appreciation of the value of some of these publications by ordering their reproduction in very large editions for distribution by Senators and Representatives, and I am gratified to be able to state that educational establishments and agricultural associations throughout the entire country have shown a steadily growing and keen appreciation of the publications of the Department and of their educational value.

In concluding this review of the work of the Department under your administration, I may properly say a word in regard to the earnest effort which has been made to administer its affairs with due regard to economy. References to great increase of the annual appropriations of this Department during the past two years have been not infrequent, but I think it will surprise those who have taken these references at their face value without much thought and consideration of the facts underlying them to learn that, after deducting the appropriation for the Weather Bureau, which was not an increase but a transfer, and the appropriations necessitated under the law endowing the State experiment stations, over which the head of this Department exercises no control whatever, the total sum remaining of the present year's appropriations barely exceeds the total appropriations of the Department, less experiment station work, for the fiscal year ended June 30, 1889. And this in spite of the fact that the present appropriation includes sums devoted to special features of the work not then in existence nor even contemplated, such as fiber and irrigation inquiries, extension of foreign markets, rainfall experiments, etc., to say nothing of the large sum necessarily devoted to the work of meat inspection. I will candidly admit that the restriction of the appropriations for the work of this Department within these narrow limits is not my fault, but I think that it is not unreasonable that I should take some credit for the accomplishment of the objects which I have enumerated within the limits to which I was restricted by a want of greater liberality on the part of Congress.

BUREAU OF ANIMAL INDUSTRY.

This year marks the successful accomplishment of the work undertaken by the Bureau of Animal Industry in 1887 and continued without intermission until the present time, in its struggles to effect the complete eradication from the United States of the disease known as contagious pleuro-pneumonia. It tells a story of what untiring patience and firm determination will accomplish, and it proves to the people of the United States that, in spite of all obstacles, oftentimes of unjust criticism, and of virulent opposition in some sections, our officers have succeeded in doing what at the outset was declared by many to be an impossible achievement. So long a period has passed since the country was thrown into excitement by reason of the discovery of this disease in the great cattle centers of the West, and since its effectual eradication from that center, together with its confinement to a restricted area in the East, that even stock-owners themselves will perhaps fail to realize the importance of the work accomplished.

When we realize, however, the extent of the losses entailed in other countries by the existence of this disease and the well-nigh insurmountable difficulties which have attended their attempts to extirpate it, and when we appreciate, moreover, the benefits to our stock-growers from restored confidence in our export-cattle trade due to our immunity from this disease, and the evidence we have given of our ability to control diseases of cattle, the appreciation of the lasting value of the work accomplished by the Bureau since its establishment in this respect alone will certainly meet with very general recognition. From the introduction of pleuro-pneumonia into Great Britain up to 1869, England had lost, according to reliable estimates, almost exclusively from this disease over five and one-half million head of cattle, worth in round numbers $400,000,000, and, judging by the records of the ravages of the disease in that country since that date, we may put the total losses, on a very conservative estimate, at $500,000,000 in deaths alone, without counting the many contingent expenses in the way of deteriorated health, loss of markets and of progeny, disinfection, quarantine, etc.

In addition to all these losses, Great Britain paid out for a period of seven years expiring with 1890 the sum of $1,624,737.06 for cattle condemned and killed on account of this disease; and yet, notwithstanding the restricted area of the British Isles and the energy in fighting the disease which such figures would indicate, there would seem to be a very general impression existing throughout Great Britain that eradication is hopeless, and that all the Government can accomplish is to limit the loss and damage by a more or less efficient control. We have no reliable statement showing the total cost to the British Government of the war which it is compelled to wage incessantly against contagious pleuro-pneumonia, the only figures available being those for the slaughtered cattle. Taking these figures, however, as a basis for comparison, the cost of the work of eradication in the United States has been very moderate. The total expenses, including the purchase of diseased and exposed animals, together with all salaries and traveling expenses and the various miscellaneous expenses connected with quarantining and policing the States in which the disease existed, have amounted to but $1,509,100.72, being in round numbers $115,000 less than the bare cost of the cattle killed by Great Britain.

The following is the text of the proclamation in which I made public the fact of the eradication of pleuro-pneumonia, and announced the raising of the quarantines heretofore existing in certain counties of the States of New York and New Jersey:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

To all whom it may concern:

NOTICE IS HEREBY GIVEN that the quarantines heretofore existing in the counties of Kings and Queens, State of New York, and the counties of Essex and Hudson, State of New Jersey, for the suppression of contagious pleuro-pneumonia among cattle are this day removed.

The removal of the aforesaid quarantines completes the dissolving of all quarantines established by this Department in the several sections of the United States for the suppression of the above-named disease.

No case of this disease has occurred in the State of Illinois since December 29, 1887, a period of more than four years and eight months.

No case has occurred in the State of Pennsylvania since September 29, 1888, a period of four years within a few days.

No case has occurred in the State of Maryland since September 18, 1889, a period of three years.

No case has occurred in the State of New York since April 30, 1891, a period of more than one year and four months.

No case has occurred in the State of New Jersey since March 25, 1892, a period of six months, and no case has occurred in any other portion of the United States within the past five years.

I DO THEREFORE hereby officially declare that the United States is free from the disease known as contagious pleuro-pneumonia.

J. M. RUSK,
Secretary.

Done at the city of Washington, D. C.,
this 26th day of September, A. D. 1892.

The following table presents in summarized form the total of herds and cattle inspected in the several States, the post-mortem examinations made, the premises disinfected, together with the diseased and exposed cattle purchased and slaughtered:

Summary.

	Illinois.	Maryland.	New York.	New Jersey.	Pennsylvania.	Grand total.
Total number herds inspected	7,551	30,627	65,192	51,330	12,251	166,951
Total number cattle inspected	24,344	306,152	610,754	421,495	242,976	1,605,721
Total number cattle tagged	....	33,746	211,109	68,778	53,333	366,966
Total number post-mortem examinations	8,979	33,048	96,422	40,734	177,221	356,404
Total number diseased on post-mortem	354	1,720	4,321	954	89	7,430
Total number premises disinfected	678	326	2,161	840	123	4,128
Total number diseased cattle purchased	176	1,974	3,347	844	63	6,404
Total number exposed cattle purchased	999	2,930	9,019	2,467	142	15,557

NOTE.—To the items "Total number diseased cattle purchased" and "Total number exposed cattle purchased" are to be added the following purchases in States other than the above-named: Vermont, Massachusetts, Virginia, and District of Columbia 45 diseased animals, making a total of 6,449; Vermont, Massachusetts, Virginia, and District of Columbia 57 exposed animals, making a total of 15,614.

TEXAS FEVER.

The regulations made during the past year for the movement of Southern cattle for the purpose of preventing the spread of Texas fever was issued February 26, 1892, and were substantially the same as those which governed the movement of Southern cattle during the season of 1891, with the exception, however, that the quarantine line was changed. The line was run so as to take in the larger portion of the Panhandle of Texas, which had been represented to the Department as being free of infection, and permitting cattle from one tier of counties to be moved into the States of Colorado, Wyoming, and Montana for feeding purposes. This was done at the earnest solicitation of the officers of these States. On June 13 the Department modified the quarantine line and these regulations, so far as they applied to the State of Virginia, by an order excluding the counties of Orange, Albemarle, Greene, Nelson, and Amherst from the infected area, and permitting the cattle from said counties to go north free of restriction.

On July 5 the permission granted for the shipment of cattle from certain counties in Texas, to Colorado, Wyoming, and Montana, for feeding purposes was extended, under the same conditions, to South Dakota. The regulations concerning cattle transportation have been as rigidly maintained as possible under the existing law. Notwithstanding these regulations, however, and the efforts made to compel compliance therewith, Texas fever has, to a modified extent, appeared in some sections of the country; but with one exception, in Kansas, the cases have been unusually few, and, as a rule, isolated. Large outbreaks, so often the rule in former seasons, have not occurred, and the cases found have been very few in number. One of the difficulties met with, notwithstanding the regulations, is that this Department is not able to follow cars of Southern cattle shipped and marketed for slaughter under the law to the various points to which they are consigned. A large corps of inspectors has been maintained at all the large stockyard centers at which Southern cattle are received, and, whenever possible, the authorities of States to which cars containing Southern cattle were destined have been informed of their shipment, so that they might deal with these market cattle in such a manner as to protect cattle interests in the localities to which they were consigned. In some instances, however, the State authorities have failed to enforce measures necessary to guard the movement of cattle from the cars to the slaughterhouse, and to this cause I attribute the occasional appearance of Texas fever in some localities.

I desire to renew my suggestion that legislation be provided to compel railroad companies to comply with our regulations for cleaning and disinfecting cars that have carried Southern cattle, and to provide penalties for the violation of the regulations made to insure the safety of the cattle of this country. If a law could be enacted to compel the use by transportation companies of cars for the sole use of Southern cattle, not to be used for transporting any other animals or merchandise during the fever season, and requiring such cars to be marked or painted with a distinctive color, so that they might be at once distinguished from other cars of the cattle traffic, it would go a long way towards preventing the spread of this disease.

INSPECTION OF EXPORT CATTLE.

This work has been continued under the provisions of the act of Congress of August 30, 1890, in the manner described in the last report made by this Bureau. The number of cattle inspected at the principal stockyards, namely, Chicago, Buffalo, Baltimore, Philadelphia, Indianapolis, and Pittsburg, during the fiscal year ending June 30, was 431,400. Of these the number tagged for export was 285,984. The number of steamships inspected for the year was 917, and the total number of cattle inspected and shipped from the ports of New York, Boston, Baltimore, Philadelphia, New Orleans, Portland, Norfolk, and Newport News, was 389,480, an increase of 7½ per cent over the exports for the preceding year. The system of tagging, adopted for the identification of animals, lest any of these should arrive in Great Britain affected with disease, and which it might be desirable to trace to the place of origin, has been found perfectly effectual, and no difficulty is experienced, whenever necessary, in tracing the origin of any individual animal and locating it on the farm whence it was purchased.

The vessel inspection authorized under the act of Congress of March 3, 1891, has been continued in accordance with the regulations made under this act, June 6, 1891, to insure the safe transport and humane treatment of cattle in their voyage across the Atlantic. Of the whole number of vessels inspected (917) 382 sailed from New York, 240 from Boston, 153 from Baltimore, 78 from Philadelphia, 35 from Newport News, 5 from New Orleans, and 24 from Portland. The beneficial result of this inspection and of the enforcement of the regulations referred to is shown by the fact that for the fiscal year ending June 30, 1892, the percentage of loss of cattle in transit, including all causes, was but seven-eighths of 1 per cent, a considerable reduction from the percentage of losses for the year ending June 30, 1891, which was 1⅗ per cent.

AMERICAN CATTLE INSPECTION IN GREAT BRITAIN.

The American veterinarians located at the foreign animals wharves at Great Britian by the courtesy of the British authorities have continued to inspect American cattle landed in that country. During the past year the British authorities have in four instances claimed to find contagious pleuro-pneumonia among our cattle. In each of these cases their diagnosis was disputed by the American inspector. In one of these cases, at least, the diagnosis of the American inspector, Dr. Wray, who declared the animal suspected of having contagious pleuro-pneumonia to be suffering simply from catarrhal pneumonia, was sustained by Profs. Brown and Duguid and Dr. Cope of the Royal College, after several days deliberation. In each case, as soon as the tag numbers of the animals were received at this office, an investigation was undertaken to ascertain their history. Each animal was traced from the port of export, through the stockyards where tagged, to the farm upon which it had been raised, with the result that no disease was found on the farms from which the animals came, or among the animals with which they had come in contact, or in any part of the country through which they had passed en route to the port of export. The history of the animals, therefore, did not sustain the position of the English veterinarians, but was quite in accord with that of the American inspector.

It may be further noted that the same fact exists as was stated in my last report, that these alleged cases of pleuro-pneumonia claimed to have been found by the British authorities occurred during the winter and spring months, at a time when cattle in course of transportation across the Atlantic are exposed to storms and severe cold weather, tending to develop lung trouble and pneumonia of a noncontagious character. The total number of cattle inspected by our veterinarians in Great Britain during the fiscal year was 368,014.

INSPECTION OF IMPORTED ANIMALS.

This work has been carried on under the provisions of the act of Congress of August 30, 1890, in the manner detailed in my last report. During the past year the outbreaks of foot-and-mouth-disease among sheep in Great Britain necessitated the suspension by this Department of the issuing of permits for the importation of this class of animals into this country. This suspension of permits is still maintained and will be so maintained until the Department is fully satisfied that this dangerous scourge has been thoroughly suppressed in Great Britain and there is no likelihood of its importation into this country. Some criticism has been made upon our refusing permits for the importation of sheep owing to this cause, and particularly from the fact that we refused permits after an official statement had been made by the authorities of Great Britain that this disease had been extirpated from that country. The wisdom, however, of the action of the Department in requiring a longer time to elapse after the alleged suppression of the disease was shown by the fact that the disease again broke out in Great Britain and appeared in several places.

The total number of cattle inspected under the act was 2,673; of sheep, 373,517; and 74 head of swine. Of the cattle, 2,001 were en route to Boston for export. This, of course, does not include imported live stock received at the quarantine stations on the seaboard.

MEAT INSPECTION.

At the time of my last report twenty-two abattoirs were having their products inspected under the regulations of the Secretary of Agriculture, made March 25, 1891. At the present time the number of establishments provided with meat inspection has been increased to thirty-eight, and arrangements are still being made to extend the inspection to other applicants.

The total number of animals examined under the regulations, both by ante and post mortem examination, and the products of which have been marked for identification in the manner prescribed by the regulations, was, for the fiscal year ending June 30, 1892, 5,076,929. Of this number 3,167,150 were cattle, 1,267,329 were hogs, 583,361 were sheep, and 59,089 were calves. There were 1,990,771 quarters of beef tagged for export and 8,160,625 for interstate trade, and 688,176 carcasses went to canning establishments. There were stamped and marked for identification, in accordance with the regulations, 797,707 packages of canned, salted, and smoked beef products. Out of the 3,167,150 head of cattle inspected 141 were condemned on ante-mortem examination and 1,914 on post-mortem examination, and 187 sheep were condemned on post-mortem examination. Out of the 1,267,329 head of hogs inspected microscopically there were found 25,899 animals affected with trichinæ, about 2 per cent of the whole number inspected.

Of the nearly 40,000,000 pounds of inspected pork products exported about 50 per cent has gone to Germany and the remainder to Belgium, Great Britain, Holland, France, Denmark, Norway and Sweden, Italy, and Spain, in quantities ranging from 7,000,000 pounds to Belgium, down to less than 5,000 pounds to Spain, and in the order of the countries named. It is very probable that the exports credited to Belgium and to England and Scotland find their way to the German and French markets, as these are forwarded to houses in both Belgium and Great Britain for orders from French and German merchants. I may state here that a preference has been shown among a certain class of customers in both the British and our own home markets for inspected products, these commanding, in some cases, from half a cent to 1 cent more in price than the uninspected. As regards the cost of meat inspection, it has amounted for the fiscal year ending June 30, to $279,508.37. There has been a steady increase, of course, from month to month, as the number of establishments provided with meat inspection has been increased, and a further increase must be provided for in the future. Of other expenses entailed on the Bureau by the recent inspection laws, that for export cattle inspection, amounts, for the fiscal year above mentioned, to $90,542.36.

ANIMAL INDUSTRY PUBLICATIONS.

During the first session of the Fifty-second Congress that body ordered a second special edition of the Report on the Diseases of the Horse for the use of Senators and Members of Congress. This edition, numbering 45,000, makes the total number of copies of this valuable work published amount to 185,000, in spite of which the supply available for distribution is already practically exhausted.

Two reports somewhat analogous in their character to that just mentioned, and relating to cattle and sheep, will be ready for distribution during the present calendar year. They will, I am convinced, be found fully as useful to cattle-growers and sheep-raisers as the Report on the Diseases of the Horse is to horsemen.

Another bulletin is just completed and ready for the printer. It covers the investigations carried on in the laboratory of the Bureau during the years covered by the present administration in regard to Texas fever, investigations which have resulted in some most important discoveries, especially to that phase of the disease which has so long been the puzzle of pathologists, namely, the manner of its communicability. These discoveries will have a most important bearing upon the feasibility of controlling the disease, and, it is hoped, of absolutely preventing its spread.

DIVISION OF STATISTICS.

The data collected in this division with reference to our domestic agricultural production indicate, as the result of the season of 1892, an agricultural production ample for the wants of 65,000,000 people of a higher standard of living than that of any other nation, and of a surplus of breadstuffs and meats, dairy products, cotton, and tobacco sufficient for a moderate supply of the requirements of foreign nations, with little danger of glutting markets and depressing prices. On the contrary, the adjustment of supply to demand promises to advance rather than to depress values.

The greatest of the products of arable cultivation—maize—which averaged 1,184,486,954 bushels in the decade ended in 1879 and 1,703,443,054 in that ended in 1889, an increase of 43 per cent, will produce only a moderate supply, insuring a much higher price than has ruled for the past year, and still sufficient, with the old corn available, for all its various uses, in all the protean forms of its secondary products. The planting was late, early development slow, yet the length of the season, the absence of frost in September, and a favoring temperature so counteracted the earlier influences of the season as to insure a medium quality and somewhat enlarge the expectation as to quantity.

It is eighteen years since this country won from France the first place in aggregate wheat production; last year the crop of the United States was nearly double the average production of France. The crop was by far the largest annual production of this best of food grains ever grown in any country of the world. The French crop of last year was only a few million bushels larger than our exportation. The Indian crop last harvested did not equal our exports, and no other country produced as much as the United States spared of its surplus. The crop of 1891 was not only the largest in aggregate, but the largest in yield per acre ever grown in the United States. While this yield was largely the result of very favorable meteorological and soil conditions, it affords gratifying evidence that a wheat famine in this country is not imminent, that our soils are not deteriorating, or rate of yield of wheat declining.

The crop of the present year has been harvested in good condition, a medium rate of yield and a good breadth, affording a supply for consumption, and an exportation at least half as large as that of last year, and quite equal to that of any of the four preceding years.

The season was unfavorable for seeding of oats; excessive rains were a serious hindrance to early growth, and drought, rust, and blight were deleterious incidents of the late season, reducing the ultimate yield, which is therefore slightly below a medium figure. Good prices are assured for this valuable crop.

Barley, the only cereal, rice excepted, of which there has been a deficient supply in later years, promises a yield above the average, above that of 1890, but not equal to the large crop of last year. The increase of area, since 1890, has greatly reduced imports from Canada, enlarged the domestic market, and benefited the farmers from New York to Dakota.

The efforts of this division have been for some time directed towards a salutary reduction of the cotton area. These have this year been measurably successful, and prices have been slowly advancing since the investigation showing such a reduction to have been made. Further advance can only be prevented by a larger production than seems at present probable. The crop will be materially smaller than those ot either of the two preceding years.

During the year the crop report has been separated from the general report of the Statistician as being more ephemeral in character and requiring more prompt issue than miscellaneous statistics. It is now sent to press on the 10th of each month, an edition of 20,000 issued, and at the same time a four-page synopsis of the same, with an edition of 125,000 copies, especially intended for the information of farmers and issued in advance of the full report, in part usually mailed on the 11th, containing the results of an investigation on two continents perfected from the forwarding of primary data to issue of coördinated results in ten days, probably the speediest execution of official investigations of equal breadth in any country.

During the past year much labor and effort have been expended in obtaining material for a history of prices of agricultural products. A part of this investigation has been made at the request of the Finance Committee of the Senate, including monthly prices for June, 1889, to September, 1891, for primary markets in each of the States, and quarterly prices of the principal farm products in New York, Cincinnati, and Chicago, for fifty years.

New editions have been issued of the Albums of Agricultural Statistics, cartographic illustrations in chromolithograph of the more important results of original work in statistical investigation, which have found favor in all grades of educational institutions, from primary schools to universities, and in popular libraries.

No small amount of labor has been necessary in satisfying the requirements of international courtesy, through foreign governments and representatives of foreign institutions and interests, for information concerning the resources and productions of this country, and for our methods of crop-reporting, which have commanded the attention and excited the admiration of foreign officials and editors.

A special section has been established in the division for the collection and distribution of information calculated to enlarge our exports of agricultural products to the countries of Latin-America, which, in accordance with the letter of instruction ordering the same, shall be devoted especially to an investigation of the character, extent, and prices of the imports into Mexico, the Central and South American States, and West Indies of agricultural products such as are or may be grown in the United States, and to the feasibility of extending our exports of agricultural products into these countries, the requirements of their markets, and the best methods of extending this trade.

DIVISION OF CHEMISTRY.

Investigations with sugar-producing plants have been carried on at four stations and in the laboratory of the division. During the spring of 1891, fifteen thousand packages of sugar-beet seed were sent to about eight thousand farmers in all parts of the country. Accompanying the seed were directions for planting and cultivating the same, and taking samples for analysis. Franks were sent for returning the analytical samples to the laboratory for examination. Several thousand samples of beets were received in this way from all parts of the United States, chiefly from the central northern States of Iowa, Wisconsin, Michigan, Indiana, Nebraska, and North and South Dakota. As the beets were analyzed a report of the character of each was sent to the person from whom the sample was received. All the analyses were tabulated by States and counties and published with the average for each State in Bulletin No. 33. While there is considerable value attached to investigations of this kind, they fail to disclose the true possibilities of any locality for the production of sugar beets. This failure is due to many causes, the chief of which are the lack of attention to details on the part of the farmers growing the beets, lack of care in sampling them, and deterioration of the beet from the time of harvesting until it reaches the laboratory for analysis. Much more accurate results are obtained by studying the possibilities of sugar-beet culture in a station established especially for that purpose. In many States such stations have been established, notably in Iowa and Nebraska.

The work of the Department, carried on at a station, was conducted at Schuyler, Nebr. Different varieties of sugar beets were planted at this station, carefully cultivated, and systematically sampled and analyzed. The results were in a high degree satisfactory. An average yield of 21 tons per acre was obtained, with an average percentage of sugar of about 13. Considering that this was the work of the first year, the results are gratifying. During the present summer this series of experiments has been continued at the same place and the results, in so far as known, bear out the favorable reports of last year's work. In addition to the work in the culture of the beet during the past summer, special experiments have been made in the production of native-grown beet seed at the Schuyler station. Typical beets were preserved during the winter in silos, and in the early spring were subjected to analysis and classified according to their sugar content. All those showing 12 per cent or less of sucrose were planted together as one class; all those showing from 12 to 14 per cent were planted as the second class, and those above 14 per cent as a special class. Seed from all these varieties has been harvested. The seed from the first class will be used for general planting for the production of beets for manufacturing purposes, while that from the second and third classes will be used for the propagation of special varieties of beets rich in sugar.

Work in the improvement of sorghum cane has also been carried on experimentally with most favorable results, both at Sterling and Medicine Lodge, Kans. The results of the present season, which are not yet all tabulated, are sufficiently abundant to show that the method of scientific selection which has been pursued is still successful in establishing standard varieties of sorghum very rich in sugar and suitable for manufacture. It seems somewhat strange that with a plant which has been developed as the sorghum has been under the careful work of the Department, capital has not been forthcoming to apply practically the principles which have been established. There yet remains, however, to be established a first-class sorghum factory in a locality favorable to the growth of sorghum, capable of demonstrating the high commercial value of sorghum as a sugar-producing plant. It is believed that the extremely favorable results of this year's work will demonstrate to men of capital the practicability and possibility of investment in this industry.

Experiments have also been commenced and continued in Florida, on the peat soil, recovered by drainage, in the cultivation of sugar cane as a sugar-producing plant. The experiments, however, are yet in their infancy and the results are not definite. Many obstacles have been met which have retarded the success of the experiments; chief among them are the ravages of insects, cane borers, etc., on the crop. It is believed that these pests are now under control, and it is expected that the present year's work, which will be finished in January or February of next year, will show definitely the great possibilities of this locality for sugar production.

The work in the investigation of food adulteration has been pushed forward with vigor. The amount of chemical work which has been done on this subject is perhaps the largest of any similar chemical work anywhere in the history of science. Since the last annual report two additional parts of Bulletin 13, devoted to food adulteration, have been published, viz, Part 6 devoted to the investigation of the adulteration of sugar, molasses, and honey, and Part 7 treating of the subject of the adulteration of tea, coffee, and chocolate. The results of these investigations have been of the greatest practical interest. In the case of sugar it was found that there was practically no adulteration. With molasses almost all the fancy brands were found to be adulterated with glucose. With honeys, over 45 per cent were found to be adulterated with glucose. Teas were found to be faced with mineral and coloring matters, so that poor and spent leaves would have the appearance of the best article. Coffee was found to be adulterated even in the berry by artificial grains and in the ground state largely by chicory and other cheap substances. Chocolate was found largely mixed with sugar and starch.

The general results of the investigations show the great extent to which the American consumers are cheated in buying foods of the character noted above, emphasizing the necessity of some national law by which the exportation of adulterated articles of food from one State to another can be prevented. The work is continued at the present time and investigations are now making on canned foods, both vegetables and meats, all kinds of preserved foods, and on flour, bread, biscuit, and cakes. These investigations will be pushed forward as rapidly as possible, and it is hoped that the publication of the results may be secured before the issuing of another annual report.

The miscellaneous work of the division has not been of any great public importance. It has consisted in the analysis of numerous samples of soils, fertilizers, and miscellaneous food products. Such work is undertaken for the benefit of individual farmers or communities, and not in the pursuit of any systematic method of investigation.

The needs of a special laboratory of much larger dimensions than the one occupied are very much felt, as the crowded condition of our building will show. In general, the work of the division has been satisfactory, the different members having been industrious and efficient, and the work has been done in a manner satisfactory to all concerned.

DIVISION OF ENTOMOLOGY.

The investigations of this division have been carried on under the unavoidable disadvantages resulting from a considerable reduction in its annual appropriation. Within the limited directions, however, the results obtained have been important.

The correspondence has comprised upwards of 4,000 letters, exclusive of many answered by circular, and the branch of the work consisting of the examination and determination of species for station entomologists and others doing original work has been particularly extensive. Some 4,000 species have been examined and named in this way.

On the whole, the year has not been marked by very great damage from insects injurious to agriculture, but a number of species have been investigated and discoveries of practical importance have been made.

The anticipations of the Entomologist regarding the nonabundance of destructive locusts or grasshoppers the present season, as indicated in my preliminary report of last year, have been fully verified. The energetic work of last season and the present spring in Minnesota and North Dakota has resulted in the practical stamping out of the swarms of the Rocky Mountain locusts which settled there last season, while of the local or nonmigratory species, many of which did great damage in restricted portions of the country last summer, little has been heard the present season except in limited parts of southern California, a result due both to the great increase of natural enemies and to wet weather at critical periods in the life history of the insects.

The agent of this division sent to Australia in coöperation with the California State Board of Horticulture, for the purpose of collecting and sending to California insects which might possibly prove of benefit to the horticultural and agricultural interests of the Pacific slope, remained abroad for about one year, and during that time forwarded to California a very large number of living predaceous insects, the most important of which are enemies of the red scale, the black scale, and the woolly root louse of the apple. These insects have been received and colonized at Los Angeles and other points in California by another agent of the division. The present outlook is only moderately promising. The newly imported insects do not breed as rapidly as did the *Vedalia cardinalis*, which was imported three years ago for the purpose of exterminating the white or fluted scale, and it seems probable that there will be no repetition of the astonishingly beneficial results produced by the *Vedalia*. The importation of these new insects has caused a division of opinion among California horticulturists, some urging the futility of further remedial work until the new importations be given a chance to multiply and destroy the destructive species; others urging that it would be suicidal to abandon spraying and fumigating until it has been proved upon a small scale that the Australian insects will accomplish the results hoped for. Wisdom dictates a middle course, such as the reservation of certain orchards for the uninterrupted experiment with the Australian introductions, while the ordinary insecticide means continue to be pushed for the protection of orchards generally.

Three successful sendings of *Vedalia* to other countries in which the fluted scale has not yet succumbed have been effected during the year. These have included Cape Colony, South Africa, Egypt, and New Zealand. In Egypt they have been found to breed rapidly and to prey upon a destructive scale insect congeneric with the fluted scale of California. In New Zealand such good results have been accomplished as to elicit resolutions of thanks and appreciation at a meeting of fruit-growers held at Nelson in July.

It seems probable that the importation of the European parasite of the Hessian fly, referred to in my last report, will result in benefit to our wheat-growers, although it may be some years before the presence of the introduced parasite in numbers is made manifest.

An important result of the work of the season is the discovery of the eggs of the American ox bot, and the confirmation of the hitherto unproved theory that the young maggots do not burrow directly into the skin, but find their way to the points from which they emerge when full grown by means of the mouth, the œsophagus, and the subcutaneous tissues of cattle. The interesting fact is also settled that the ox bot fly of Europe does not occur in this country.

Several new importations in the way of injurious insects have been investigated, among them a small moth whose larva damages potatoes both in the field and when stored, and a new scale insect infesting the olive. It is hoped that by timely information and warning the spread of these undesirable immigrants may be averted. A careful study has been made of the life histories of the pea and bean weevils and a number of interesting, practical, and scientific points have been ascertained.

The records of the division indicate that the life histories of two-hundred and fifty new or nearly new insect pests have been studied to a greater or less degree during the year. One of the most interesting of these is a caterpillar which attacked the sugar beets at the Department experiment station at Schuyler, Nebr. Experiments have shown, however, that it is rapidly destroyed by arsenical poison.

The investigation of the bollworm has been completed. A number of new facts have been ascertained and experiments have proved that while contagious germs can not be practically used in the case of this insect, feeding as each individual does in an isolated manner, trap crops may be used practically with the best results.

Efforts have been made to introduce a fungous disease of the European white grub and to use it against the American white grub, which is related, although differing both specifically and generally. The spores of this fungous disease are on sale in France and several tubes were sent to this country and tested by the Entomologist in the laboratory at Washington and in the field at Ames, Iowa, and Lincoln, Nebr. In one case only the grubs were successfully inoculated, the disease appearing and the insects becoming covered with the fungus. At the present time, however, no evidence of transmission from such grubs to others not treated directly has been found, even when those inoculated were confined in the same breeding jars with healthy grubs. The life histories of our different white grubs have also been studied. This is a part of a series of observations begun last year and which will require at least three years for completion.

The work in apiculture continued up to the 1st of July. Up to that time, however, several important experiments had been made, including experiments in the evaporation of honey by artificial apparatus tending to prove that this can be done profitably; experiments in planting for honey showing that this process does not pay; the feeding of extracted honey for the production of comb honey, and several others of almost equal importance.

The publications of the division during the year have been, in addition to the regular issue of Insect Life, a bulletin consisting of reports of observations and experiments in the practical work of the division, and another presenting reports on the damage by destructive locusts during the season of 1891.

DIVISION OF BOTANY.

During the year large additions have been made to the National Herbarium under the care of this division. Not less than 12,000 specimens have been mounted and labeled and distributed into the permanent collection. Fifteen thousand specimens have been distributed to the herbaria of the experiment stations and colleges of the several States. Altogether, more than 50,000 specimens have been secured through the collectors employed by the division, or by exchange. The publication work of this division during the past year has been important. It has included the second part of a Manual of the Plants of Texas, which will be found a convenient and helpful work in determining the plants of this region. There was issued also the first part of a Monograph of Grasses, a work which will contain descriptions of all the known species in North America, of which there are nearly 800. Several other valuable bulletins have been issued specially helpful to botanists.

Considerable attention has been given to the study of weeds, especially of some varieties recently introduced into this country from abroad. I may mention in particular the so-called Russian thistle, introduced some years ago into the Northwest, and which has in some sections, especially in the two Dakotas, created the greatest apprehension among the farmers. Its ravages have indeed assumed so serious an aspect that I thought it proper this year to direct a special agent of the Department to proceed to the infested section and study its character and habits, with a view to the issue of a practical treatise showing what can be done and what ought to be undertaken in order to effectually get rid of this pest. It was fully described and figured in my last annual report.

The Botanist, Dr. George Vasey, was last August commissioned as the joint representative of this Department and of the Smithsonian Institution to attend the Botanical Congress held at Genoa, Italy, in connection with the Columbian Quadro-centennial celebration in that city. The congress was of an international character, and considered many important questions relating to the science of botany.

The experiments in relation to grasses, forage plants, and cereals at Garden City, Kans., under the direction of this division, have this year been remarkably successful, and show conclusively that in the semi-arid regions of western Kansas and Nebraska a good average success in farming can be obtained if the methods be followed which have been thoroughly tested at this station. From 20 to 30 acres of excellent pasture and meadow grasses are now growing, which have yielded 2 tons per acre the present season. Thirty bushels per acre of a grain called Jerusalem corn has been obtained, which is fully equal to maize for fattening of hogs and cattle, and is good also as human food. Excellent crops of several early varieties of wheat and rye have also been secured. Several hundred bushels of these grass and grain seeds will be distributed to farmers in that region. Experiments in the same line have been conducted in connection with several experiment stations in the western States.

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

During the past year the work of the division has been carried on as heretofore under two heads, (1) investigations relating to the geographic distribution of species, and (2) the collection of information concerning the economic relations of mammals and birds to agriculture.

A special effort has been made to publish the bulletin on hawks and owls, which has been ready for the printer several years, but could not be issued earlier owing to the expense of the colored plates. The appropriation for the division is too small to admit of carrying on the customary biological survey and at the same time to pay for these plates. Hence, in order to bring out this important bulletin, the survey has been suspended temporarily and all available funds have been used in the reproduction of the plates, all of which have now been engraved. The text is in the hands of the Public Printer and it is hoped that the work will be ready for distribution before the end of the year.

Colored drawings have been made to illustrate two bulletins on the pocket-gophers and spermophiles or prairie ground-squirrels of the Mississippi Valley, in the preparation of which the division has been engaged for some time, and the latter will be ready for distribution as soon as the plates can be put on stone.

The division has been somewhat crippled by the circumstance that its chief, Dr. C. Hart Merriam, who was appointed by the President as one of the two Bering Sea Commissioners for the United States (in connection with Prof. T. C. Mendenhall, Superintendent of the Coast Survey), has been so fully occupied with the duties incumbent on that position that he was able to give but little time personally to the work of the division until August, for which reason the report of the biological survey of southern California and Nevada made last year, and known as the Death Valley Expedition, has been delayed several months. It is now, however, nearly ready for the printer, and will probably be published early in the year. Several additional points in central and southern California have been visited by a field agent for the purpose of supplementing and completing the work undertaken by the expedition. Nearly all of the enormous collections brought together by this expedition have been worked up, in which labor the assistance of several naturalists of world-wide renown has been rendered without expense to the Department.

The most important field work of the year has been done in the Lower Sonoran and Austroriparian zones, comprising the arid and humid parts of the Southern States from eastern New Mexico, Texas, and Indian Territory to Georgia. This area is of great importance from an agricultural standpoint, since it includes the cotton, cane sugar, and subtropical fruit-producing districts of the Gulf States. The special object of the work was to ascertain the northern boundary of this belt and to determine the species of animals and plants by which it is characterized and the conditions required for their existence. This had already been done in the southwest by Dr. Merriam, who last year traced the northern limit of the Lower Sonoran zone from Arizona to California. The task of continuing the work through the South Atlantic and Gulf States was assigned to Mr. Vernon Bailey, chief field agent of the division. With this end in view Mr. Bailey and his assistants visited many points in Mississippi, Louisiana, Texas, Oklahoma, Indian Territory, Arkansas, southern Missouri, and western Tennessee and Kentucky, and data have been secured by which the line in question can be determined with much greater accuracy than has been possible heretofore.

In order to ascertain more completely the affinities of the Lower Sonoran region, which includes large portions of California, Nevada, Arizona, New Mexico, and Texas, as well as the table-lands of Mexico, a field agent was sent to western Mexico early in the year to study the relations of the fauna and flora of this region to those of the adjacent tropical region along the coast. The results of this work are likely to prove of considerable importance, and the collections already received contain many interesting and valuable specimens.

During August and September Dr. Merriam made a brief biological reconnoissance of the higher portions of the southern Alleghanies, visiting Roan Mountain and Mount Mitchell and ascertaining the important fact that the subalpine fauna and flora do not reach these mountains, their southernmost outposts in the eastern United States being in the Adirondacks and White Mountains. Field work was also done in the States of Georgia, Alabama, Tennessee, Kentucky, Illinois, Iowa, Kansas, Nebraska, Arkansas, and southeastern New Mexico.

SECTION OF ECONOMIC RELATIONS.

Studies have been made during the year of the food and economic status of many species of birds of prey, crows, jays, blackbirds, woodpeckers, cuckoos, kingbirds, and horned larks. In addition to this work, special attention has been paid to the distribution, habits, and means of exterminating the several species of gophers and spermophiles of the Great Plains, Gulf States, and Mississippi Valley, and the information obtained has been incorporated in two illustrated bulletins on these species, now nearly ready for the press.

The work on crows has received constant attention, one or more assistants being occupied most of the time in examining stomachs of this species alone and in tabulating the results. Nearly 600 crow stomachs have been examined since the beginning of the year, and, with the exception of the insect material (now in the hands of the Entomologist), the results have been prepared for publication. As soon as the Entomologist's report is received the bulletin will be ready for the printer.

About seven hundred blackbird stomachs have been examined since January 1, and most of the material for a report on the crow blackbird is now at hand and being shaped for publication. Small lots of the stomachs of woodpeckers, horned larks, and a few other species have been examined for the settlement of special questions referred to the section, and, in connection with the exhibit for the World's Columbian Exposition, studies of the food of cuckoos, kingbirds, cedar birds, and some other species have been undertaken.

More than 1,900 bird stomachs have been received during the year, and about 1,600 have been examined during the same time. The collection now numbers 15,618 stomachs. The reference collection of seeds and other things likely to be found in bird stomachs has been considerably augmented, and many slides have been prepared for the microscope.

Considerable time has been devoted by the division force to the preparation of a suitable exhibit in order to illustrate the work of the division at the World's Columbian Exposition.

DIVISION OF FORESTRY.

Appreciation of the work of this division is rapidly growing, as is attested from the increasing correspondence and frequent references to and reprints from its reports appearing in technical and other publications. While this is gratifying, a much greater interest among our people is to be desired in order to bring about what is most needful, namely, a radical change of our present forest policy in all parts of the country. In order to stimulate this interest the method pursued in the division has been not only to present the general subject in reports, bulletins, and addresses, but also to exhibit existing wasteful practices in particular lines of business which rely on forest resources, showing the needs and the means of improvement with the necessary technical detail, thus enlisting the good will of such business interest in the general movement for better forest management.

There are so many business interests of importance closely dependent on forest supplies that with the limited appropriations allowed for the Division of Forestry it is impossible to meet the growing demand for special studies of this nature. Thus, the tanning industry, which will probably be the first to experience a dearth of raw material, demands an investigation into the value of tan extracts and additional sources of supply when hemlock and chestnut oak bark are exhausted. The wood-pulp industry is waiting to have suitable and cheaper supplies pointed out, to be utilized in addition to the more valuable timbers which form now its source of raw material. Both of these investigations are planned for. The railroad interest has been satisfied by the exhaustive study of the adaptability of metal as a substitute for wood in ties.

The largest share of the energy and the greater part of the funds of the division are now devoted to a continuation of the exhaustive examination and tests of our important timbers, which was announced and outlined in my last report. The object of this work is not only to establish more accurately the properties of these timbers, but especially to find the relation, if any, between these properties and the anatomical structure as well as the conditions under which the tree has grown. The first preliminary report from this work was published during the year in Bulletin 6 of the Division of Forestry as one of the series under the caption of "Timber Physics," and has met with unusual appreciation by civil engineers, architects, builders, lumbermen, and others concerned in using timber. A progress report, now preparing for the printer, will record the results obtained for the longleaf pine of the South, and will more fully show the influence which the practice of turpentine orcharding has upon the quality of the timber. The outcome of this special series of examinations, which must remove the prejudice now existing among Northern consumers against the product of thousands of square miles of Southern timber lands, will at once demonstrate the high economic value of the work.

I regret that the limited appropriations at my command will not permit me to respond to the many calls from all sections of the country to have their timbers included in this examination without delay.

A bulletin discussing the influence of forest areas on climate, as exhibited by the long-continued observations at the German forest meteorological stations and by other records, is ready for publication. The revision of the nomenclature and check list of our arborescent flora is nearly completed, and will probably be ready for the printer before the end of the year, while the long-delayed publication of the biological monographs of our important conifers is also expected shortly.

Reports on the following subjects, "Statistics and methods of charcoal production" and "Statistics of mine timber and methods of timbering," are in preparation.

The ever-growing correspondence of inquirers, asking for information on a multiplicity of subjects having more or less close relation to the subject of forestry and the use of forest materials, occupied a large part of the time of the office force. Sometime has also been taken up by the work for the Columbian Exposition.

The value of advice which might be derived from the Division of Forestry by other Departments found expression in a call by the Hon. Secretary of War for plans of management of the woodlands in the Chicamauga National Park, and by the Board of Governors of the Soldiers' Home in this city for coöperation in improving landscape effects and enlarging the educational value, as an arboretum, of the grounds of that institution.

Although as a nation we must still acknowledge ourselves far behind all European nations in the practice of forestry, the last two years have seen such advance of public opinion in behalf of a more rational forest policy that we may expect soon to see a change in the treatment of our forest areas. This advance may be claimed as due in a measure to the exercise of the executive prerogative in withdrawing from disposal and permanently or temporarily reserving certain tracts of public timber lands in Colorado.

DIVISION OF VEGETABLE PATHOLOGY.

The laboratory work of the division has been pushed forward as rapidly as the time and means at hand would permit. Work on pear, apple, grape, and peach diseases has been under way. Considerable attention has been paid to diseases affecting plants under glass, especially lettuce, tomatoes, and cucumbers. A fact which becomes more apparent each year is the absolute necessity for thorough physiological and anatomical work as preliminary to the study of any plant disease. Plant physiology alone is a subject of vital importance to agriculture, and for this reason, if for no other, it well merits the earnest attention of the division, and whatever equipment may be needed for the study of these highly important subjects will, it is hoped, ere long be forthcoming.

Since my last report the investigation of the diseases of citrous fruits has been diligently prosecuted. A special agent of the division has carried on studies at various points in the heart of the orange region of Florida. The results of the preliminary studies of this year confirm the views expressed in my last report as to the serious nature of the diseases and the urgent necessity of a thorough study of them. Already the damage from one of the maladies is estimated at over $1,000,000. As the diseases are of the most obscure nature, they demand that the investigations be carried out on the ground by trained men furnished with the best equipment. Experiments bearing on the possibly contagious character of several of the diseases are already well under way. Others on the effect of various methods of cultivation, fertilization, and spraying are being carried out. From the importance of the subject it has been deemed best to establish a station for the study of citrous diseases in Florida. Two special agents have been detailed for the work and will give their whole time to the subject and to such other diseases as can be studied only in the far South.

The special agent assigned for duty in California has continued his investigations of the vine disease which has prevailed so destructively in the southern part of the State during the past few years. A report on the subject is now ready for distribution. In addition to the work on the vine disease, the agent has had under investigation a number of maladies affecting fruits, among which may be mentioned the shot-hole fungus of the almond, the souring of figs, blasting and blighting of grape flowers and fruit, etc. The shot-hole disease of the almond has been successfully prevented the past season at very little expense. This is one of the most troublesome diseases of the almond, and a cheap and effective means of preventing it will be of great service to the fruit-growers of the Pacific slope. The souring of figs is another troublesome disease which gives promise of being successfully prevented.

The pear-blight investigations, to which reference was made in my last report, have been continued during the year. In addition to the laboratory work, experiments were carried on in the field with a view of ascertaining the possible methods of infection and the effect of different compounds on the germ causing the disease. A series of feeding or fertilizer experiments was inaugurated in Virginia, to test the effects of various forms of plant food on the pear tree, in its relation to blight, to other diseases, and to fruitfulness. It was found during these experiments that spraying with Bordeaux mixture would afford almost complete protection from leaf-blight, a destructive fungous disease which prevails more or less seriously all over the country.

The work along these lines has led to an extensive series of experiments on the pollination of pear and apple blossoms. It has been proved that the majority of our cultivated pears, including such well-known varieties as Bartlett, Clapps Favorite, Lawrence, etc., are incapable of self-fertilization. The utter unfruitfulness of one orchard of 20,000 Bartletts was traced to this cause. By top-grafting and planting other varieties it is believed that this orchard can be made to fruit at comparatively little expense.

In the work on peach yellows, a bulletin has been published demonstrating the communicable nature of the disease; the experiments with fertilizers have been completed and the results prepared for publication. The question of immunity has received further consideration, and a brief report giving the result of experiments and observations on this subject will be prepared for publication during the winter.

The orchards of western New York and western Michigan have been reëxamined with special reference to the effect of restrictive legislation, and the agent in charge is now engaged in microscopic and bacteriological examinations. The disease still prevails destructively in certain sections of the country, and it is very important that scientific study should be prosecuted without interruption.

The field experiments and laboratory investigations inaugurated in 1891, in coöperation with the New York State Experiment Station at Geneva, have been continued with some slight modifications. The work has clearly demonstrated the possibility of largely preventing the leaf-blight of quince, pear, plum, cherry, and other nursery stock. Aside from the main work with nursery stock, extensive investigations of apple and pear scab have been in progress. One result of this work has been the discovery of the scab fungus on the unopened flower buds, a fact long suspected but never before demonstrated. This knowledge will modify the treatment of the disease to a considerable extent. A fungous disease, which has been in use in New York State for a number of years as a means of destroying a troublesome weed known as "live-forever," has received some attention. The possibility of growing large quantities of the fungus in artificial media and disseminating it among the farmers for distribution over their fields is being studied.

An extensive experiment, having in view the prevention of rust in wheat and oats, has been in progress during the year. The work was carried on in Maryland and Kansas, two special agents in different localities of the latter State being engaged in the investigations. The work was in a measure preliminary; yet notwithstanding this fact much time was consumed in laborious field tests which involved soil and seed treatments separately and combined, spraying at various intervals with numerous fungicides, and other lines of work. The results of the work are now being prepared for publication.

The question of fungicides has received special attention during the year. The present number of really valuable remedies or preventives of plant diseases is limited to half a dozen preparations. All of these are open to one or more objections, the most serious being the matter of cost. In the hope of obtaining some information of value along this line, twenty-five preparations which had been under investigation in the laboratory for some time were tested in the field during the growing season. Several of the preparations not only proved worthless as preventives of fungous attacks, but utterly destroyed the leaves, flowers, and fruit as well. A number of the compounds, however, give promise of being improvements on the old ones, especially in the matter of cost and ease of preparation and application. The work will be continued another year. Meanwhile, the results of the present season's investigations will be prepared for publication.

OFFICE OF EXPERIMENT STATIONS.

The duties of the Office of Experiment Stations may be divided into two general classes. On the one hand, it examines the work of the stations with reference to its general character and practical usefulness, in order that the Department may be prepared to report on the progress of the enterprise and to supply information of the results to farmers and others throughout the country. On the other hand, it collects and publishes data regarding the researches in agricultural science carried on in this and other countries in order that the stations may know what is going on in the lines in which they are working, and thus may be able to pursue their investigations with the greatest economy of time, labor, and money.

In the performance of its duties of the first class, members of the office force have, during the year, visited various stations and attended meetings of station workers. An extensive correspondence with station officers has also been carried on. The requests for information from farmers and others have been more numerous than ever, covering a wide range of subjects.

The third volume of the Experiment Station Record has been prepared and published during the year. This publication is designed to supply concise and timely accounts of the methods and results of the work of the stations, together with abstracts of the reports published by this Department, and of the more important publications of similar work done in foreign countries. The space devoted to accounts of foreign work has been greatly enlarged, with a view to more thoroughly acquainting our station workers with what is being done in those countries where scientific researches relating to agriculture have been longest in progress. A carefully prepared index has been issued with this as with the previous volumes of the Record. The amount and variety of the literature issued by the Department and stations make its orderly arrangement in a publication like the Record a matter of importance second only to the original work. Many testimonials regarding the usefulness of the Record have been received.

As a permanent and extensive means of reference to the literature of the stations and kindred institutions, a printed card index has been begun. A number of installments of this work have been furnished the stations and agricultural colleges. The value of that portion of the index already issued has been so clear that there is a general and very urgent demand for its continuance.

The other publications of the office have been numerous. The following merit special notice:

The compilation of analyses of American feeding stuffs, prepared by Messrs. Jenkins and Winton, of the Connecticut State Experiment Station, presented the results of more than 2,000 analyses. The averages calculated from all the analyses for a large number of feeding stuffs will be of practical use in connection with feeding experiments. Heretofore, in experiments made in this country regarding the relative value of feeding stuffs for the nutrition of farm animals, it has been necessary to rely upon compilations of European analyses or a very small number of American analyses.

The bulletin on the fermentations of milk, prepared by Prof. H. W. Conn, is a satisfactory résumé of the results obtained at home and abroad in the investigation of the bacteria and other ferments to which, as has been known for some time, the various changes in milk, butter, and cheese are largely due, and in regard to which definite information has only been obtained in recent years. In view of the wide interest attaching to this subject, a farmers' bulletin on the same topic has been prepared for general distribution.

At the meeting of the Association of American Agricultural Colleges and Experiment Stations, held in Washington August, 1891, a course of lectures on the investigations carried on at Rothamsted, England, was delivered by Robert Warington, F. R. S., who was generously sent to this country by Sir John Lawes to give our people information on the important and interesting work carried on there, and justly regarded as of very high value. The lectures have since been published as a bulletin of the Office of Experiment Stations. They deal for the most part with researches regarding the nitrogen of the soil and atmosphere and the ways in which it is made available to the plant.

Experiment stations are now in operation in all the States and Territories except Montana. During the year a new station has been established in Idaho. Considered as a whole, the work of the stations is proceeding with greater regularity and thoroughness than ever before. There is a gratifying tendency on the part of individual stations to confine their attention to the relatively few problems to which they can give adequate treatment. The demand for information of an immediately practical nature has of course influenced the stations thus far to devote a considerable share of their time to the preparation of compilations of information on many agricultural topics. This demand is a pleasant indication of the intellectual awakening of the farmers. At the same time it is important that the stations should not be too widely diverted from the various lines of original research claiming their attention. There is urgent necessity for experimental work in agriculture, and much time will undoubtedly be needed for the solution of many of the most important problems of agriculture which confront the farmer, and upon the satisfactory solution of which his future prosperity largely depends.

I feel compelled to call serious attention to the fact that in a few instances ignorance of the real purposes for which the stations were established has led to the dissipation of their resources in trivial enterprises, or to a vacillating policy in the management which has prevented the proper carrying through of many well-planned experiments. While these cases are comparatively isolated, they raise the question whether it would not be best to give to this Department some supervisory discretion over the expenditure of the funds granted to the stations from the National Treasury.

While the work of the stations during the past year has been marked by progress along well-established lines rather than by striking discoveries of new principles, illustrations of important and useful results are not difficult to find.

In a number of States, especially those west of the Mississippi, much attention has been given to the culture of sugar beets. The stations, working in many cases in coöperation with this Department, have already done much to show whether there is a reasonable prospect of success in this industry in their several localities, and to teach the farmers the conditions for the profitable growth of this crop. In the South the stations are, by practical example, encouraging the introduction of new crops and agricultural industries. While they have by no means abandoned the effort to improve the treatment of the cotton crop, they are endeavoring to show that a more diversified agriculture would be far more profitable and satisfactory.

In dairying, the work of the past year has been highly satisfactory, presenting results of immense importance to the dairy interest.

Tests in the method of curing tobacco, chemical studies on California fruits, the feasibility of using the electric light for forcing certain plants, are among some of the most interesting experiments conducted by some of the stations.

DIVISION OF POMOLOGY.

The fruit crop has been below the average. Apples have been especially scarce, except in a few small sections. The same is true of the pear, plum, cherry, and peach crops. Grapes have been abundant, and the markets well supplied at a moderate cost. Berries have also borne quite well. Dried and canned fruits left over from last year's large yield will be needed to supplement the small amount secured this year.

The work of the division has been essentially the same as last year, as no increase has been made in the appropriation for its use. Notwithstanding the light crop in most of the more important fruit-growing districts, the general interest in fruit-growing continues active. Nearly as many specimens of fruit have been received from growers for examination and identification as in 1891, when the crop was large, while the number of growers in correspondence with the division has been larger than ever before. From the rapid increase in this part of the work it is probable that almost the entire time and attention of the force will need to be devoted to it during the summer and autumn months whenever there is a large crop throughout the most of the country.

The work on a catalogue of fruits is progressing, and within the coming year it is expected to be able to publish that part pertaining to the apple, as much of the work has been done within the past year. This will be a check list which will give the latest approved name of each variety in accordance with lately established rules for simplifying the names of fruits and also the synonyms. This list will be of great use in helping to disentangle the confused state of pomological nomenclature and place within the hands of the fruit-growers a standard authority. In this connection it might be well to state that at a recent meeting of the American Horticultural Society at Chicago, Ill., a series of resolutions was adopted, in which it was urged upon the public that this division of the Department of Agriculture be recognized as the national authority on the identification and nomenclature of fruits and also as to the value of new varieties which are about to be offered to the public.

The importation of new fruits from foreign countries has been limited by the small fund available for that purpose. Some varieties of the kaki reputed to be hardy in the colder parts of Korea and Japan have been received and placed in the hands of propagators. Some choice Italian chestnuts from the slopes of Mount Ætna were secured early in the year and distributed among 150 experimenters for testing in various parts of the country. A few other small importations and distributions have been made. The collection and distribution of promising wild fruits, particularly of the plum and currant, have been continued through the instrumentality of voluntary collectors and experimenters in several States.

In response to numerous requests from national and State horticultural societies, meetings of a few such organizations have been attended by representatives of the division. It is believed that through this means much has been done to make plain to fruit-growers the advantages afforded them by the work of the division and the best means of availing themselves of it.

The monograph on wild grapes remains yet unpublished for lack of necessary funds.

DIVISION OF MICROSCOPY.

During the past year this division has been largely engaged in collecting specimens of the edible and poisonous mushrooms of the United States and Territories, which are intended for exhibition, collectively, at the World's Columbian Exposition. In this work the division has had the cordial assistance of the agricultural experiment stations of the country, and upwards of 600 molds have been made of individual specimens in this collection. The models will be colored from nature, and grouped and classed according to their edible or poisonous character. The groups, as a whole, will illustrate in miniature a forest scene, and indirectly will show some of the permanent causes of forest decay

In consequence of the increased demand by the public for information relating to the cultivation of edible mushrooms, this subject has received continued attention, and new illustrations will be published from time to time showing the latest discoveries in this direction.

In the prosecution of experiments upon the oils, butter, and other fats, a new device connected with the microscope has been invented during the year, which promises to be of great value in the detection of adulterations of food fats and medicinal oils, such as have hitherto escaped detection.

New and important experiments have also been made in connection with silver nitrate as a test for adulterated food, medicinal or other oils, such as cotton-seed, olive, castor, linseed, etc., with well-defined results, which will be illustrated in the forthcoming report, showing the relative reactions of the silver nitrate and the respective oils. Further experiments are also in progress relating to the testing of farmers' binding twine, pure and adulterated. Samples of cotton for microscopical examinations have been received from nearly every cotton-growing country in the world, as also a large assortment of animal fibers for examination and comparison.

FIBER INVESTIGATIONS.

The fiber investigations during the past year have been confined to flax culture, to the ramie interest, and to the semi-tropical leaf fibers, chiefly sisal, and bowstring hemp.

Early in the year the special agent in charge of the work spent some time in south Florida, where an experimental cleaning factory was temporarily established, and was successful in obtaining sufficient quantities of sisal hemp, and the fiber from the false sisal, bowstring hemp, pineapple, etc., for manufacture and test to show their commercial value. The plantations of sisal hemp from plants sent by the Department are growing finely, and there is considerable interest in the culture. Large plantings of Sanseveria or bowstring-hemp roots have also been made, and those interested in this new industry are sanguine of success. The plants grow readily, spreading rapidly, and can be cheaply harvested and cleaned, while the fiber is superior to sisal hemp, as it can be used in higher grades of manufacture.

There is the greatest interest in ramie, particularly since this industry has been fairly established in France. In October the Department tested three machines at New Orleans, and while the results of these tests showed that the machines presented were unsatisfactory, the official trials have stimulated invention, and improvements in American ramie machinery will inevitably follow. Save in the number of machines brought to test, the trials are fully as satisfactory as the French trials of 1889 in Paris, which marked the beginning of that advance in ramie machine construction abroad which has since brought about such favorable results. It is the opinion of fiber experts and mechanical engineers in this country that such official trials are valuable as giving opportunity for making comparisons of principles of construction and for studying defects with a view to improvement.

From the fact that the manufacturing industry is now interesting capital largely in the United States, and that the question of a supply of the raw material will soon be a vital one, there is need for carefully and scientifically conducted experiments to show, once and for all, whether it will pay the Southern farmer to grow this crop. The fact that farmers are being urged by interested parties to go into ramie culture without this knowledge makes such experiments all the more important to save them from possible losses through attempting culture without knowledge of its requirements.

While progress in the flax industry has been slow, the interest continues, and several new inventions tending to materially reduce the cost of harvesting and preparation of the fiber are recorded. Among these is a machine to accomplish mechanically the laborious work of pulling flax by hand, the cost of which operation has been one of the chief arguments against flax culture in this country. Several new fiber-cleaning companies have established working plants, and the outlook is favorable for the production of fiber, though it must necessarily be confined to coarse uses at the outset. One of the results of the Department's recent flax-cultural experiments has been to show conclusively that, under proper conditions of cultivation, a fine quality of spinning fiber can be grown in many localities.

DIVISION OF GARDENS AND GROUNDS.

Besides the ornamentation and keeping of the grounds attached to the Department, this division is zealously engaged in the introduction, extension, and dissemination of utilizable plants, especially those of commercial importance. The operations of the division in this line of work have been recognized as attaining results of much value, particularly in regard to pomological interests.

It can not be made known too widely that this Department does not now, and never has, propagated for general distribution plants of merely ornamental repute. The want of recognition of this fact involves much unprofitable correspondence. Requests for collections of plants of the most varied character and of the most incongruous description are received. Many of these requests contain names of plants which could not be of any value to the applicant even if they could be supplied. Hence it is necessary that the prescribed operations of the garden should be kept in view, for it is neither useful nor expedient for the Department to propagate or distribute plants indiscriminately; but while the majority of these applications are not framed on a practical basis, they indicate praiseworthy efforts towards a greater diversity in production, efforts which the Department is especially anxious to foster in every practicable direction.

Plantations of pineapples are constantly being extended in southeastern and in some other portions of Florida where the plants are not injured by winter colds. The demands from these districts for the best varieties are both numerous and pressing, and applicants are supplied as far as our present limits of propagation will permit.

About 66,000 plants have been distributed during the year. These were all what are termed economic plants, distinguished from those of merely ornamental value.

DIVISION OF RECORDS AND EDITING.

The steady growth of the work of this division, which includes the editorial work found to be necessary with reference to the bulletins prepared in the several divisions and a general supervision over the publishing interests of the Department, has fully confirmed the conviction which prompted its establishment by my direction nearly three years ago. The necessity for a most careful and judicious oversight of all features of the work relating to the publications of the Department becomes more and more apparent as the scope of the work enlarges and the consequent demands upon our appropriation for printing is increased.

The proper distribution of our publications has also received material promotion by this division through the synopses and publication lists which have been supplied regularly to the agricultural press. By this means the assistance which the Department is able through its printed information to render to the various agricultural interests of the country has been promptly brought to the notice of the class for which it is intended.

DOCUMENT AND FOLDING ROOM.

The provision of additional rooms for the use of the Document and Folding Room has facilitated in a marked degree the prompt mailing of publications, so that, notwithstanding the growth of this work, it has been accomplished without increase in the force assigned for its performance, although the continued growth of the publication work of the Department will soon make such an increase inevitable in order to efficiently carry on the work of distribution.

Exclusive of the monthly crop synopses, the issue of which aggregates nearly a million and a half yearly, and also of the publications of the Weather Bureau, over three-fourths of a million publications have been received and handled during the past year.

RAINFALL EXPERIMENTS.

Congress having again assigned a sum to be expended in experiments with a view to ascertain the possibility of producing rain by the use of explosives, it became my duty to continue these experiments on the same lines as pursued last year. The work has been placed in the hands of the same gentleman who conducted the experiments last year and upon whose report Congress saw fit to extend an appropriation covering the present fiscal year. At present, of the facts relating to this subject now in my possession, I must say that they are not such as in my opinion justify the anticipations formed by the believers in this method of artificial rain-making. I have not included in my estimates for the ensuing fiscal year any sum for further experiments.

WEATHER BUREAU.

I am happy to be able to say that, as the result of the work of the first year during which this Bureau has formed a part of this Department, our first care, the improvement of the forecasts and their extended distribution, has met with some measure of success. The yearly percentages of verifications for all stations east of the Rocky Mountains are: Twenty-four-hour forecasts, 83.7; wind signals, 76; cold-wave signals, 67.4; being respectively 0.2, 5.1, and 10.4 per cent higher than for the preceding year. A much larger number of forty-eight and seventy-two hour forecasts were made than during the preceding year, namely, 7,157 of the former, and 271 of the latter, by comparison with 2,189 of the former, and 114 of the latter in the year previous. The improvement in the character of the forecasts calls for special scientific research into the fundamental physical laws underlying meteorology, and into the relations between meteorology and general terrestrial phenomena. We must now have also in meteorology observations of the conditions prevailing in the upper air strata. The policy of the Bureau has looked, therefore, to the reëstablishment of high-level stations, and the station at Pike's Peak has been reopened. Nevertheless, all the requirements of modern meteorology can not be fully met by mountain stations. We need a certain number of observations made in free air, and for this purpose balloons seem to be the only means at present available. With a proper outfit, which need not necessarily be very expensive, doubtless much could be ascertained.

A radical departure from the established policy of the Bureau was undertaken in the way of local forecasts, official predictions having been restricted up to a comparatively recent date entirely to the officials at Washington. In the first appropriation for the Weather Bureau provision was made for twenty of these local forecast officials; six more were appropriated for by last Congress, and as the demands continue urgent for the assignment of such officials at other cities, the number will doubtless have to be increased. These local forecast officials, having the advantage of a personal knowledge of the topography and climatology of their districts, ought to be able to make more accurate predictions for their individual districts than has been possible for the officials of this office.

The total number of weather maps issued daily during the past fiscal year was 6,800, an increase of 3,700 over the year previous. The rule is to furnish these maps, which cost the Bureau less than half a cent apiece, to all who will display them for the information of the public. They are also furnished to many schools and colleges where instruction in meteorology is given. Many of the newspapers in large cities have also undertaken to print facsimile maps, reduced, thus reaching hundreds of thousands of persons at comparatively little expense to the Bureau. It was found desirable to issue an explanation of the weather charts, including with necessary brevity a general statement of the laws governing the motions of storms in the United States, for popular reading in connection with the map. This has been printed and freely distributed.

In the cotton region the Bureau has continued to render important information to cotton-growers. The time for taking and reporting the observations has been extended, and these are now made from April 16 to November 30 of each year. Requests for new stations have been received, but it has been found practicable to open only two.

The arrangement for receiving reports from the West Indies during the hurricane season, namely, from July 1 to October 15, has been maintained, although the daily telegraphic reports have been discontinued, except when an unusual meteorological condition prevails or information is received of an approaching storm, either at the time of the regular observation or during the interval between the two observations.

An arrangement has also been made with the governor of the Bahama Islands for daily reports by telegraph without expense to the Bureau, this office in return transmitting reports once a day to Nassau.

FLOOD PREDICTIONS.

We have now in active operation 166 special river stations and 59 special rainfall stations, arranged in groups or sections. The river observers record the rainfall also. River bulletins are issued at 22 places. On April 21 a special bulletin in relation to an expected flood along the Lower Mississippi was issued and found to be of great value; it was verified in all detail.

A special study has been made of the most destructive storms and of the losses occasioned thereby, as also of deaths caused by violent winds and lightning. Of 1,207 storms considered, 71 per cent were storms not especially dangerous either to life or property, while only 70 storms were destructive to the amount of $10,000 or more. The death record shows the deaths by lightning to have been far more frequent during the past two years than deaths from wind storms. This condition was reversed during the year 1890.

The table showing the meteorological forms and reports received from all classes of observers presents an aggregate of 195,218, or 6,978 more than in the previous year. In addition to the above, numerous special reports of severe local storms, tornadoes, etc., have been received.

The promptness and efficiency of regular and special observers deserve special commendation. It is a remarkable fact that out of nearly 200,000 reports there should be but 113 delinquents.

Requests for meteorological data have been as numerous as in former years, and as varied in character, and the Bureau has followed out the liberal policy of furnishing climatological information as outlined in previous reports. All recent applications have been met and satisfied. The total number of such requests received from the various States of the Union aggregate 504.

The State weather service work has been carried on to a much greater extent than heretofore, and the results accomplished prove the usefulness and importance of this branch of the Bureau. The entire territory of the United States, with the exception of Alaska, is now covered by local weather services. During the year Iowa, Maryland, New Jersey, and Ohio have provided for the maintenance of their respective State services, and it is possible their action will be followed in the present year by the legislatures of other States. The work in New England, which until March 22, 1892, was conducted under the direction of the New England Meteorological Society, with a central station at Cambridge, was on that date transferred to Boston and the name changed to the New England Weather Service. In California, in addition to the usual work of the service, weekly weather crop bulletins have been issued from Red Bluff, Fresno, and Los Angeles. The regular monthly reports now contain important tables, so that it is possible to obtain the special features of the climate of every section of the country.

THE DISTRIBUTION OF FORECASTS AND FROST AND COLD-WAVE WARNINGS.

This branch of the work of the division has greatly increased during the past year, but has been hampered by inadequate appropriations for telegraphic purposes. The increase in the number of stations supplied by telegraph at Government expense with the daily forecasts, as compared with the number supplied on June 30, 1891, is over 200 per cent, and on the 1st of July, 1892, our lists show a total number of 1,888 receiving a daily telegram at the expense of the Weather Bureau.

A large number of applications could not be favorably considered, as the allotment of the telegraph appropriation would not admit of any increase over the number already supplied. One hundred and thirty-six stations have been established under the auspices of the National Grange of the Patrons of Husbandry, many of which were supplied with flags by the Weather Bureau, while others disseminated the forecasts and warnings by means of steam whistles.

There appears to be no abatement in the interest manifested by all classes and conditions in the forecasts and warnings, and hearty coöperation is met with by this office in its endeavors to place the in formation in the hands of all who would be benefited.

The railroad, telegraph, and train service, as gratuitous means of distribution, are largely utilized, and nearly three thousand places receive the forecasts daily in this manner, and over one thousand points are supplied by mail or a free telegraph or telephone service.

The total number of forecasts and cold-wave and frost warnings distributed was 6,368, of which 2,480 were distributed by telegraph or telephone at Government expense, the remainder without expense to the Government by telegraph and railroad services, and 639 of them by mail.

The wide and intelligent distribution of the forecasts is a feature of great importance in the work of the Bureau. The matter has received special attention during the past year, and I am warranted in saying that the success obtained has been limited only by the appropriation. This is an expenditure made directly for the benefit of the people. None of it goes in any way to the support of the Bureau or its employees, but is returned directly in giving warning of impending changes.

REPORTS.

Scientific reports for the use of the various scientific divisions of the Department were made as follows: For the Division of Ornithology and Mammalogy, a report on the temperature of a number of places in the United States, as illustrating the effect of climate on vital phenomena; for the Division of Pomology, a series of frost charts showing the average date of the last killing frost in the United States, and also the dates of last killing frosts in 1889, 1890, and 1891; and for the Division of Vegetable Pathology, a report of the temperature and rainfall of certain years in the peach-growing districts of Delaware and Maryland.

During the past four or five months something like 400,000 annual reports and extracts from the same, professional papers, and other publications, including weather maps, have been sent out by the publications section.

Four important bulletins have been published and widely distributed. The first consists of notes on the climate and meteorology of Death Valley, California, by the Chief of the Weather Bureau, and treats of (1) the physical features of the valley; (2) station and instruments; (3) discussion of observations; (4) the weather in the valley; (5) the automatic registers, and (6) the deductions, with tables of the daily pressure, temperature, relative humidity, wind directions and velocities, etc.

Bulletin No. 2 consists of notes on a new method for the discussion of magnetic observations, by Prof. Frank H. Bigelow. Bulletin No. 3 is a report on the relations of soil to climate, by Prof. E. W. Hilgard, of the University of California, and treats of the processes of soil formation, first, through mechanical agencies, such as changes of temperature, freezing water, etc.; second, through chemical agencies; and third, by weathering or fallowing. Bulletin No. 4 is a report on some physical properties of soils in their relation to moisture and crop distribution, by Prof. Milton Whitney, of the Maryland Agricultural College. This report is based partly on the author's original work and partly on a generalization of the work of others in this line, as reported in the literature of the day.

WORLD'S COLUMBIAN EXPOSITION.

The general work of preparing a suitable exhibit illustrative of the functions and work of this Department has been continued under the charge of the Assistant Secretary, who has also filled the office of chairman of the World's Fair Government exhibit, which will embrace exhibits from all the departments of the Government. The preparation of the exhibits of this Department is in a forward state, and has necessarily occupied a considerable portion of the time and attention of the force in each division.

The extent and variety of the contributions from this Department are set forth in the summary presented by Assistant Secretary Willits to the committee of Congress having the matter in charge.

From the Museum: Specially prepared displays of selected cereals, tobacco, and animal and vegetable fibers (now in process of collection and arrangement), illustrating distribution, the effects of transplantation, of changes of soil, climate, and altitude, and illustrative as well of departmental methods of study and treatment.

From the Bureau of Animal Industry: Illustrations of the parasites of animals; of the work of quarantine stations; of the processes of meat inspection; of transportation of live animals and meat; tagging; the handling of live stock; horseshoeing, and the diseases incident to defective shoeing; the work of the Department in connection with animal diseases, and disease germs from the bacteriological laboratory.

From the Weather Bureau: A complete set of meteorological instruments in operation. The entire work of forecasting, from the receipt of telegrams to the publication and distribution of weather maps, will be carried on upon the ground, in the presence of any one who may care to study the methods of the Bureau, and the various processes will be explained, with a view to the popularization of meteorological knowledge.

From the Division of Entomology: Collections and models of insects injurious and beneficial to agriculture, enlarged illustrations of their operations, and implements and materials of suppression and culture.

From the Division of Ornithology and Mammalogy: A large model of the Death Valley region, where altitudes varying from several hundred feet below to 15,000 feet above sea level are in such close proximity as to disclose at a glance all the life zones of the country, animal specimens and groups characteristic of these life zones, birds and mammals beneficial or harmful to the farmer.

From the Botanical and Horticultural Divisions: Collections, growing and preserved, of medicinal, forage, and other economic plants, with cases illustrating herbarium methods of work and treatment.

From the Division of Forestry: A classified collection of sections of forest trees of the United States, with demonstrations of their economic uses; apparatus (in operation) for testing the strength and other qualities of timber; illustrations of methods shown by experience to be best adapted to forest culture; metal railway ties advocated as a substitute for timber, and whose adoption would serve powerfully to protect our remaining forests from destruction.

From the Division of Chemistry: A complete agricultural laboratory, in which demonstrations of food adulteration, the saccharine value of sugar plants, and analyses of soils will be carried on; samples of adulterated foods which have been tested by the Department.

From the Division of Statistics: Charts and maps illustrating the values of agricultural products, the range of prices, and the distribution of staple products; blanks and materials illustrative of the statistical methods of the Department.

From the Division of Microscopy: A collection of models of fungi, edible and poisonous; models of fungi which attack forest and other trees; articles, instruments, methods, and results of investigations of adulterations of butter and other commercial fat.

From the Division of Vegetable Pathology: Models and drawings illustrative of fungous diseases of fruits and fruit trees; remedial agents, implements, and methods of protection, cure, and eradication.

From the Division of Pomology: Models of American fruits, illustrating differentiation due to transplantation; classified exhibit of edible nuts; illustrations of methods of planting and cultivating small fruits.

From the Office of Experiment Stations: Illustrations of its methods of editorial work, and of summarizing the reports of stations.

From the Division of Records and Editing: A complete set of the publications of the Department arranged for consultation, and a "bureau of information."

From the Division of Illustrations: The original plates and figures used in the reports and bulletins of the Department, illustrating the care and skill demanded in the preparation of these publications.

From the Office of Fiber Investigations: A complete collection of the commercial and indigenous textile fibers of the United States, with their partial manufactures.

From the Office of Irrigation Inquiry: A model of an ideal valley, with canals and sluices, illustrating modern irrigation methods; a map of the arid region, showing location of artesian wells and irrigation works.

BUILDINGS.

It seems necessary that I should again call to your attention the urgent necessity for a suitable provision by Congress for additional buildings for the accommodation of this Department and its work. When I assumed control of it, as I stated in my first report, I found the present buildings overcrowded, the work hampered by the inconvenience and unsuitable arrangements which we were compelled to make for want of proper accommodation, including occasionally the assignment of the force of a single division to separate buildings. All these conditions continue to exist, and the difficulties inherent thereto are enhanced by the great increase in the work of the Department, which now numbers eighteen principal divisions, as compared with twelve when I assumed control, inclusive of the Weather Bureau. They are difficulties, moreover, which it is not in the power of the head of this Department to remedy until additional building accommodation is provided.

It has been found imperatively necessary during the present administration for this Department to lease buildings outside of its grounds, and at an inconvenient distance from the main building, for the Division of Chemistry and its important laboratory work, and for the laboratory facilities necessary to carry on the experimental work of the Bureau of Animal Industry. Moreover, as I have already had occasion to impress upon the committee of Congress representing this Department, our present buildings are not fireproof, and the immense amount of valuable material accumulated in them is constantly exposed to serious loss on this account. Some plan for a building which shall ultimately accommodate in a suitable manner the entire Department in all branches of its work should be devised, and this plan should be of such a nature that construction could be undertaken and completed in sections, thus accommodating within a short period certain divisions which are at present the most embarrassed, owing to the difficulties I have mentioned. By this means, moreover, the cost of the building would be distributed throughout several years, with the result of having at the end of that time a building which will compare favorably with any of the buildings provided for our public departments at the Capital, and which will be equipped in every respect, as it should be, for the carrying on of the Department work.

As regards the accumulation of valuable property I need only instance a single case. I refer to the herbarium, which includes the largest collection of American grasses in existence, and contains type specimens of nearly all the species of American grasses described during the last fifteen years. Were such property as this to be destroyed the loss would be in some respects irreparable, while it would take many years and a very large sum of money to even partially replace it. In regard to the enlargement of the museum, which it is hardly necessary to say should be the most complete strictly agricultural museum in the world, the principal difficulty lies in the want of a suitable building and necessary accommodation. Our present lack in this respect practically renders any further reference to this very important feature of the Department unnecessary.

FUTURE ORGANIZATION.

Before closing this report it seems to me important that, as the result of nearly four years' experience in conducting the work of this Department, I should indicate, as definitely as possible, some of the plans for its future administration which seem to me eminently desirable in order to maintain and promote its efficiency. Before proceeding to state these plans in detail I desire once more to emphasize the fact that, in all plans designed for the future conduct of this Department, the future growth and development of this country and of its agricultural resources, its population, and its standing among the nations of the world must be duly appreciated and considered. The possibilities of the present may do for the consideration of private enterprise seeking immediate return on capital invested, but in the affairs of the nation true prescience is an essential attribute to the wise administrator. I must not, therefore, be deemed extravagant if I present designs for the future development of the Department which I conceive to be necessary to meet the demands not only of the near future but those of a score of years hence.

One of the first difficulties confronting the head of this Department under its present organization is the fact that the number of responsible heads of the several branches of the work who are in direct consultation with the Secretary or his Assistant is too great; and desiring to adhere as closely as possible to the methods which have been found satisfactory in the administration of the other great Departments of the Government, I should advise the application of the bureau system which obtains in most of them to the wants of this Department. The grouping of the several branches of the work into various bureaus, each one having for its chief the right kind of man, would most sensibly facilitate the administration of the work, reducing the number of persons in direct consultation with the head of the Department from 18 to 20 down to about one-third of that number, and placing the chief of each division, as at present organized, under a chief whom he would find readily accessible, and who, on his part, would secure thorough and systematic coöperation between the several divisions grouped together under his control.

Another advantage of this system is that it would provide in the Department several offices of sufficient emolument and dignity to attract men of the highest standing in the several departments of the work which it maintains, men thoroughly qualified to lead in their several specialties, and to command the respect and appreciation of all workers on the same lines not only in this but in foreign countries. Under our present system it is extremely difficult to retain in the departmental service men combining the highest attainments with administrative capacity. The following groups, as the basis of bureau organization, suggest themselves to my mind, without, however, suggesting names at present other than those necessary to indicate the general character of each group:

First, plant culture, which should embrace the present Divisions of Horticulture, Vegetable Pathology, Pomology, Gardens and Grounds, and the Seed Division.

Second, biological, to embrace the Divisions of Botany, Ornithology, and Mammalogy, and Entomology.

Third, statistical, the present division to be made a bureau of agricultural statistics, and to cover, in addition to its present work, the entire field of economic agriculture, the extension of markets abroad, and to embrace, say, three divisions, one of crop conditions and statistics, one of agricultural economics, and one of foreign markets and crops.

Fourth, educational. This should control the relations of the Department with the various channels of agricultural education, such as agricultural societies, granges, farmers' institutes, etc., and should include the present Office of Experiment Stations, the Division of Records and Editing, the Division of Illustrations, the Library and Museum, and the Folding and Document Room. There should also for the present be included in this group a division of agricultural engineering, covering the subjects of drainage, irrigation, public roads, farm buildings, etc.

The Bureau of Animal Industry is already organized, and constitutes a well-defined group as it stands, including divisions of inspection, field investigation and miscellaneous work, animal pathology, and quarantine.

The Weather Bureau would also stand without essential modification. There remain, then, not included in any groups enumerated, two highly important divisions, one of which, however, Forestry, will, I believe, ere long, if properly fostered and administered, develop into a bureau embracing at least two divisions, one of scientific investigation and study, the other of an administrative character and closely akin in its general administrative features to the present organization of the Bureau of Animal Industry.

To include the Division of Chemistry in any of the groups enumerated would be impossible, owing to the relations which it must necessarily hold to the general scientific chemical work of the Department, since the chief, with his principal assistants, must be at all times available as scientific chemical advisers in any branch of the work requiring the highest chemical ability and laboratory service.

UNIVERSAL MEAT INSPECTION.

Having thus endeavored to sketch a plan whereby the machinery of this Department would, in my opinion, run more smoothly, and facilitate the execution of the responsible duties imposed upon it, I will now suggest three or four features, which it is imperative should be undertaken at the earliest date possible under the auspices of the Department of Agriculture. What has been already said in this report in regard to the effects of cattle and meat inspection and the excellent results indicated in restoring the confidence of the trade in our animals and meats, a confidence which had been shaken, and in some cases destroyed by exaggerated and false reports of disease circulated by our competitors and by alarmists in this country, has impressed me with the conviction of the absolute necessity of providing for a meat inspection in the near future, which shall extend to every pound of meat consumed as food by the people of the United States. By what means this may be effected it is not for me to dictate, but I conceive it to be a duty which I must not shirk, to make public the results of the experience which the work already done under my direction in this respect has afforded me, and I unhesitatingly assert, as a prime necessity for the accomplishment of two great objects, the need of such a universal inspection, covering all animals slaughtered for human food. These two great objects are, first, to secure to American consumers who are large meat-eaters, and who ought to have the very best kind of food, the most healthful meats, free from all possible taint of disease. Science is revealing every day more intimate relations between the diseases of animals and the diseases of the human race, and the insidious means by which these are communicated from one to the other. Against the possibility of such results we must protect our people. As a result of the meat inspection already executed under the direction of this Department, we have raised the standard of taste in this matter among consumers themselves: witness the increased price willingly paid, not only in our own markets but abroad, for meat bearing our certificate of inspection. The second object to be thus accomplished, is that which has been already in a very satisfactory degree attained, but which must be sedulously maintained—the reputation of our meat products abroad.

PURE MILK.

Closely akin to this subject of cattle and meat inspection comes that of the dairy, and of milk consumed throughout the country, for which a system of inspection is quite as urgently needed. It is impossible to exaggerate the importance of securing pure milk from the most healthful sources, or the dangers to which the human race is exposed from consuming milk from those which are diseased or tainted. It is needless to dwell here upon the extent to which milk enters into human consumption.

Having called attention to the great danger attending the consumption of animal products without some guaranty as to healthfulness, and having demonstrated, so far, at least, as cattle and meats are concerned, the feasibility of an inspection which shall secure such a guaranty, I will not undertake to discuss the means by which these desirable objects can be attained. All details must be left to the wisdom of Congress, to which body I respectfully commend them.

The object to be kept in view, and one which ought to be dear to every American citizen, is that, in so far as all American products are concerned which enter into food consumption, the word "American" shall be recognized the world over as synonymous with healthfulness and honesty, and that, wherever it is seen, the certificate of this Department shall stand for a brand of excellence.

NATIONAL STANDARD OF GRAIN.

Another matter which is the subject of legislation now pending is that of a national standard of grain. There is evidence in the correspondence of this Department of a steadily growing feeling in favor of the establishment of such a national standard, which will relieve the grower from the annoyance inseparable from the existence of several standards, varying in the different grain markets of the country. Unquestionably, some system of national inspection and grading under the control of the Secretary of Agriculture should be established in the interest of the grain-growers, and would be, without doubt, in a very short time accepted and recognized in all the great market centers of the United States.

FOUNDATION FOR THE FUTURE.

The work of the Department hitherto has been but foundation work, as I may say. Moreover, until the Department was given its present status in the National Government it was impossible that even foundation work should be undertaken and carried on with any great degree of success, from the fact that the ultimate plan of the superstructure to be erected upon it had never been fully depicted nor carefully laid out. During my administration as Secretary my endeavor has been to gather together all that was available for the future work of the Department, to reorganize, rearrange, fit, and combine the several branches of the work, adding thereto all that seemed necessary to lay a broad and lasting foundation for the ultimate carrying out of plans which I have kept constantly in my mind in performing the work assigned to me. If in the future my humble share of credit in the history of the Department should be that I had been instrumental in securely laying a broad and lasting foundation for a magnificent superstructure of which every American farmer, and, I may say, every American citizen, will feel proud, I shall be more than compensated for my labors during the past few years.

The motto of this Department must be "ever onward." It has, in my opinion, succeeded during the few years since it has been an Executive Department of the Government in impressing upon the 10,000,000 of industrious citizens who represent the workers in the field of agri culture in the United States its capacity to advance their interests, and with the growth of this confidence on the part of the American farmers, we must not forget there is a corresponding growth in the responsibilities of the head of this Department. The National Government has taken, as it were, a contract with the farmers, and to carry it out efficiently this Department must be prepared to answer all reasonable expectations in bringing into the service of agriculture all that science, whether in this country or in any other country upon the globe, has been able to evolve for its benefit. The history of science is a history of continual discovery, and all discoveries in the solution of agricultural problems calculated to lighten the burdens of the farmer and increase his profits must be made the property of the Department through the energy and intelligence of its head and its responsible officers, and be thus made available through them to the farmers of the

United States. I have already shown the important part which agriculture plays in the commercial interests of the country, and in this respect also the Department must prove itself a capable source of information, an intrepid leader into new fields, and a worthy representative of the interest upon which all other interests, and thus the entire prosperity of our country, depends.

In the earnest hope that the wisdom of succeeding administrations may find the men and the means to carry on the work of this Department to the high destiny which I conceive it to be designed to attain, I have the honor, Mr. President, to submit this, my last report, and I desire, as my last word, to express to you my profound appreciation of the cordial sympathy and broad intelligence with which you have uniformly, throughout your administration, heeded the needs of the agricultural interests of this country. While no one has been so situated as to understand and appreciate this better than myself, I confidently believe that the people, and especially the farming people of this country, will learn to appreciate more and more the fact that the first administration during which their representative department held the rank of an Executive Department of the Government was presided over by a Chief Executive who never failed to appreciate the importance of agriculture, its dignity, and its value to the country at large.

Very respectfully, your obedient servant,

J. M. RUSK,
Secretary.

SPECIAL REPORT OF THE ASSISTANT SECRETARY.

SIR: I have the honor to submit herewith a review of the duties of the Assistant Secretary of Agriculture, together with a report of the work accomplished during the last four years by the divisions which were by your order placed under my direct supervision.

Very respectfully,

EDWIN WILLITS,
Assistant Secretary.

Hon. J. M. RUSK,
Secretary.

DUTIES OF THE ASSISTANT SECRETARY.

This Department became one of the Executive Departments of the Government by act approved February 9, 1889. By the same act the office of the Assistant Secretary was created, but no appointment was made to it till March 29, 1889, when I was honored with the position, entering upon my duties April 24, 1889. Under the law I was to have such duties as should be assigned to me by the Secretary. It was generally understood that in the division of the labor I should have the primary administration of the scientific work, and should be charged with consideration of it wherever it might be found. But the special divisions assigned to me at first will appear by the following order:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., April 26, 1889.

In accordance with section 2 of the act entitled "An act to enlarge the powers and duties of the Department of Agriculture, and to create an Executive Department to be known as the Department of Agriculture," approved February 9, 1889, the following assignments and duties are hereby prescribed to the Assistant Secretary of Agriculture, and the following order is promulgated in accordance therewith, to take effect at once:

The following-named divisions, and sections thereof, are hereby transferred to the office of the Assistant Secretary, subject to the reservations hereinafter mentioned:

The Botanical Division, and the Section of Vegetable Pathology.

The Pomological Division.

The Microscopical Division.

The Chemical Division.
The Ornithological Division.
The Forestry Division.
The Entomological Division, and the Silk Section.
The Office of Experiment Stations.

The Assistant Secretary will, in general, control and direct the scientific policy and operations of the above-named divisions, and sections thereof, and all questions and correspondence involving the scientific work of said divisions and sections will be submitted to him for approval and signature.

All questions relating to the scientific operation and policy of the above-mentioned divisions, but in which questions of administrative policy are involved, shall, primarily, be matters for the consideration of the Assistant Secretary, but shall be submitted to the Secretary for his approval before final action is taken.

All matters considered by and all correspondence originating in either of the above-mentioned divisions, in which only an administrative feature or policy is involved, will be referred to and prepared for the approval of the Secretary, as heretofore.

The investigations and experiments in the manufacture of sugar from sorghum, etc., are excepted from the above order.

J. M. Rusk,
Secretary.

Subsequently were added the charge of the Library and the Museum. In time the Section of Vegetable Pathology became a division, and the Silk Section was separated from the division with which it had been connected, and both reported to the Assistant Secretary. Other special investigations and matters were included under my supervision, such as Artesian Wells and Irrigation, Fiber Investigation, Rainfall Experiments, and the Exhibit of this Department at the World's Columbian Exposition. I was supposed to be conversant with the work of all these divisions, investigations, and matters; to keep careful watch of the funds appropriated for their use, and to know every item of expenditure connected therewith; to personally know the persons and the work of every employee engaged; to be in touch with every line of scientific inquiry, so as to be able to consult with and advise the chiefs of the several divisions, and to report at any time verbally or in writing to the Secretary or any committee in Congress the status of every matter under my supervision. I was held responsible for every report, bulletin, or publication issued by any chief, officer, or subordinate under my charge; to see that the matter was clear and concise; that it was of such character as would warrant publication; that it should be free from controversy or any reflection or imputation upon other workers in the Department, or any unjustifiable criticisms of the acts or motives of persons or officers out of it. I was to coördinate the work of the several divisions, or inquiries, so far as I might be able, to avoid duplication, either in lines of work or in publications, and thereby to bring about a harmonious coöperation in the Department.

These duties necessarily brought to my table for consideration matters and topics which could not be referred to any one division or any one person, but should draw upon every resource in the Department. The study of the effect of climate and soil and seed upon productions; the variety of grain or grass or forage plants or vegetables adapted to localities; where to buy and when to distribute; matters relating to flax and other vegetable fibers, to wool and cotton, to fruits and their distribution, to injurious insects and diseases; and an innumerable line of special investigations, to be made by me or through me, by many others, to make a complete whole, found place at my desk.

It is perhaps superfluous to remark, after the foregoing partial statement of the supposed duties of the Assistant Secretary, that the position is not a sinecure. In fact, it took but a short time to demonstrate that no one man could efficiently carry on all the matters charged to his personal supervision. Some relief came to him in the forming of an Editorial Division, which very materially assisted him in the review, under his general directions, of the publications issued by the divisions under his charge. This was by far the largest single burden imposed upon him, and he can testify to the very efficient aid the able gentlemen connected with that division rendered him. This will be more apparent from the statement of the number and size of the publications given out by the Department, as appears in the reports of the Division of Records and Editing for 1890, from page 442 to page 447; in that for 1891, from page 492 to page 498; in that for 1892, in the report of the chief of that division, as given in this volume.

The burden of this supervision was great at the beginning of the administration, but has year by year increased in a ratio corresponding to the increase of the work of the Department and its appreciation by the public as shown by its demands for its bulletins on special subjects.

This increase is best shown by the fact that the total number of pages of the bulletins issued by the Department during the year 1888 numbered less than 20,000,000, these figures representing, of course, not only the total number of bulletins, but the total number of copies of each bulletin. In 1889 this amount was more than doubled, trebled in 1890, while for the year 1891 it was 123,000,000 and for 1892, up to December, the figures reached more than 100,000,000 pages of printed matter. The Secretary's Annual Reports, running from 550 to 700 pages, with editions each of 400,000 copies, are not included in this statement, nor are the Annual Reports of the Bureau of Animal Industry and of the Weather Bureau.

I may add here the fact that, while there has been a marked increase in the sum appropriated for the printing of this Department, the increase in the amount of printing done has greatly exceeded the increase in amount of appropriation. For instance, whereas the amount of printing done in 1892 was five times greater than in 1888, the amount of the appropriation available in 1892 was only two and a half times as great as in 1888.

This increased number and variety of publications were rendered possible by increased appropriations both for work and for printing.

It may not be out of place to record here a statement which will show the consideration of Congress for the work of the Department as expressed in the sums allotted to it. There were appropriated, including deficiencies and the sums allotted for printing—

For 1882	$371,500.00
For 1883	487,780.00
For 1884	428,140.00
For 1885	677,690.00
For 1886	598,452.50
For 1887	673,758.85
For 1888	1,046,730.00
For 1889 (including $595,000 for Experiment Stations)	1,770,154.03
For 1890 (including $600,000 for Experiment Stations)	1,736,005.45
For 1891 (including $675,000 for Experiment Stations)	1,878,900.00
For 1892 (including $728,000 for Experiment Stations, and $889,753.50 for Weather Bureau)	3,113,153.50
For 1893 (including $728,000 for Experiment Stations, and $913,660.72 for Weather Bureau)	3,323,060.72

The appropriations for Experiment Stations are carried on our appropriations for the convenience of the Treasury officials.

The sums allotted for printing do not include the $200,000, which, for several years past, Congress has annually appropriated for the printing of the 400,000 copies of the Secretary's Annual Report, mainly for its own distribution, nor for the special reports ordered printed for the same purpose generally in large editions.

The general appropriations, however, included many special items worthy of notice. For fiber investigations in 1891, $4,000; 1892, $10,000; 1893, $5,000. For investigations and reports on artesian wells and irrigation in 1890, $20,000; 1891, $40,000; 1892, $10,000; 1893, $6,000. For cotton bollworm for the years 1891, 1892, 1893, $2,500 each. For corn products abroad in 1892, $2,500; 1893, $10,000. For investigations of peach yellows and other diseases for the four years ending June 30, 1892, $10,000 each year; for 1893, $15,000. For reports on adulteration of food in 1890, $5,000; 1891, $10,000; 1892 and 1893, $12,500 each. For grass and forage experiments in 1889, $5,000; 1890, $8,000; 1891, $15,000; 1892, $15,000; 1893, $7,500. For meat inspection in 1892, $150,000; 1893, $350,000. For experiments in the manufacture of sugar in 1890, $25,000; 1891, $50,000; 1892, $60,000; 1893, $20,000. For experiments in producing rainfall in 1892, $7,000; 1893, $10,000.

Nearly all the work done under these appropriations, and for which so much printing was ordered, was performed by experts in the various lines of work. At least one-half of the time of the chiefs and assistant chiefs of the respective divisions was, however, taken up in correspondence, either in person or through subordinates, relative to their technical and practical work. From year to year the appreciation of the public of this work can be measured by the increasing demand for the publications and by the almost numberless inquiries, nearly all of a practical nature, from a very large percentage of 60,000,000 of people.

They have important interests which they are energetically pushing to a successful issue, but they are meeting with the obstacles common to agriculture, in the nature of diseases and insects and other disabilities, and they are desirous of learning the best methods and the best material for a higher and better agricultural production. As has been repeatedly stated, many of these inquiries involve a large amount of work and investigation, and the answer to a single letter will frequently involve a week's labor. As a rule, the Department is able to give a satisfactory answer and to render valuable assistance.

In the matter of this growing appreciation, I may add that the back numbers of reports and bulletins, which for a time were stored away, have, within the last three years, been called for to such an extent that in large measure this supply has been exhausted. It is now practically impossible to secure anywhere a complete list of the publications of this Department. They would make a small library of themselves. The requests for these full sets are increasing with every year, and with reason; for this Department has not been in existence for forty years without having recorded experiments and information on a large number of subjects which, in the nature of things, repeat themselves, and it is important that, in a new experiment, with added facilities and modern research and scientific appliances, we should be able to take into consideration the work heretofore done on the same subject, and the time is not far distant—in fact, I may say is now at hand—when the charge can not be made that these reports and bulletins are fitted only for the waste-paper basket, and the challenge may be made, without fear of contradiction, that every report and bulletin issued by this Department, placed in proper hands, is worth all it has cost. The misfortune is that in the distribution of these documents reliable information as to the proper parties, *i. e.*, parties who will carefully and thoroughly examine them, is hard to obtain In times past a large portion of them were distributed indiscriminately, and of course were of practically no use to many of the parties receiving them. By a gradual process of elimination and by the increasing number of requests of applicants, we are more and more sure that they are falling into the proper hands. There is, however, still much to be done in this direction. No person not conversant with the difficulties of having reliable and proper lists has any conception of the difficulty involved in this gratuitous distribution of public documents. There are so many people who feel that, if they can get a document free of charge, whether they really need it or not, they may as well exercise their rights as citizens to demand something from the Government or the Department for whose support they are taxed. It frequently happens, moreover, that when a valuable document has been issued, to which the attention of the public is more especially invited, numerous applications are made through a Senator or Representative, or through both Senators and several Representatives, so that they may secure duplicates which may be turned over to second-hand book stores for sale. Frequently these applications are made also to the chiefs of all or nearly all the divisions, and to some official or several officials of the Department, the applicant hoping thereby to secure, through their influence, several copies. Nothing but a well-prepared index can prevent this, at times almost wholesale, distribution of documents to a single person. I will simply add that, though great progress has been made in this matter in the last four years, there is still need for a more complete and perfect system; or rather the system now in use is susceptible of great improvement.

GENERAL REVIEW OF THE WORK FOR THE LAST FOUR YEARS.

The effort will be to make this review as concise as possible, reference being made, for a more enlarged description of the subjects, to the reports on these subjects in the annual reports and bulletins. I shall first make some few notes relating to the work of the several divisions.

DIVISION OF BOTANY.

The scientific work proper of this division has brought it into wide public notice, both at home and abroad. The work of collecting, classifying, mounting, and assigning to the Herbarium of the flora of this and other countries has increased to such an extent, and the stores thereby collected have become so ample, that public attention has been arrested, and the world is beginning to appreciate that we are fast winning a standing as a National Herbarium. The work of the division may be divided into three parts: First, the scientific collection and classification of specimens for the Herbarium; second, the distribution of plants already classified and known to the agricultural colleges and experiment stations and other scientific institutions, and the exchange of plants with other herbaria; and, third. the conducting of experiments with grasses and forage plants.

The work under the first head has already been alluded to, but it is desirable that something further should be said about the character and extent of this collection of plants. The United States is topographically a very large country, and includes within its bounds many regions of considerable extent that are practically unexplored and unknown, especially botanically. For the last fifty years or more it has been the field for extensive botanical explorations by foreign governments, and it may seem strange that the herbaria of some of the European countries contain plants unknown to or not to be found in the herbaria of this country. It is not an uncommon thing for botanical students to find it necessary to go to Europe for information as to the plants of our own country. The effort of this Department is to secure, as soon as may be, a thorough collection and classification of our flora. Some parts of the country have been systematically and fairly well explored, but it may be said that as a whole we have made but a fair beginning. Up to four years ago this collection had been more or less sporadic, by individual botanists engaged by this Department, or by special agents sent out into detached places, generally of convenient access, but not with the idea of thoroughly and exhaustively collecting or noting the existence of everything within a certain region. The effort has been made to consolidate this work and to take up the least-known regions. In pursuance of this policy a comparatively thorough collection has been made through Texas, which, up to a few years ago, was practically unknown, and more or less systematic explorations of the Territories of New Mexico, Arizona, and southern California, have been made. An elaborate and systematic exploration was made in 1891–'92 of the Death Valley, in southern California, ranging over the borders into Utah—a region of 100 miles square before that practically unknown. Also last year a similar exploration was made of northwestern Idaho and eastern Washington. These systematic explorations were conducted with all the appliances for noting the altitude, temperature, and characteristics of soil and climate in which the plants grew. The information derived and the flora collected in these two expeditions were a complete vindication of the policy adopted, not only in the number of plants collected, but in the data relating to their growth. And it is my judgment that in the future, so far as it may be practicable, the country should be covered thoroughly by this systematic work, beginning first at the least-known localities.

Under the second head, large amounts of plants, systematically arranged and classified, have been sent to the institutions of this country and have, in the last four years, been of great benefit, especially to the new agricultural colleges and experiment stations. The plants so distributed, carefully mounted, become an object lesson and a standard for the work done by these institutions themselves.

The work under the third division needs more than a passing notice. I have in my first report referred to the importance of the forage question, and I need add nothing on this point save to again express my opinion that the production of grasses and forage plants is of more importance to this country than any other line of productiveness; worth more to the South than cotton, to the West than gold and silver, and to the North than wheat and corn. The effort of the Division of Botany during the last four years has been sharply directed to this point. Arrangements were made in 1889 for the possession for five years of a tract of land of 240 acres in the vicinity of Garden City, Kans., at about the one hundred and first degree of longitude west. The region is classified as the semiarid, with sufficient rainfall, perhaps, for the cultivation of cereals and annuals, provided it came at the proper season, but being distributed through the whole year is necessarily so small in amount as to prevent successful agricultural operations. The problem was to find a grass or forage plant that would grow successfully in such a climate without irrigation. An experimental grass and forage station was established there in 1889, and has therefore been in operation four years—a time sufficient to enable us to take our bearings as to results. The first experiments naturally were with seeds already known and in use, which could be bought in the open market, to determine what could be done by their careful cultivation in said locality; next, to obtain from other countries seeds of plants cultivated in regions of a similar character; and, thirdly, the collection of seeds of native grasses and forage plants growing in the great West itself under similar conditions. These had to be collected by hand at the time of maturing, by skilled botanists, and for three years these seeds have been so collected in New Mexico, Kansas, Colorado, and the Dakotas. Manifestly these seeds will be first planted the year subsequent to their being gathered. The result is that at most we have had but three years' experience with them. The same may be said with reference to those gathered abroad. At first all, or nearly all, the seeds were sown in comparatively small plats and experiments were made with different kinds of care and cultivation adapted to the locality, and then on wider areas of 1 acre up to 20 or more. It soon became evident that the ordinary grasses and forage plants in use at the East would not thrive successfully in that region under any cultivation, and that reliance must be had upon foreign and native seeds grown in regions of like conditions. It will suffice to say that the report for 1892 will show that one foreign plant, the *Bromus inermis*, which comes from the semiarid portions of Austria, is the only one from abroad that has proved an absolute success up to this time. Many others from abroad are of great promise, some of those from Australia being considered especially hopeful. Of the native grasses, three have been proved to a demonstration to be of great value.

The results of the experiments with these four grasses alone are, in my judgment, an ample compensation for all that has been expended on the Garden City Station, and I am hopeful that there are at least twenty varieties that will demonstrate their usefulness the coming season. It was my opinion that the five years' experiments at Garden City would be the extent to which the experimentation should be carried, but I shall reserve my final judgment in the matter until the results of the experiments for 1893 shall come in. It will be noticed that these experiments, beginning first with small plats and then extending into fields, covered the two conditions that are deemed essential for absolutely successful determination. I can not concur in the opinion which is so prevalent among our scientific experimenters that the successful use of any plant can be determined in a carefully-prepared small plat of ground. Its economic use is only demonstrated when applied to large fields under ordinary though careful cultivation.

Reference is here made to the report of the Division of Botany, which may be found elsewhere in this volume, as to the other operations at Garden City which I have not covered in this brief sketch. The results show that there are millions of acres on the border land between successful cultivation and the desert region, heretofore classed as unproductive, which are susceptible of successful agriculture with plants and cereals adapted to the climate. This was, in a sense, believed heretofore in a sort of intangible way, but is now proved to a demonstration.

In addition to the operations of the Garden City Station, conducted by the Department itself, an effort, more or less successful, has been made to elicit and stimulate the interest of the experiment stations in the same subject. Allotments were made of money to be expended in the respective stations under our direction, and mainly with seeds furnished by this Department, to the stations of North Dakota, South Dakota, Wyoming, Utah, Arizona, New Mexico, Louisiana, Mississippi, Georgia, Florida, and North Carolina. These efforts, while not so successful as was to have been hoped, yet resulted in a positive direction of the energies of these new stations toward the propagation of forage plants, and we shall have to look to the future, in a measure, for these results. The stations were too newly organized to give the work the needed time and attention, especially in the West. In the South there has been manifested a very greatly increased interest in the subject, to be traced directly to the efforts of this Department through the action of the several stations. From the first the Mississippi Station was made the center of operations, and there have been propagated as an experiment a great many kinds of plants especially adapted to southern needs. From the constant elimination of those which were found not so adapted and the continued experimentation with those which were more successful, much desirable information has been promulgated, and the successful cultivation of many plants found to be possible. The interest in this subject has increased at least a hundredfold in the South in the last three years, and I believe that at no distant future the South can be clothed with a verdure that shall completely redeem its waste places, shall call a halt to growing sterility, and shall more widely and successfully promote the cattle and sheep industry. Take it altogether, the prospect of the South for a larger variety of production and a greater diversity of industry is most flattering; and the future of the "new South," so called, depends upon the permanent adoption and cultivation throughout its whole area of a successful line of forage plants—more so than upon its mines and manufactures.

DIVISION OF ENTOMOLOGY.

The year 1889 marks the successful advent of the Australian *Vedalia cardinalis* in the orange groves of southern California, where, as a parasite, it most successfully destroyed the fluted scale. The destruction of the orange groves by the scale insect, which was impending in 1887–'88 on my visit to California, was stayed, and without exaggeration it may be said that the importation of this one parasite has saved to the country millions of dollars. Other scale insects, of which Vedalia is not a parasite, still exist and do great injury to the citrus industry, but not to the destructive extent of the fluted or white scale. These have been combated by agents of the Department and by horticulturists in California in various ways, not with entire success, however, and a recent effort has been made by this Department in coöperation with the State Board of Horticulture of California, to import parasites to combat those other varieties—with what success has not, at this date, been demonstrated, though it is claimed with strong hope. The field of operations of the Division of Entomology is so broad, the work is so varied, and the insects so multitudinous that it is impossible in this brief statement to make many specific notes of the character of the foregoing. There are coming to the front so many insects, either indigenous or imported, that it has been almost impossible for the Division of Entomology to compass their life history and habits. Insects that ten years ago were not pests have become such under new conditions and in new localities. An excessive rainfall may nurture into life an insect supposed heretofore to be harmless to vegetation. On the other hand, an extreme drought will develop to an amazing degree an injury hitherto unknown. The country is so vast, the conditions so varied, and the climate so changeable that the most skillful entomologist can scarcely keep pace with the growing demand for investigation and information. The application of sprays, so vigorously advocated and so successfully promoted by this division, has been of incalculable benefit to agriculture in this country. The fact that the Entomologist, from years of observation and experience, is able by a simple letter or bulletin to appease the alarm of a region over the advent to the locality of an insect hitherto unknown to it, by showing that the destruction is only temporary and caused by some condition of weather or climate, has been in the last four years of invaluable assistance to agriculture. The farmer with this assurance in mind, though suffering present affliction, can with confidence plow and sow for the future. There have been repeated instances of their character, which should be placed to the credit of the division, though in the general estimation they may be lost sight of. The advice the Entomologist is able to give, on the other hand, as to time, season, and methods for the destruction, in whole or in part, of destructive insects, has also, whenever followed, been of vast benefit to horticulture and agriculture.

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

The work of this division, as heretofore stated by me, is of two classes. First, the practical one of the study of the habits of birds and mammals injurious or beneficial to agriculture. A large amount of work has been done in this line and a vast amount of data has been collected which, when published, will give absolute information as to the extent of such injury or benefit, and the best methods of combating the one or promoting the other. I wish to speak, however, more specifically in reference to the second line of work. It may be considered biological, as to the scope of its inquiries, and covers the whole biological field, including not only birds and mammals, but vegetation as well. In its deductions it covers the botanical, as well as the animal world, and in the last three years there has been considerable coöperation between this division and the Division of Botany. The Division of Botany, as it has been observed, in its collections is not limited to the collection of plants, but takes note of the locality, altitude, temperature, rainfall, under which they occur—data which are similar to the data taken in collections of this division—so that between the two there has been hearty and systematic coöperation. The problem is the distribution of animal and vegetable life, so that, the conditions of climate and soil being known, *a priori* may be known what plants and animals will successfully exist in a distinctive locality, region, altitude, or latitude. On broad lines this is more or less known now. It is known, for instance, that oranges will not grow in the open air in Michigan; but a distinctive, systematic knowledge of all the localities in the United States, as to the possibilities of animal and vegetable life, has not been obtained. The law of this distribution is undefined, and I consider that one of the most important scientific investigations now being conducted in the U. S. Department of Agriculture is this biological study. It has been the effort of the Assistant Secretary to coördinate this work in all the branches in any degree impinging upon this question. The law of climate runs through all the divisions; it is found in the distribution of fruits, of insects, of birds, and of vegetable and animal diseases; it is found in that universal effort of life to adapt itself to changed environments. Given accurate information as to the climate and soil of a new region, biology can with reasonable assurance indicate the species which may be successfully introduced. In fact, I consider this the most important single inquiry—the most far-reaching and the most likely to produce ultimate permanent results—that is now being carried on in the Department. The incorporation of the Weather Bureau with this Department opens up a wide field of observation and study that will be ultimately of vastly more benefit to agriculture in coöperation with the other divisions of the Department than the announcement of storms and the daily prediction of the weather. The study of the climate and its effects has become so fixed in the Department within the last two years that it is sincerely to be hoped that no halt shall be made in this line of work, and I speak of this in connection with my remarks on the work of this division for the reason that four years ago, on the beginning of my administration here, I found this class of work done almost exclusively in this division; that is, as a special point to be made, and having, prior to my acceptance of my present trust, paid considerable attention to the subject (in an incidental way, however), I unqualifiedly indorsed the work being done, and have facilitated it in every way possible by coördinating the work of the other divisions and by encouraging it by word and deed. I again repeat that it is to be hoped that this line of work shall not cease, but shall in the future be encouraged and developed.

DIVISION OF VEGETABLE PATHOLOGY.

This division, as heretofore stated, was simply a section of the Division of Botany in 1889. Subsequently its work took so wide a scope that it was deemed best to make it a separate and independent division. Its work is surrounded by much the same difficulties that exist in that of the Division of Entomology. It is impossible to keep pace with all the new diseases afflicting vegetation, some of which are extremely destructive. The peach yellows is of comparatively recent origin, at least in its sweepingly destructive effects. The vine disease of southern California, which blasted so many of its vineyards, was unknown a few years ago. The orange blight, now afflicting Florida, has come to public notice only within the last two years. The pear blight came into the field within the memory of men not far advanced in life, and, in fact, almost all of the diseases have made their appearance or have assumed destructive proportions in the last quarter of a century. This division has taken hold of all these diseases with a will. By experiments in the field, by work in the laboratory, it has demonstrated the high order of its intelligence and administration. As in the Division of Entomology, great results have come from spraying. So, too, in like degree, are seen the benefits of spraying the mixtures devised or promoted by this division—benefits which may well be counted invaluable. A recent computation, made from reports from vinegrowers in only a limited portion of the United States, based upon what they had saved by the use of a single mixture, according to rules laid down by this division, showed that the benefits for that one season, to their single industry alone, had a money value far in excess of what the division has cost the Government since its organization. Many of the diseases are very elusive. We do not yet know what is the cause of peach yellows, nor of orange blight, nor of pear blight, nor of the vine disease in southern California. There seems to be no question that the experiments of this division demonstrate the fact that these diseases are contagious, and are not simply the outgrowth of defective nutrition and the immature growth and impaired vitality of the plant. Elaborate experiments have demonstrated what they are not, thereby restricting the field for future investigation. It has successfully shown that budding from a diseased tree to a healthy one does produce the disease in the latter. Investigations in the laboratory and special studies of the life history and conditions of these diseases are being carried on by the most skillful experts, with the best obtainable appliances, to determine absolutely the cause in the first instance, and then, if possible, to devise a remedy. It may take years, but I firmly believe that a satisfactory solution of many of these problems is in the near future.

DIVISION OF FORESTRY.

There has been a marked advance in forestry sentiment in the last four years. The work in the Division of Forestry is beginning to be felt and more extensively appreciated. It has not been confined simply to the gathering of data as to the effect of deforestation and the best methods of reforestation, nor to the effort to secure data of the distribution in lumber measure of the various kinds of timber in the United States, which has yet by no means been neglected, but has been a factor in the gathering of information as to the proper selection of reservations in the great West. It has entered upon a more important inquiry as to the relative strength of timber for constructive and architectural purposes, and in this line is being so thoroughly appreciated by architects in wood and constructors of bridges and large buildings that there has come to the support of its work an entirely new class of advocates. The support four years ago was largely sentiment, based upon the maxim "Woodman, spare that tree." Now, added to that, is the strong, practical sense of the manufacturing and constructive interests of the country, and of that large body of agriculturists, constantly increasing in the great West, whose products are so largely dependent upon irrigation, the source of which lies in the mountains now covered by forests. The direct benefit of these forests to the water supply is so apparent that the Division of Forestry is being consulted as an authority on the subject. This appreciation justifies the belief that this division has before it a growth far more rapid than in the past. Heretofore, in the eastern portions of the continent the sentiment has been largely in favor of cutting down and destroying the forests rather than their perpetuation, but the time has come when even in regions east of the Mississippi River the changes of climate and the unwonted and sudden freshets have called the attention of all thoughtful men to the principal causes of the changed conditions. As the country has settled up west of the Mississippi River in regions but recently classed as desert with no supposed agricultural possibilities, the subject of water rather than land has become predominant, and the preservation of the forests on the mountain sides and along the streams is being considered not simply desirable, but necessary; so that the East and the West, so different in their physical conditions, are now joining hands in the forest enterprise, and in a comparatively short period the subject of the preservation and systematic use of the forests and the best methods of restoring them will be one of the most important questions of the time.

DIVISION OF POMOLOGY.

The work before this division is one of the most difficult, and, as now organized, is so incomplete because of the lack of funds that it can not be satisfactorily described. The fruits of the country are almost innumerable in their species and varieties. New varieties are being propagated at a rate so much faster than any single division can keep pace with, that it is almost discouraging. One important function of the division is the identifying and naming of fruits. So many of the supposed new varieties are simply abnormal growths of the old, or with the changes in character and form produced by the different conditions of climate and culture, that it is almost impossible to detect the synonymous features. There is hardly a plant that by processes known to the skillful horticulturist or gardener can not be made to assume characteristics which shall mislead the innocent and unwary, and this division should be so fully equipped in men, material, and appliances that it may become a check against the delusive wiles of the pomological speculator. The division, having no laboratory and no experimental grounds, can not apply the tests that would render its decisions authoritative. It is, therefore, limited to gathering such data as it can from the experiments of others. It should charge itself also with collecting information relating to the number, labors, and products of all the fruit-growers of the country, with the well-known characteristics of the different regions. It should charge itself with the study of the fruits best adapted to all localities, with the distribution of the same according to climates and soil, and with the changes that obtain with changed conditions.

The division, so far as it has been able to do so, has labored in all these directions, and is accumulating data and material that shall enable it, when more adequate funds are granted, to handle all these questions authoritatively, which will be of vast benefit to the fruit industry. Its work has been most efficient, so far as it has gone along the lines indicated, and within the four years it is manifest that its purposes and efforts have assumed more definite plans. It has become recognized by the horticulturists of the country as a positive factor in their work.

DIVISIONS OF CHEMISTRY AND MICROSCOPY AND THE OFFICE OF EXPERIMENT STATIONS.

The Division of Chemistry, the Division of Microscopy, and the Office of Experiment Stations were so fully treated in my former report that I have but little to add. The first has more distinctly assumed the attitude of coöperation with the work of other divisions, and has associated with its distinctively chemical work for comparison results of bacteriological study, as conducted by other divisions, and to a certain extent by itself, and its work is assuming that comprehensive character that may in time solve some of the questions that chemistry itself has been found insufficient to solve. It has become apparent that chemistry can not traverse all of the elements of plant growth nor all the conditions of animal nutrition. Chemical changes are wrought by bacteria, digestion is promoted to such an extent by the active energy of the life principle, whether in plant or in animal, that chemistry is only one of the coördinate branches in the comprehensive study of the whole. There has been substantial progress, therefore, along the line of modern investigation in this regard, and this hearty coöperation is more distinctively a feature marking the work of the last four years. The Division of Microscopy has simply added to its labors the investigations made necessary by new inventions, new manipulations, and new discoveries in arts founded upon agricultural production. The Office of Experiment Stations, whose existence is coincident with this administration, has established its line of work. Its hearty coöperation with the experiment stations of the different States has won their regard, and its labors have justified the allotment of duties to it by Congress and by the Department.

FIBER INVESTIGATION.

It will be noted that the first appropriation for this investigation was made in 1891. These investigations have been largely specific, directed toward flax, ramie, and sisal hemp. A special study has been made of the conditions of each one of these—flax as a product of the Northern and Western States and ramie and sisal hemp for the South. The possibilities of producing flax that shall rival the best of Europe has been demonstrated, and all that is needed to establish the industry on a most thoroughly competitive basis is a division of labor between the flax-producer and the flax-manufacturer, carried on by each by better and more economic methods. In the past the farmer did his own retting and scutching. Neither of these are agricultural processes and should be done by a distinct line of operatives. Manufacturers should encourage this division of labor into an intermediate branch, so that the farmer should find a market for his raw material at the doors of the new industry that shall manufacture it into the most approved fiber. These conditions existing, with appropriate legislation that shall encourage its culture, millions of acres can be devoted to a product now comparatively abandoned, thereby bringing a very much needed diversification to agriculture. The study of ramie culture is still crippled by the as yet unsolved question of processes and machines for its decortication. It can be produced in this country of a quality that shall rival that of India and China; but the tests made by this Department of the machines and processes now existing are not flattering, and assurances can not be given that success is near at hand. Better results are apparent in the culture of sisal hemp. This is a product largely raised in and exported from Yucatan. It is our supply in large degree of material for cordage and binding twine. It was supposed that it could not be raised in this country, but it is fast becoming demonstrated that it can be successfully produced in southern Florida. The southern half of that State has wonderful possibilities in store for it, not only relating to fibers, but to sugar cane and semitropical fruits. The production of fibers is not the least of its possibilities. Even if this fiber inquiry should proceed no further, sufficient data have been collected to warrant us in the belief that experience and appropriate legislation will save to the country many millions of dollars now expended in the purchase of commodities and materials abroad which might be produced at home.

ARTESIAN WELLS AND IRRIGATION.

It will be observed that the first appropriation for this inquiry was made in 1890. It will be remembered that in the remarks relating to the Division of Forestry the fact was noted that in the great West it was a question of water rather than of land. This water is sometimes found in subterranean channels and sometimes on the surface. That on the surface is utilized by dams, reservoirs, main and distributing canals. The underflow waters are reached by artesian-wells, large numbers of which overflow at the surface, and others reaching so near that they can be easily raised by pumps driven by windmills or cheap machinery. The investigation has, therefore, taken two lines: (1) As to the extent of country which may be considered the artesian-well region, a large portion of which is away from and beyond the reach of the surface streams. The principal investigation of these artesian basins was along the foothills of the Rocky Mountains, and it has been found that from the British possessions almost to the Gulf of Mexico there is a supply of this underflow water, in some places most marvelous in amount, which, used to supplement the natural rainfall, will add hundreds of thousands of square miles to possible agricultural cultivation. (2) The Anglo-Saxon race know nothing of irrigation. Its home has always been, until recent years, exclusively in the rainy regions. The first seventy-five years after the adoption of our Constitution little thought was given to the subject of irrigation. As the country developed and its migration passed beyond the Missouri it met altogether another civilization—another system of agriculture. The Mexican irrigation ditch, as borrowed from Spain, was a surprise and in some respects a revelation. The marvelous production of a single acre and the possibilities of support to a single family that can be found in a home of 5 acres by the simple control and appropriate distribution of water made a profound impression upon the Anglo-Saxon mind, and during the last twenty-five years the practical energies of this indomitable race have been thrown into the irrigation question. Congress, realizing that this was in a sense a new agricultural question, very properly charged the Department of Agriculture with its consideration, not only for the West itself, but for the East as well. There are seasons when the use of a little water properly distributed will add largely to the products east of the Mississippi River. It is a live question, and the reports already made by this Department have proved of great value, and it is to be hoped that the Department may have firmly established, as a part of its work, the duty of considering it in all its bearings, and the giving of information of the best methods of using for agriculture the waters that are running to waste to the sea. Wise statesmanship should foresee the necessities of this country from sea to sea, with a population possibly increased threefold in the next one hundred years. No fear of competition with the products of the East should prevent appropriate legislation to the end that all regions should be made capable of the highest production. The West will use its own productions, and its growth will avoid the competition which our eastern agricultural friends at the present time so greatly apprehend.

CONCLUSION.

From the foregoing brief statement, which by no means covers all of the points of work desirable to be stated in the divisions over which the Assistant Secretary has had special charge, such rapid progress is observable that he congratulates himself on the fact that in small part he has been connected therewith. The topics always changing have been to him highly interesting, so much so that from this point of view, and this mainly, he regrets the severing of his relations with them. His work has been but in the slightest degree perfunctory. He knows more of this great country, of its possibilities, of the obstacles to agriculture, of the means to overcome them—vastly more than he did when he entered upon his duties. The associations have been so pleasant, not only with all connected with the divisions over which he has had special charge, but with all of the officials of the Department, including the Secretary, who has ever been most kind and considerate, that he shall go into private life with a feeling of heartfelt and kindly remembrance.

A few words to close, of suggestion only. One of the duties, as well as one of the pleasures, that both the Secretary and his assistant have been obliged to suspend and forego, should be the more frequent response to demands from all regions of the country that they should appear before and address assemblages interested in the subject of agriculture. The work has been so exacting, and the Secretary and myself have been able to meet this demand to such a limited degree that the effort to do so has been practically abandoned. There is no department of the Government that represents so many people and which should stand so near to them as the Department of Agriculture; and one of the highest obligations imposed upon its head is to meet them and discuss the questions uppermost in their minds. The Department itself would be better understood, and the ties between it and the practical workers of the soil would be essentially strengthened. The devising of some method for the relief of the Secretary and Assistant Secretary from a large amount of routine labor which could, in my opinion, be made to devolve upon some other officer by an enlargement of the staff of the responsible administration officers of the Department, and perhaps by a reduction in the number of persons with whom the Secretary and Assistant Secretary are compelled to deal directly, would relieve the situation and make possible a more extended personal intercourse between the heads of the Department and the people. No man can be called to the head of this Department who is personally conversant of the needs and demands of the whole country, and nothing will better fit him for a proper adjustment of its work than the personal information which he shall acquire by visiting regions so dissimilar and yet all component parts of a whole included in the sphere of his consideration and proper action.

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

SIR: I have the honor to transmit herewith my report for 1892, which contains a condensed account of the work accomplished during the year by the Bureau of Animal Industry.

Very respectfully,

D. E. SALMON,
Chief.

Hon. J. M. RUSK,
Secretary.

Since April 1, 1891, the force of the Bureau of Animal Industry has been divided, by order of the Secretary of Agriculture, into four divisions, viz, the Inspection Division; the Division of Animal Pathology; the Division of Field Investigations and Miscellaneous Work, and the Division of Quarantine. The different branches of the work will therefore be considered as it was in the report of last year, under the head of the division to which each belongs.

INSPECTION DIVISION.

To this division is assigned all work of an executive nature, including the eradication of contagious diseases, the inspection of export and import animals, meat inspection, vessel inspection, and the regulation of the movement of animals infected with the protozoal disease known as splenetic, or Texas fever of cattle.

CONTAGIOUS PLEURO-PNEUMONIA.

One of the chief objects for the establishment of the Bureau of Animal Industry, as specified in the organic act creating the Bureau, was the eradication of the disease of cattle known as contagious pleuro-pneumonia. This work has been carried on as rapidly as was possible under the conditions prevailing in this country. In the report of the operations for the year 1891 it was stated that all of the States which had been infected with this disease had been freed from the contagion, with the single exception of the State of New Jersey. In that State four affected herds had been found during the year, and it was not possible to consider the State free from infection. The number of inspectors was increased and a vigorous policy of inspection and quarantine was continued, the result being the discovery of the disease in a few additional herds. The affected animals and all which had been in contact with them were at once slaughtered, and the result was the complete disappearance of the disease. No affected animals have been found in New Jersey or in any other State since March 25, 1892. On the 26th day of September, 1892, the following proclamation was issued, declaring the United States to be free from this disease.

PROCLAMATION—ERADICATION OF PLEURO-PNEUMONIA.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

To all whom it may concern:

Notice is hereby given that the quarantines heretofore existing in the counties of Kings and Queens, State of New York, and the counties of Essex and Hudson, State of New Jersey, for the suppression of contagious pleuro-pneumonia among cattle, are this day removed.

The removal of the aforesaid quarantines completes the dissolving of all quarantines established by this Department in the several sections of the United States for the suppression of the above-named disease.

No case of this disease has occurred in the State of Illinois since December 29, 1887, a period of more than four years and eight months.

No case has occurred in the State of Pennsylvania since September 29, 1888, a period of four years within a few days.

No case has occurred in the State of Maryland since September 18, 1889, a period of three years.

No case has occurred in the State of New York since April 30, 1891, a period of more than one year and four months.

No case has occurred in the State of New Jersey since March 25, 1892, a period of six months, and no case has occurred in any other portion of the United States within the past five years.

I do therefore hereby officially declare that the United States is free from the disease known as contagious pleuro-pneumonia.

J. M. RUSK,
Secretary.

Done at the city of Washington, D. C., this 26th day of September, A. D. 1892.

Since this proclamation was issued, a continuous inspection has been maintained in New Jersey, and in that portion of New York adjoining the district of New Jersey which had been infected, but no animal has since been found showing any evidence of being affected with pleuro-pneumonia. The success of this branch of the work of the Bureau of Animal Industry has therefore been complete, and this dangerous and much dreaded disease has been eradicated from our soil.

The United States is the first of the large nations of the world which, having been once extensively infected with this contagion, has been able to completely extirpate it. The time required for this was only about five years, and the total expenditure has been but a little in excess of $1,500,000. When it is considered that there were grave doubts entertained of the possibility of eradicating this disease, and also that other countries have labored a much longer time and made greater expenditures of money without success, the favorable outcome from our efforts which has been reached in such a comparatively short time, and with so small an expenditure of money, is one with which we have every reason to be pleased. The danger from this source which menaced the American cattle industry has been removed, the local restrictions placed upon our interstate trade have been revoked, and the cattle market is beginning to recover from these depressing influences. The following tables show the amount of work which has been done in the different infected States, by years, and also a summary of the whole work:

Table showing the amount of work done in the State of Illinois, by years, for the eradication of pleuro-pneumonia.

	Sept. 1, 1886, to Dec. 3, 1887.	1888.	Total.
Herds inspected	7,411	140	7,551
Cattle inspected	24,059	285	24,344
Post-mortem examinations	7,267	1,712	8,979
Number diseased on post-mortem	350	4	354
Premises disinfected	677	1	678
Diseased cattle purchased	172	4	176
Exposed cattle purchased	870	129	999

Table showing amount of work done in the State of Maryland, by years, for the eradication of pleuro-pneumonia.

	1887.	1888.	1889.	1890.	Total.
Herds inspected	5,704	9,809	10,904	4,210	30,627
Cattle inspected	57,868	60,312	79,606	108,376	306,152
Cattle tagged	....	17,749	10,534	5,463	33,746
Post-mortem examinations	2,788	5,820	11,491	12,949	33,048
Number diseased on post-mortem	1,137	507	76	....	1,720
Premises disinfected	145	145	35	1	326
Diseased cattle purchased	1,442	459	73	....	1,974
Exposed cattle purchased	1,564	1,036	310	20	2,930

NOTE.—To the items "Diseased cattle purchased" and "Exposed cattle purchased," in 1887, are added all purchases of cattle from July 1, 1886, to December 31, 1886.

Table showing amount of work done in the State of New York, by years, for the eradication of pleuro-pneumonia.

	1887.	1888.	1889.	1890.	1891.	1892.	Total.
Herds inspected	1,511	12,333	15,861	19,569	13,381	2,537	65,192
Cattle inspected	25,122	99,726	149,396	150,474	136,111	49,925	610,754
Cattle tagged	....	100,370	33,135	33,752	30,294	13,558	211,109
Post-mortem examinations	1,347	15,538	15,375	18,338	26,953	18,871	96,422
Number diseased on post-mortem	447	2,287	1,012	544	31	....	4,321
Premises disinfected	....	1,339	339	434	49	....	2,161
Diseased cattle purchased	266	1,576	1,053	427	25	....	3,347
Exposed cattle purchased	736	3,196	2,819	1,984	284	....	9,019

NOTE.—The figures for 1892 are brought down to September 26, the date on which the quarantine was removed.

Table showing amount of work done in the State of New Jersey, by years, for the eradication of pleuro-pneumonia.

	1887.	1888.	1889.	1890.	1891.	1892.	Total.
Herds inspected	1,428	8,018	8,455	8,492	8,124	16,813	51,330
Cattle inspected	16,461	72,095	76,001	60,659	68,262	128,017	421,495
Cattle tagged	....	13,318	11,672	8,817	12,818	22,153	68,778
Post-mortem examinations	248	6,846	14,242	9,419	4,417	5,562	40,734
Number diseased on post-mortem	113	514	189	43	63	32	954
Premises disinfected	....	275	208	104	57	196	840
Diseased cattle purchased	94	502	116	44	48	40	844
Exposed cattle purchased	117	945	714	242	227	222	2,467

NOTE.—The figures for 1892 are brought down to September 26, the date on which quarantine was removed.

Table showing amount of work done in the State of Pennsylvania, by years, for the eradication of pleuro-pneumonia.

	1888.	1889.	1890.	1891.	1892.	Total.
Herds inspected	5,291	1,311	1,915	1,096	2,638	12,251
Cattle inspected	72,565	24,003	24,388	55,533	66,487	242,976
Cattle tagged	51,820	1,513	....	....	....	53,333
Post-mortem examinations	13,157	13,412	15,008	55,260	80,384	177,221
Number diseased on post-mortem	72	17	....	....	....	89
Premises disinfected	117	6	....	....	....	123
Diseased cattle purchased	63	....	....	....	....	63
Exposed cattle purchased	131	11	....	....	....	142

NOTE.—The figures for 1892 are brought down to September 26, the date on which the quarantine was removed.

Table summarizing amount of work done in the different States in which pleuro-pneumonia has existed, for the eradication of this disease.

	Illinois.	Maryland.	New York.	New Jersey.	Pennsylvania.	Grand total.
Total herds inspected	7,551	30,627	65,192	51,330	12,251	166,951
Total cattle inspected	24,344	306,152	610,754	421,495	242,976	1,605,721
Total cattle tagged		33,746	211,109	68,778	53,333	366,966
Total post-mortem examinations	8,979	33,048	96,422	40,734	177,221	356,404
Total diseased on post-mortem	354	1,720	4,321	954	89	7,438
Total premises disinfected	678	326	2,161	840	123	4,128
Total diseased cattle purchased	176	1,974	3,347	844	63	6,404
Total exposed cattle purchased	999	2,930	9,019	2,467	142	15,557

NOTE.—To the items "Total diseased cattle purchased" and "Total exposed cattle purchased" are to be added the following: Purchased in Virginia and District of Columbia, 45 diseased animals, making a total of 6,449; Virginia and District of Columbia, 57 exposed animals, making a total of 15,614.

The following table gives a summary of the expenditures for the eradication of pleuro-pneumonia from the beginning of the work to September 1, 1892:

Table showing expenditures for the eradication of contagious pleuro-pneumonia from July 1, 1886, to September 1, 1892.

State.	Salaries.	Traveling.	Miscellaneous.	Affected cattle.	Exposed cattle.	Total.	No. of animals.	
							Affected.	Exposed.
New York	$385,672.70	$58,013.29	$28,897.52	$87,241.69	$198,669.80	$758,495.00	3,347	9,019
New Jersey	185,533.92	44,018.03	12,956.79	20,477.50	60,967.70	323,953.94	844	2,467
Pennsylvania	40,201.36	4,462.42	2,614.66	1,243.50	3,357.50	51,879 44	63	142
Maryland	124,948.22	33,705.74	5,667.42	48,363.41	76,115.85	288,800.64	1,974	2,930
Illinois	52,170.31	3,819.29	4.126.61	3,260.80	16,561.64	79,938.65	176	999
Vermont,* Mass.,* Virginia, and District of Columbia	3,342.28	1,177.72	19.55	739.00	754.50	6,033.05	45	57
Total	791,868.79	145,196.49	54,282.55	161,325.90	356,426.99	1,509,100.72	6,499	15,514

* Investigating reported outbreaks.

MOVEMENT OF CATTLE FROM SPLENETIC FEVER DISTRICT.

The regulations for preventing the dissemination of the disease known as splenetic or Texas fever, which have been enforced during 1892, are substantially the same as those issued in 1891. The changes which have been made have had the effect to place outside of the infected district a number of counties in Texas, Tennessee, North Carolina, and Virginia which were previously included in this district, but which experience has shown were free from the contagion. The object of the regulations is to separate the infected from the noninfected cattle in the stock yards and channels of transportation outside of the infected district, and to secure the cleaning and disinfection of all cars which have carried infected cattle. The regulations have not prevented or hindered the shipment of cattle from the infected districts to the markets for slaughter, nor have they depreciated the value of these cattle. On the contrary, they have had a marked tendency to sustain and increase the values of cattle by preventing losses from this disease, and by increasing the purchases for feeding purposes, on account of the safety with which these can now be made. The full text of the regulations is as follows:

REGULATIONS CONCERNING CATTLE TRANSPORTATION.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., February 26, 1892.

To the managers and agents of railroad and transportation companies of the United States, stockmen, and others:

The regulations concerning cattle transportation issued by this Department January 11, 1892, are hereby revoked, and the following prescribed in place thereof:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases of domestic animals," and of the act of Congress, approved March 4, 1891, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1892, you are hereby notified that a contagious and infectious disease known as splenetic or Southern fever exists among cattle in the following-described area of the United States:

All that country lying east and south of a line commencing at the southwest corner of Valverde County, State of Texas, on the Rio Grande River; thence running northerly along the western boundaries of Valverde and Crockett counties to the northwest corner of Crockett County; thence easterly along the northern boundaries of Crockett and Schleicher counties to the southeastern corner of Irion County; thence northerly along the eastern boundary of Irion County to the northeast corner of said county; thence northerly to the southern boundary of Coke County; thence westerly to the southwestern corner of Coke County; thence northerly along the western boundary of Coke County to the southern boundary of Mitchell County; thence easterly to the southeast corner of Mitchell County; thence northerly along the western boundaries of Nolan and Fisher counties to the southern boundary of Kent County; thence easterly along the southern boundary of Kent County to the southwestern corner of Stonewall County; thence northerly along the western boundary of Stonewall County to the southeastern corner of Dickens County; thence easterly along the northern boundary of Stonewall County to the southwestern corner of Knox County; thence northerly along the western boundaries of Knox and Hardeman counties to the Red River; thence northwesterly following the Red River to its point of intersection with the one hundredth meridian of longitude; thence northerly from said point of intersection along said one hundredth meridian to the southern boundary of the State of Kansas; thence easterly along the southern boundary of the State of Kansas to the northeast boundary of the Indian Territory; thence southerly along the eastern boundary of the Indian Territory to the southwest corner of the State of Missouri; thence easterly along the southern boundary of the State of Missouri to the Mississippi River; thence running southerly along the Mississippi River to the southwestern corner of the county of Lauderdale, State of Tennessee; thence running easterly, following the southern boundaries of the counties of Lauderdale, Crockett, Gibson, Carroll, Benton, Perry, Lewis, Maury, Marshall, Bedford, Coffee, Grundy, Sequatchie, Hamilton, Meigs, McMinn, and Monroe, State of Tennessee, to the easterly boundaries of said State; thence following the northern boundaries of the counties of Cherokee, Macon, Jackson, Transylvania, and Henderson, State of North Carolina, to the southeast corner of the county of Buncombe of said State; thence in a northeasterly direction, following the Blue Ridge Mountains, to the southwestern corner of the county of Madison, State of Virginia; thence easterly along the southern boundaries of the counties of Madison, Culpeper, and Stafford; thence northerly along the eastern boundary of Stafford County to the Potomac River; thence following the Potomac River southerly to the Chesapeake Bay; thence easterly along the southern boundary of the State of Maryland to the Atlantic Ocean.

From the 1st day of March to the 1st day of December, 1892, no cattle are to be transported from said area to any portion of the United States north or west of the above-described line, except by rail for immediate slaughter, and when so transported the following regulations must be observed:

(1) When any cattle in course of transportation from said area are unloaded north or west of this line to be fed or watered, the places where said cattle are to be fed or watered shall be set apart and no other cattle shall be admitted thereto.

(2) On unloading said cattle at their points of destination, pens shall be set apart to receive them, and no other cattle shall be admitted to said pens; and the regulations relating to the movement of Texas cattle, prescribed by the cattle sanitary officers of the State where unloaded, shall be carefully observed. The cars that have carried said stock shall be cleansed and disinfected before they are again used to transport, store, or shelter animals or merchandise.

(3) All cars carrying cattle from said area shall bear placards stating that said cars contain Southern cattle, and each of the waybills of said shipments shall have a note upon its face with a similar statement. Whenever any cattle have come from said area and shall be reshipped from any point at which they have been unloaded to other points of destination, the cars carrying said animals shall bear similar placards, with like statements, and the waybills be so stamped. At whatever point these cattle are unloaded they shall be placed in separate pens, to which no other cattle shall be admitted.

(4) The cars used to transport such animals, and the pens in which they are fed and watered, and the pens set apart for their reception at points of destination, shall be disinfected in the following manner:

(*a*) Remove all litter and manure. This litter and manure may be disinfected by mixing it with lime or diluted sulphuric acid, or, if not disinfected, it may be stored where no cattle can come into contact with it until after December 1.

(*b*) Wash the cars and the feeding and watering troughs with water until clean.

(*c*) Saturate the walls and floors of the cars and fencing, troughs, and shutes of the pens, with a solution made by dissolving four ounces of chloride of lime to each gallon of water. Or disinfect the cars with a jet of steam under a pressure of not less than fifty pounds to the square inch.

(5) It is expressly provided that cattle may be removed from those counties in the State of Tennessee which lie south of the line hereinabove described to those counties lying north of said line in said State for grazing purposes, in accordance with the regulations of the authorities of the State of Tennessee.

(6) It is further expressly provided that cattle which have been at least ninety days in the counties of Coke, the eastern portion of Tom Green, Nolan, Fisher, Stonewall, Haskell, Knox, and Hardeman, State of Texas, which lie within the above-described area, may be moved from said counties by rail into the States of Colorado, Wyoming, and Montana, in accordance with the regulations made by said States for the admission of Southern cattle thereto: *Provided*,

(1) That cattle from said area shall go into said States only for slaughter or grazing, and shall on no account be shipped from said States into any other State or Territory of the United States before the 1st day of December, 1892.

(2) That such cattle shall not be allowed in pens or on trails or on ranges that are to be occupied or crossed by cattle going to the eastern markets before December 1, 1892, and that these two classes of cattle shall not be allowed to come into contact.

(3) That all cars which have carried cattle from said area shall, upon unloading, at once be cleaned and disinfected in the manner provided by these regulations.

(4) That the State authorities of the States of Colorado, Wyoming, and Montana agree to enforce these provisions.

The losses resulting yearly to the owners of susceptible cattle in the interstate and export trade, by the contraction of this disease from exposure in unclean and infected cars and pens, and by means of the manure carried in unclean cars from place to place, have become a matter of grave and serious concern to the cattle industry of the United States. It is absolutely essential, therefore, that this cattle industry should be protected as far as possible by separating the dangerous cattle and by the adoption of efficient methods of disinfection.

Inspectors will be instructed to see that disinfection is properly done, and it is expected that transportation companies will promptly put into operation the above methods.

Very respectfully,

J. M. RUSK,
Secretary.

The following supplementary regulations were made during the year:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 13, 1892.

Notice is hereby given that the regulations of the U. S. Department of Agriculture, dated February 26, 1892, concerning cattle transportation, are modified so as to exclude the counties of Orange, Albemarle, Greene, Nelson, and Amherst, in the State of Virginia, from the infected area described in said regulations, and the quarantine line established by said regulations is hereby changed so as to run along the southern boundaries of said counties, placing these counties north of said line.

J. M. RUSK,
Secretary.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., July 5, 1892.

The permission granted to ship cattle from the counties named in the sixth regulation of the Regulations of the Department of Agriculture, of date February 26, 1892, concerning cattle transportation into the States of Colorado, Wyoming, and Montana, is hereby extended to shipments, under the conditions named in said sixth regulation, to the State of South Dakota.

J. M. RUSK,
Secretary.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., July 18, 1892.

To the managers and agents of railroad and transportation companies of the United States, stockmen, and others:

Whereas the county of Uvalde, State of Texas, was, by an order duly made by the Secretary of Agriculture, on the 26th day of February, 1892, in pursuance of the act of Congress of May 29, 1884, and acts supplemental thereto, declared to be infected with a contagious and infectious disease, known as splenetic or Southern fever; and

Whereas the county of Pecos, State of Texas, was, by said order, included in the area of country declared to be free of the said contagious and infectious disease; and

Whereas a large number of cattle have been moved from the said county of Uvalde into the county of Pecos, State of Texas, since the making of said order, and such movement of cattle is a violation of said order, and the cattle moved into Pecos County having rendered all cattle in said county dangerous to be moved into other uninfected areas of the United States: It is therefore

Ordered, That no cattle shall be moved from the county of Pecos, State of Texas, into parts of the United States north or west of the said county of Pecos, except for purposes of immediate slaughter, and then to be kept separate as infected cattle.

J. M. RUSK,
Secretary.

These regulations concerning cattle transportation have been as rigidly maintained as was possible under existing laws. In the main they have been extremely successful in preventing the spread of the disease, and cattle have been safely purchased in all the large stock yards of the country for feeding purposes without any losses having occurred among them from splenetic fever. The numerous large outbreaks which have been the rule in former seasons have not occurred, and with the exception of an outbreak in western Texas, and one in Lyons and adjoining counties in Kansas, none have been reported. The number of cases of splenetic fever occurring among export cattle has also been greatly reduced, as compared with former years. One of the main causes of the appearance of splenetic fever among export cattle is the shipment of these animals in cars which had not been disinfected, and which had carried infected cattle to points in various States where this Department had no representatives. The Department has maintained a corps of inspectors at all of the large stock yards to which infected cattle are transported, and from which they are sent to other points in small consignments, and has, whenever possible, informed the authorities of the various States to which cars containing such cattle were going of their destination. In such cases it has been necessary to leave to State authorities the enforcement of their local regulations for handling such cattle and for disinfecting the cars. In many cases, however, the cars under such circumstances are not disinfected, and being used for the shipment of susceptible cattle, the disease is thereby contracted. The prevention of this disease will probably not be absolute until Congress enacts some legislation that will compel railroad companies to comply with the regulations for cleaning and disinfecting cars that have carried infected cattle, and to provide penalties for the violation of the other sections of the regulations. There have been reported 131 head of cattle in the export trade affected with this disease during 1892, as compared with 524 for the same period in 1891. This shows a very gratifying improvement, but in order to maintain the reputation of our export cattle, and to keep the trade at its present proportions, the exposure of export cattle to the disease must be entirely prevented. This can only be accomplished by rigidly maintaining the boundary lines of the infected district as at present defined, and in adopting still more stringent measures to secure the disinfection of cars. The following table shows the places at which inspection has been made, the number of cattle which have been inspected, and also the number of cars which have been cleaned and disinfected under the supervision of Department employees:

Statement showing work performed by inspectors of the Bureau of Animal Industry in supervising the movement of infected cattle during the quarantine season, February 26, to December 1, 1892.

Place.	Car loads of cattle received from infected district and inspected at quarantine pens.	Cattle contained in cars received at quarantine pens.	Car loads in transit for points beyond.	Cars cleaned and disinfected.
South Omaha, Nebr	274	6,939	17	274
Chicago, Ill	25,628	690,681	2,476	25,173
Kansas City, Mo	12,344	356,970	7,498	....
East St. Louis, Ill	15,415	430,126	10,754	....
Indianapolis, Ind	1,361	28,581	1,134	265
Pittsburg, Pa	580	15,269	539	41
Baltimore, Md	8	172	3	7
Philadelphia, Pa	504	10,594	37	504
New York, N. Y	1,218	39,862	....	1,218
Boston, Mass	50	977	....	....
Buffalo, N. Y	1,286	39,151	1,213	873
Argentine, Kans	7,597	229,809	7,597	6,644
Herington, Kans	3,942	109,391	3,942	2,098
Parsons, Kans	9,086	243,651	9,086	2,016
State Line, Kans	2,058	57,110	2,058	1,323
Baxter Springs, Kans	306	8,976	306	79
Poplar Bluff, Mo	1,920	53,280	1,920	....
Springfield, Mo	8,177	227,662	8,177	....
Total	91,754	2,545,601	56,757	40,515

It appears from the above table that more than two and a half millions of cattle from the infected district have been inspected and kept separated from other cattle in the channels of commerce, and that more than forty thousand cars have been disinfected under the supervision of the Department inspectors. This great amount of work has been accomplished without friction, and without hardship to those who have owned the stock. It is a line of work which has been extremely popular, as every one who has been engaged in the shipment or sale of cattle has been able to see the benefits which the regulations have secured. Just how much has been saved by the prevention of disease and facilitating the movement and sale of cattle it is impossible to accurately estimate, but there is no doubt that it amounts to several millions of dollars. The insurance on export cattle has been greatly reduced because of the diminution of losses from this disease, and it is estimated that there has been a saving in this direction alone of about $5 on each animal exported. This would amount to nearly $2,000,000 with the number of cattle exported during the present year.

INSPECTION OF EXPORT ANIMALS.

The inspection of animals for export has been continued during the year, under the provisions of the act of Congress approved August 30, 1890, and in the manner described in the last report made to Congress. The animals inspected have been principally cattle, and the following table shows the number inspected, the points at which the inspection was made, the number tagged for export, and the number of animals rejected by the inspectors:

Statement showing number of cattle inspected and tagged for export at the various stock yards and ports during the fiscal year ending June 30, 1892; also number rejected on account of disease.

Stock yards.	Inspected.	Tagged.	Rejected.
Chicago, Ill	244,109	243,343	766
Buffalo, N. Y	153,435	33,096	46
Baltimore, Md	70,530	41,116	5
Philadelphia, Pa	28,509	2,293	4
Indianapolis, Ind	2,677		
Pittsburg, Pa	27,568	8,248	6
Boston, Mass	129,512	20,417	7
Portland, Me	8,251	45	
New York, N. Y	149,800	36,460	9
Norfolk, Va	912	912	
New Orleans, La	661	661	
Newport News, Va	8,242	2,889	
Total	824,206	389,480	843

Under the column "Inspected" is included all reinspections made at ports of export of cattle previously inspected and tagged at interior yards; also reinspections made at the yards at Buffalo and Pittsburg of cattle that had previously been inspected at Chicago. This column shows the total amount of work done at the various yards and ports throughout the country in the handling of export cattle.

The following table shows the number of vessels inspected, the number of cattle exported from the various ports, and the countries to which they were shipped:

Exports of domestic cattle to Europe for the fiscal year ending June 30, 1892, as compared with the exports for the fiscal year ending June 30, 1891.

Port of export.	Steamers inspected.	Great Britain.	Germany.	Belgium.	France.	Total.
New York, N. Y	382	145,762	3,440	448	150	149,800
Boston, Mass	240	129,512				129,512
Baltimore, Md	153	62,422	382	588	520	63,912
Philadelphia, Pa	78	28,190				28,190
New Orleans, La	5	661				661
Portland, Me	24	8,251				8,251
Norfolk, Va	5	912				912
Newport News, Va	30	8,242				8,242
Aggregate fiscal year ending June 30, 1892	917	383,952	3,822	1,036	670	389,480
Aggregate fiscal year ending June 30, 1891	489	344,417	5,518	6,582	5,885	362,402

NOTE.—The exports for the fiscal year ending June 30, 1892, show an increase of 7½ per cent over the exports for the preceding year.

INSPECTION OF IMPORT ANIMALS.

The inspection of animals imported into the United States under the provisions of the act of Congress approved August 30, 1890, is made partly under the Inspection, and partly under the Quarantine Division of this Bureau. Animals from Canada and Mexico are inspected at ports of entry, and in case they are found healthy are allowed entry without detention. This inspection is made by the Inspection Division. Animals coming from other countries than those situated in North, Central, and South America, are quarantined at the port of entry under the direction of the Quarantine Division. This work will be referred to later on in this report. No entries of animals have been reported from Mexico during the year. The number and kind of animals imported from Canada, as reported by the inspectors of the Inspection Division, is shown by the following table:

Statement showing the imports of cattle, sheep, and swine into the United States from Canada during the fiscal year ending June 30, 1892.

Port of entry.	Cattle.	Sheep.	Swine.	Remarks.
Buffalo, N. Y	185	194,103	1	
Charlotte, N. Y	....	2,858	....	
Suspension Bridge, N. Y	5	504	....	
Richford, Vt	2	8,932	....	
Newport, Vt	783	18,323	....	513 cattle en route to Boston for export.
Vanceboro, Me	3	29,176	....	
Houlton, Me	5	11,156	2	
Ogdensburg, N. Y	4	34,879	....	
Morristown, N. Y	6	6,565	6	
Cape Vincent, N. Y	19	3,579	2	
Rouses Point, N. Y	2	13,766	8	
St. Albans, Vt	1,389	10,169	....	1,388 cattle en route to Boston for export.
Island Pond, Vt	103	34,356	2	100 cattle en route to Boston for export; 103 sheep quarantined for foot-rot; recovered.
Detroit, Mich	120	1,450	12	
Port Huron, Mich	47	3,701	41	
Total	2,973	373,517	74	

NOTE.—This statement does not include imported live stock received at the quarantine stations located on the seaboard.

The necessity for the inspection of animals from Canada is evident from the widespread prevalence of foot-and-mouth disease and pleuro-pneumonia in Europe, and the constant importation of animals from Europe into Canada. Only one lot of animals from Canada has been detained, and that was a lot of 123 sheep affected with foot-rot, a contagious disease which causes heavy losses to sheep-owners, and which should be guarded against. At present there is no authority for inspecting imported horses, and as these animals are liable to be affected by any one of several serious contagious diseases, some provision should be made for the inspection of these animals, and for preventing their entry in case they are found to be affected with such diseases.

REVOCATION OF ORDER REQUIRING SLAUGHTER OF SHEEP LANDED IN GREAT BRITAIN.

It should be mentioned, in this connection, that since the regulations of the Secretary of Agriculture have been enforced which require the quarantine of sheep imported into the United States, and, also, the inspection of exported sheep, an order has been issued by the British authorities revoking the regulations which caused the slaughter of sheep from this country on the docks where landed. This concession is extremely gratifying, since this burdensome restriction on the export trade in live sheep had been in operation for thirteen years. The order removing this restriction went into effect September 1, 1892.

INSPECTION OF AMERICAN CATTLE IN GREAT BRITAIN.

The American veterinarians located at the foreign animals wharves in Great Britain, by the courtesy of the British authorities, have continued inspecting cattle landed there from this country. The object of this inspection has been to learn the condition in which our cattle arrive, the extent of the losses at sea, and to determine if the lung disease with which some of these animals have been found affected by the British inspectors was really contagious pleuro-pneumonia, as alleged by them. In order to obtain all the evidence possible on this point, our cattle have all been tagged with a number, and records kept by which they could be traced to the stock yard where originally purchased, and also to the farms on which they were fed. This gives a history of any individual animal in connection with the veterinarian's diagnosis of disease. During the fiscal year ending June 30, 1892, four animals have been reported by the British inspectors as being affected with contagious pleuro-pneumonia. Two of these, according to the opinion of the American inspectors, were affected with broncho-pneumonia, from cold and exposure during the voyage, and two were reported as affected with emphysema of the lungs. In none was there any appearance of contagious pleuro-pneumonia. The tag numbers of these animals were cabled to the Department, an inspector was sent to the farms from which they came, where a careful investigation showed that there had been no contagious disease of cattle to which these animals might have been exposed. It is evident, therefore, that none of these animals were affected with contagious pleuro-pneumonia, because this disease did not exist in the section of the country from which they came. The total number of cattle inspected by the veterinarians of this Department in Great Britain during the year, and the loss reported by them as having occurred at sea, is shown by the following table:

Statement showing losses at sea and number of cattle inspected by United States inspectors stationed at London, Liverpool, and Glasgow, during the fiscal year ending June 30, 1892.

Port.	No. cattle inspected.	Loss at sea.
London	139, 750	991
Liverpool	183, 693	1, 814
Glasgow	44, 571	468
Total	368, 014	3, 273

Percentage of loss during the fiscal year ending June 30, 1892, seven-eighths of 1 per cent.
Percentage of loss during the fiscal year ending June 30, 1891, 1$\frac{3}{8}$ per cent.

It will be interesting at this time to review the alleged cases of contagious pleuro-pneumonia found among United States cattle by the British inspectors since the representatives of this Department have been stationed in England. The official reports state that fourteen cases of pleuro-pneumonia were found in 1890 among cattle from the United States. The American inspection began August 16, 1890, and from that time to the end of the year no cases alleged to be this disease were reported. The entire number reported had consequently been found previous to August 16, and the sudden disappearance of the disease indicated either that the eradication of pleuro-pneumonia in the United States had prevented the exportation of infected animals or that the English inspectors were more careful in their diagnosis and for the time being stopped reporting cases of broncho-pneumonia as contagious pleuro-pneumonia.

It is not a pleasant task to question the diagnosis of professional gentlemen under any circumstances, but in this case there is no other alternative. It has been asserted for more than ten years by competent English and American authorities that the cattle from this country alleged by the British inspectors to be affected with contagious pleuro-pneumonia were not suffering from that disease, but from ordinary pneumonia, induced by injuries and exposure during the voyage. The answer to this assertion has simply been that the British inspectors know pleuro-pneumonia when they see it, and that, so long as lungs are found in American cattle affected as the ones in question have been, the United States will be treated as a country affected with that disease.

This is a serious commercial question to the United States, and it is also a serious scientific question to the veterinary profession of the world. Are we, as veterinarians, to admit that after the years of struggling with pleuro-pneumonia, after the scientific investigations which have been made, after the thousands of autopsies which we have had an opportunity to witness in eradicating the disease—are we, after all this, to admit, I repeat, that we know so little about the changes caused by it in the affected animal that there is any substantial reason for the differences of opinion which have been expressed by men who stand high as authorities on such questions?

Every veterinary pathologist who has had experience with pleuro-pneumonia must know that there are certain appearances of the lungs in this disease which are peculiar to it, and which, if they were found associated, would immediately disarm criticism as to the diagnosis. On the other hand, it is equally well known that in the absence of these peculiar appearances or pathognomonic lesions, the animal affected can not be pronounced affected with pleuro-pneumonia, unless there is a clear history of exposure to that disease or unless experiments have shown that typical cases of pleuro-pneumonia can be produced in other animals by cohabitation with them. In other words, pleuro-pneumonia can not be properly diagnosed in an animal or a group of animals unless some lesion is found which is peculiar to and characteristic of that disease.

In the whole decade of controversy in which the discovery of hundreds of cases has been claimed, the British inspectors have never produced for the satisfaction of this Government one single lung from an American bullock which presented characteristic lesions of contagious pleuro-pneumonia. This is an important assertion to make, and one the serious character of which is fully appreciated by the writer. Having, however, carefully followed the discussion and the official reports, having seen specimens from a considerable number of the lungs said to be affected with typical pleuro-pneumonia, and having had careful descriptions of the others seen by the American inspectors, this assertion is made with the fullest confidence that it is correct.

With these views, clearly expressed, the history of such discoveries on the English docks will be continued, to include the latest returns which have been received.

From August 16, 1890, to February 1, 1891, not a single case of alleged pleuro-pneumonia was reported. On February 2, 1891, during the temporary absence of the American inspector, a case of pleuro-pneumonia was reported at Deptford, as having been discovered in the lungs of a bullock shipped from New York. On April 15, 1891, two more cases were found among a lot shipped from Baltimore. These were the only cases brought to the attention of the American inspectors during 1891, and these animals, in their opinion, were affected with broncho-pneumonia.

Specimens from these lungs were submitted to Prof. Williams, the eminent veterinarian of Edinburg, who had no hesitation in pronouncing them affected with simple broncho-pneumonia, without any of the peculiar characters of contagious pleuro-pneumonia. The history of the animals in question was also traced in the United States, and it was shown that there was no pleuro-pneumonia in the sections of the country from which they came, and that they could not have been exposed to the contagion on their way to the vessels by which they were shipped.

When the annual report of the director of the veterinary department for the year 1891 appeared, it was found that four cases of pleuro-pneumonia had been charged against the United States. One of these was said to have been found in a shipment from Boston, but the American inspector was neither shown the lung nor notified that this case had been reported.

From August 16, 1890, to January 1, 1892, but four animals from the United States were reported as affected with pleuro-pneumonia. In May, 1891, one of the British inspectors found a lung similarly affected in a Canadian steer, but when this case was brought to the attention of the director of the veterinary department, it was promptly decided to be simple broncho-pneumonia.

In January, 1892, one case of pleuro-pneumonia was reported in a shipment from Boston and two cases in a shipment from Philadelphia. In February one case was reported in a shipment from Baltimore. These animals, according to the American inspectors, were affected with broncho-pneumonia. All of these animals were traced by their tag numbers, and it was clearly established that none of them could have been exposed to the contagion of pleuro-pneumonia previous to their shipment from the United States.

No other cases alleged to be pleuro-pneumonia were brought to the attention of the United States inspectors previous to the issuance of the proclamation of the Secretary of Agriculture declaring the United States to be free from that disease, and to have been free for the previous six months. Immediately after the publication of this proclamation in the newspapers of Great Britain, the British inspectors commenced reporting cases of pleuro-pneumonia, and they have continued making such reports with the most astounding frequency.

Bearing in mind that during two years but eight cases of pleuro-pneumonia, all told, were reported by the British inspectors, we will see what a wonderful stimulus for such discoveries the proclamation of eradication proved to be. This proclamation was issued on September 26, 1892. The number of cases sinces reported by the British inspectors is as follows:

Steamship.	Sailed from—	Date.	Cases.
England	New York	Sept. 22	1
Greece	do	Oct. 11	1
Borderer	Boston	Oct. 21	2
Cufic	New York	Oct. 25	1
Othello	do	Oct. 25	3
Venetian	Boston	Nov. 6	1
Roman	do	Nov. 9	1
Montezuma	New York	Nov. 12	1
Ottoman	Boston	Nov. 15	1
Michigan	do	Nov. 22	2
Angloman	do	Nov. 26	3
Sedgemore	Baltimore	Nov. 26	6
Durham City	Boston	Nov. 26	1
Roman City	do	Dec. 11	3
Total			32

This table shows that in two and one-half months since the promulgation of the proclamation declaring the United States to be free from pleuro-pneumonia the British inspectors have reported four times as many cases of that disease among American cattle as they did in the previous two years. Instead of the number of animals reported being at the rate of four per annum, as it had been for two years, it suddenly increased to 150 per annum. No one can pretend that there has been any change of conditions to account for such a sudden and enormous increase in the number of cases of pleuro-pneumonia existing among our export cattle, if we admitted, which we do not, that the cases reported were really of that disease. The number of animals exported has not been measurably increased, and the districts from which they have been purchased have been the same; pleuro-pneumonia has been so thoroughly eradicated that no case of it has been discovered in the United States during the last nine months, and yet, in spite of these facts, the number of affected animals found on the other side has increased 3,700 per cent.

Animals from Canada have been found affected with the same lung disease as has been reported to be pleuro-pneumonia when found in cattle from the United States. Until recently, however, this was passed as simple broncho-pneumonia. Since the greatly increased number of cases have been charged against the United States, a few cases of pleuro-pneumonia have been reported in Canadian cattle. In one case it was alleged that the affected Canadian animal transmitted the disease to other cattle with which it came in contact. It would certainly be interesting to see the character of the lesions which these cases presented. According to Prof. Williams, the disease was broncho-pneumonia and not pleuro-pneumonia.

It is reported in the English agricultural press that all the cattle in this shipment, and all of those which had been in any way exposed to them, were slaughtered at great expense to the Government. As a result, an order has been issued requiring Canadian cattle to be slaughtered on the docks where landed, under the same conditions as cattle from the United States. It may be added, however, that notwithstanding the great danger to the British cattle interests from pleuro-pneumonia in Canadian cattle, which this circumstance would lead one to believe must exist, the order mentioned did not go into effect immediately, but its action was considerately postponed until the shipments for the year had all or nearly all arrived.

It has already been stated that during the ten or more years of controversy no American inspector has ever been shown the lungs of a bullock from the United States, slaughtered in England, which presented the characteristic lesions of contagious pleuro-pneumonia, and it may be added that, in spite of the enormous interests involved, there is no evidence beyond the mere assertion of the British inspectors that a lung with such characteristic lesions coming from an American animal has ever been found by them. It is plain that in this case assertion is not sufficent evidence, for what the British inspectors assert to be characteristic lesions of pleuro-pneumonia the American inspectors assert are the lesions of an entirely different disease. What is needed is the production of one or more lungs taken from American cattle, which present the lesions generally recognized as forming a typical representation of contagious pleuro-pneumonia.

It ought not to be very difficult to agree as to what constitutes such a typical case. It is not necessary to consider the endless controversies which have arisen in the field of pathological histology as to the origin and extension of the disease process, the peculiar microscopical characters, or the varieties of germs which are present. There appears to be little prospect of harmony on these points among microscopists for a long time to come. The macroscopical changes, however, are evident to the eye of every veterinarian; there is practical unanimity in regard to their significance, and we should be able to decide when a lung presents the characteristic and typical appearances of a disease which has been so long known and so carefully studied.

One of the most characteristic features of contagious pleuro-pneumonia is the extent of lung tissue involved and the intensity of the process. The inflammation is not confined to the anterior and inferior portions of the lung, but it extends to all parts of the organ. We may find one-half, two-thirds, or the whole of one lung involved. The affected portion is completely hepatized, very solid, the alveoli, the finer bronchi, the lymph spaces are all filled with exudate; the lung may be cut into slices which are firm, solid, and resistant, and is so increased in weight that a single lung may weigh 30, 35, or even 40 pounds. The pleura are greatly thickened, covered with false membranes, and adherent to the thoracic walls. The pleural cavity contains quarts or gallons of effusion in which float masses of coagulated lymph. The lung on cross-section shows lobules of different color, indicating hepatization of various ages, and the interlobular connective tissue is distended with yellowish lymph, either liquid or coagulated. The veins are found inflamed on their internal surface and plugged with thrombi which are firmly adherent to the diseased surface.

This is the description of a typical case of acute contagious pleuro-pnuemonia, and it requires all of these different features to constitute such a case. Neither hepatization of the lobules, distention of the interlobular connective tissue, nor pleurisy, nor all three combined are characteristic of contagious pleuro-pneumonia. It is impossible to select any one character as pathognomonic, and it is the effort to do this which has created so much confusion and uncertainty. What we insist upon is the combination of characters which together make up the peculiar picture of the lung affected with contagious pleuro-pneumonia. These are, briefly, (1) the great extent of lung tissue involved; (2) the firmness, solidity, and weight of the hepatized tissue; (3) the intense pleuritis, as shown by the thickness of the pleura, the abundance of false membranes, and the quantity of effusion; (4) the difference in age of the hepatization, as shown by the varied colors of the lobules in different portions of a cross-section; (5) the distention and thickening of the interlobular connective tissue; (6) the inflammation of the internal surface of the veins, with firmly adherent thrombi.

Such cases as that outlined above are very common, indeed are the rule in the genuine contagious pleuro-pneumonia of cattle. Why is it that not one single lung affected in this manner has ever been found among the hundreds of cases of alleged lung plague found by the British veterinarians among American cattle?

So much for acute pleuro-pneumonia. The chronic form also has its typical characters, which are well known and easily distinguished. It has been often remarked, and very justly, that, with cattle brought from a pleuro-pneumonia district, chronic cases are more often discovered than acute ones. Why have no chronic cases of pleuro-pneumonia been found among the hundreds of thousands of American cattle shipped to Great Britain since the United States inspectors have been located in that country? Has this mystery ever suggested itself to the British inspectors, and, if so, what can be their explanation of the singular absence of the cases which would be most likely to be found?

In contagious pleuro-pneumonia the plugging of the veins and the intense hepatization which follows lead to necrosis or death of the entire mass of tissue affected. The result is, if the attack is not fatal, that a thick, fibrous cyst-wall forms around the necrosed tissue, and this is preserved in such perfect condition that there are no signs of putrefaction, and the structure and appearance of the hepatized tissue may be made out for months afterward. This condition is typical of chronic contagious pleuro-pneumonia. It is found in the greater part of the animals which have had an attack and recovered. It is the most common leison found in the lungs of cattle in pleuro-pneumonia districts. If pleuro-pneumonia exists in sections of this country from which cattle are being shipped to England these cysts, with thick fibrous walls, containing great masses of hepatized lung tissue 3 to 6 inches in diameter, should be found even more frequently than the acute form of the disease. How can the singular freedom of American cattle from such lesion be explained?

With such acute cases or such chronic cases of pleuro-pneumonia as are above described there would be no difficulty in making a diagnosis. The acute lesions mentioned are pathognomonic, and if there is any other disease of cattle in which there is encystment of such hepatized masses of lung tissue it must be very rare. But the British veterinarians have not discovered either the acute or the chronic forms of disease above described, and for that reason their diagnosis is contested. The cases of lung disease which they have discovered have varied in character, and to the mind of the writer have evidently been produced by various causes. The most common of these causes have been exposure and injury.

It may be freely admitted that in some of these cases there has been distention of the interlobular connective tissue, with more or less hepatization, and in occasional instances moderate pleurisy. In this, however, there is nothing characteristic of contagious pleuro-pneumonia. Neither in the extent of organs involved, in the firmness and density of the hepatized tissue, in the degree of the pleurisy, in the difference in the age of the hepatized areas, in the width of the connective tissue bands, nor in the plugging of the veins, much less in a combination of these, has there been anything to denote contagious pleuro-pneumonia.

In one of the cases pronounced to be beyond doubt, of which a specimen was forwarded to Washington for examination, the lesion was evidently not extensive, the connective tissue bands were only moderately distended, the coagulated lymph could be easily picked from the meshes in little masses from the size of a pin head to that of a pea, the hepatization was very slight, and the tissue of the affected lobules still quite spongy, while the thickening of the pleura was scarcely more than visible. This was the first case reported after the publication of the proclamation of the Secretary of Agriculture declaring the United States free from the plague. It was widely heralded through the press as a typical case. In the majority of cases the lesions, according to the reports of the American inspectors and of Prof. Williams, are those of broncho-pneumonia.

Croupous pneumonia, interstitial pneumonia, and broncho-pneumonia are conditions which have long been described and are still recognized by veterinary authorities as liable to occur in cattle without any connection with contagious pleuro-pneumonia. No one can successfully contest the independent occurrence of these lesions, and there certainly could be no conditions in the surroundings more favorable to their production than obtain on board ship during the cold months of the year, when storms, high winds, and extremely low temperature are common.

When cattle have been exposed alternately to the close hot atmosphere between decks when the hatches and port holes were closed, and then to the abundant and cold drafts of air when these were thrown open in the season of storms and extremes of temperature, it is not surprising that a small proportion of them, scarcely ever reaching 1 per cent in any shipment, should show lesions of croupous, interstitial, or broncho-pneumonia. Indeed, it would be amazing, and far different from our experience on land, if these conditions did not produce such lesions in the lung tissue. During the two and one-half months in which the thirty-two cases of alleged pleuro-pneumonia were reported, about 71,000 head of cattle were exported, the lung lesions being therefore found in one animal out of about 2,200 landed. Such a small proportion of affected animals is inexplicable with a contagious disease, when we consider that the animals of each lot are crowded together for fully four weeks before slaughter.

It ought to be plain to any veterinarian that he is not justified in deciding an animal to be affected with contagious pleuro-pneumonia when he has only found the appearances or lesions in the lungs which are known to result from croupous, interstitial, or broncho-pneumonia. If such an animal came from a stable where pleuro-pneumonia was known to exist, that disease might be diagnosed, but then the diagnosis is made upon the history and not upon the lesions. The writer is perfectly aware that in eradicating pleuro-pneumonia in various countries it has been the rule to consider nearly all cases of acute lung disease as possible cases of pleuro-pneumonia and to act as if they were such. Here again the decision is based upon the knowledge of the existence of the disease and the possibility of contagion; in other words, upon the history of the district.

In a district where pleuro-pneumonia was unknown, or in one where the disease had been eradicated, it certainly would not be considered proper by any veterinary sanitarian to impose quarantine and slaughter because an isolated bovine animal had been found there with the lesions of croupous, interstitial, or broncho-pneumonia. Under such circumstances it would be necessary to search for a typical case of contagious pleuro-pneumonia, or to obtain facts showing undoubted contagion, with somewhere in the chain an animal showing the typical characters of the disease in question.

The necessity of a typical case of pleuro-pneumonia is insisted upon because contagion is often suspected where it does not exist. A large number of cows may all be exposed to the same draft of cold air, and 25 per cent of them may contract broncho-pneumonia. One man would say, so many cases of lung disease in a stable indicates contagion, while another, recognizing the true cause of the trouble, would properly diagnose it as a noncontagious affection.

Furthermore, there is a form of pneumonia in cattle, probably worldwide in its distribution, associated with a certain microörganism, and liable to occur in several animals at the same time. The infectiousness or contagiousness of this disease are matters of doubt, as are the pneumonias of man associated with similar microörganisms; but if there is any power of dissemination it must be very slight, and then only among animals subjected to the same causes favorable to the development of pneumonia, because when affected animals are mixed with healthy ones under proper sanitary conditions, the disease is not conveyed.

These several diseases may be expected from time to time among cattle landed in England from the United States. But in none of these diseases are the typical lesions of contagious pleuro-pneumonia found, and it is an error to consider them allied to or identical with that disease. These diseases, common to the whole world, will be found in a certain proportion of cattle shipped either from America to England or from England to America, as long as the transatlantic trade in live cattle continues. Such isolated cases should be easily diagnosed by competent inspectors, and should not be allowed to interfere eternally with an important trade when there is no danger connected with them. There is a scientific aspect to this question as well as a political one, and science should not be modified to suit political requirements. The veterinary profession has the knowledge by which it can discriminate between contagious pleuro-pneumonia and other diseases affecting the lungs, and that there should be such a difference of views in regard to the disease found in American cattle landed in England can only be explained upon the hypothesis that one side or the other is not forming its opinions in accordance with such knowledge.

The statement of the case has been confused and covered with intricate discussions as to whether this or that special feature was or was not pathognomonic of contagious pleuro-pneumonia or of some other disease. Such discussions serve to pass away the time and to furnish some apparently scientific grounds for the advocates of each position to stand upon. There is, however, no prospect of any practical results being reached in that way.

There is no one character which in the present condition of knowledge surely indicates contagious pleuro-pneumonia, but taking the various characters together as they exist in a typical case of the acute disease, a picture is formed which can not be mistaken. Stress has been laid in times past upon the distention and thickening of the interstitial connective tissue bands; upon the marbling caused by the contrast in color between the yellow bands and the areas of red or nearly black parenchymatous tissue surrounded by them, and upon the concomitant enlargement of the lymphatic glands. It is now known, however, that all of these conditions may occur independently of contagious pleuro-pneumonia.

The marbling in color, which is now referred to as characteristic, is due to areas of inflammation of different age, and has been accepted as pathognomonic on the theory that contagious pleuro-pneumonia is the only disease of the bovine lung which progresses by gradual extension from one section of the lung to other parts of it. But admitting, as we must from recent investigations, that there are other inflammations of the lungs of cattle, associated with and which may be produced by microörganisms, what is more reasonable than to suppose that these microörganisms may begin their multiplication in one section of the lung and penetrate by degrees to other sections? In such a case there would be found hepatization of different ages in the various parts of the lung. Again, in ordinary croupous pneumonia the lobules are often of varying color, owing to more or less hemorrhage in the different regions, and this variation of color is sometimes mistaken for the variation due to hepatization of different ages.

The inflammation of the internal coats of the veins, and the firmly adherent thrombi, may be a more characteristic lesion; but the writer is not inclined to accept this character by itself as surely indicating contagious pleuro-pneumonia until more extended observations have been made.

The conclusion which we must reach is, therefore, that to diagnose pleuro-pneumonia safely we must have a typical case of the disease combining the different changes which have been enumerated. Unless these characters are all present we are not justified by the lesions in declaring a district, much less a whole country, to be infected with contagious pleuro-pneumonia. It may be true that every case of contagious pleuro-pneumonia is not typical, and that the lesions in such cases resemble those of broncho-pneumonia or interstitial pneumonia, but all that can be said in regard to these cases is that under such circumstances contagious pleuro-pneumonia can not be diagnosed from the lesions. We must then rely upon the history of the case to confirm or disprove our suspicions. Where cases are reported among imported cattle by the inspectors of a country at the rate of three a week, there should be no difficulty in discovering the typical lesions of the plague, in case the plague exists.

It is unfortunate that this whole question has been plunged into still deeper polemical complications by the alleged discovery in Nebraska of a hitherto undescribed pneumonia which has been designated "the cornstalk disease," and which it is assumed is the same disease which has been discovered in the lungs of American cattle abroad. The breaks and inconsistencies of this theory are such as should have led any scientist to have hesitated a long time before accepting it, and yet eminent authorities have gravely discussed it as though it were an established fact for eighteen months, and they only now begin to discover some of its serious defects.

In the first place, this theory would require us to discard the action of cold and exposure as factors in the pneumonias found among our cattle shipped across the Atlantic. These are, however, the most obvious causes of the different forms of sporadic pneumonia, and as nearly all of the cases have been found in the cold months of the year it would be absurd to claim that none of them were due to extremes of temperature.

In the second place, but three cases of lung disease found among cattle which had been feeding upon cornstalks have been offered to demonstrate this theory which is to revolutionize our knowledge of the lung diseases of cattle. This certainly is a very insufficient amount of material upon which to found a theory, much less to expect its immediate adoption by the entire world.

In the third place, the conclusion that a form of pneumonia is produced among cattle by feeding upon cornstalks is purely hypothetical. There is a disease in cornstalks produced, according to Burrill, by a motile bacillus, and it is assumed that this bacillus in some unaccountable way acquires virulence by the drying of the cornstalk and produces the disease in cattle known as the cornstalk disease. There is then another assumption that the interstitial pneumonia found in three instances is identical with the cornstalk disease. It should also be noted that the author of this theory did not see one of the animals alive, nor did he conduct the autopsies upon them.

In the fourth place, the assumption that the disease seen among American cattle in France was identical with the cornstalk disease of Nebraska was not consistent with the facts and very improbable. Nocard was of the opinion that these cattle were affected with a form of pneumonia which did not exist in France, and as he discovered a bacterium associated with the disease, which he took to be motile, he jumped to the conclusion that the disease which he had under observation was identical with the cornstalk disease of Nebraska. There is no evidence that these cattle had been feeding in "stalk fields, or upon snap corn with the husks on"—conditions which are laid down as essential to the production of the malady; but, on the contrary, the presumption would be that export cattle had not been so fed. More important still is the assertion of the discoverer that the bacillus of the cornstalk disease is actively motile, grows upon potatoes, and has other characteristics which demonstrate that, whatever may be its nature, it does not belong to the rabbit septicæmia group of microörganisms. On the other hand, I have been furnished, through the kindness of M. Nocard, with cultures of the germs discovered by him in American cattle, and can assert positively that they are not motile, do not grow upon potato, and that they belong to and have all the characters of the rabbit septicæmia group. This is sufficient to show that the diseases are not identical, and that the superstructure of theory built upon this assumption can not be maintained.

In the fifth place, disease with the same lesions has been observed by Williams among English and Irish cattle. It was recognized by him in the lung of the Canadian animal killed at Lindores in Fife. It has also since been seen among French cattle by Nocard associated with the same germ he found in the American cattle. For my own part, I have frequently seen the disease in our Eastern States, in cows shipped from districts where there had been no pleuro-pneumonia, and where they do not feed cattle in stalk fields or upon snap corn with the husks on. The disease in question is not the result of feeding upon any particular kind of food, but is a common form of broncho and interstitial pneumonia, as asserted by Williams, and when other European authorities follow his example and study the forms of pneumonia in cattle which occur in their own countries, they will have no difficulty in recognizing it.

VESSEL INSPECTION.

The inspection of vessels carrying export cattle has been maintained during the year under the act of Congress approved March 3, 1891, to insure the safe transportation and humane treatment of cattle on their voyage across the Atlantic. The total number of vessels inspected during the year was 917, of which 382 sailed from the port of New York, 240 from the port of Boston, 153 from the port of Baltimore, 78 from the port of Philadelphia, 35 from the port of Newport News, 5 from the port of New Orleans, and 24 from the port of Portland, Maine. There has been a marked improvement in the fittings and ventilation of most of the vessels carrying cattle, and this has resulted in the animals reaching their destination in better condition, and also in a diminished loss at sea. The percentage of loss of cattle during the voyage, including all causes, was only seven-eighths of 1 per cent. As the loss during 1891 was $1\frac{3}{5}$ per cent, a marked improvement is shown by this report.

MEAT INSPECTION.

At the time my report for last year was written, inspection was being made of the products of twenty-two abattoirs, under the act of Congress approved March 3, 1891. At the present time the number of establishments provided with meat inspection has been increased to thirty-eight, and arrangements are being made to extend the inspection still more. The total number of animals examined under the Department regulations of March 25, 1891, and the products of which have been marked for identification in the manner prescribed in the regulations, was for the fiscal year ending June 30, 1892, 5,076,929. Of this number 3,167,150 were cattle, 1,267,329 were hogs, 583,361 were sheep, and 590,859 were calves. There were 1,990,771 quarters of beef tagged for export and 8,160,625 for the interstate trade, while 688,176 carcasses went to canning establishments. There were stamped and marked for identification, in accordance with the regulations, 797,707 packages of canned, salted, and smoked beef products. Of the 3,167,150 head of cattle inspected, 141 were condemned on ante-mortem examination, and 1,914 on post-mortem examination. Of 583,361 sheep, 197 were condemned on post-mortem examination. Of the 1,267,329 hogs inspected microscopically, there were found 25,899 infected with trichinæ. The following table shows the work in detail for the period ending June 30, 1892:

Meat inspection work, fiscal year ending June 30, 1892.

Number cattle inspected	3,167,150
Number diseased on inspection	141
Post-mortems made	3,167,009
Number diseased	1,914
Dressed quarters for export	1,190,771
Dressed quarters for interstate trade	8,160,625
Carcasses to other establishments than were examined	627,237
Packages of canned meat stamped	495,577
Packages of salted meat stamped	142,698
Packages of smoked meat stamped	159,432
Number hogs inspected	1,267,329
Number diseased with trichinæ	25,899
Packages of salted pork, bacon, and hams stamped for export.	76,266
Number sheep inspected	583,361
Number diseased	197
Dressed carcasses for export	383,157
Calves inspected	59,089
Number certificates issued	5,783
Total number of animals examined	5,076,929

EXPORTATION OF INSPECTED PORK PRODUCTS.

The first decree removing the prohibition against the importation of American hog products into any of the European countries was made in September, 1891. From that time until the close of the fiscal year ending June 30, 1892, the Department issued certificates for 76,911 packages of pork products, containing 38,152,874 pounds. The following is a table showing the exports of inspected pork products to June 30, 1892, giving the countries to which the same were exported, respectively:

Statement of number of cases and weight of pork products exported for the fiscal year ending June 30, 1892.

Country.	Cases.	Pounds.
Germany	39,355	19,627,726
Belgium	14,098	7,141,946
Holland	8,345	4,279,416
France	3,432	1,645,625
England and Scotland	9,567	4,399,675
Denmark	1,238	671,697
Italy	156	75,713
Norway and Sweden	610	306,139
Spain	10	4,937
	76,911	38,152,874

The exports in the above table credited to Belgium and England and Scotland probably found their way to the German and French markets, as they were forwarded to houses in Belgium and Great Britain for orders from French and German merchants. We may, therefore, conclude that practically all inspected pork certified to by the Department went either directly or indirectly to those countries which have lately removed their decrees of prohibition against the importation of American pork. While the direct effect of the removal of the prohibition by foreign countries, obtained by reason of the system of meat inspection inaugurated in this country under the act of Congress approved March 3, 1891, has been to find a market in such countries for 38,152,874 pounds of bacon, hams, and pork, the indirect effect has been to increase our exports to all European countries to a large extent. The mere fact of the removal of the decrees of prohibition was to reëstablish confidence in the purity of our pork products, which had been seriously damaged by reason of these decrees made in the latter part of 1881 and subsequently.

For the fiscal year 1881, just prior to the imposition of these decrees of prohibition, the total exportation of hog products from the United States to foreign countries amounted to $104,660,065. For the fiscal year 1883, after these decrees went into effect and their influence was fairly felt, our exports amounted to but $70,966,268, being a loss of $33,693,797 in the values of our exports for 1883 as compared with 1881. Of this loss the proportion chargeable directly to Germany and France was $11,624,884, leaving a loss of $22,068,913 as the loss to be accounted for in such portions of the exports taken by Germany and France through the channels of commerce entering from other countries, and by the loss of confidence in other countries caused by these prohibitory decrees.

It is early yet for our export trade in these products to feel the full effect of the restoration of confidence in the wholesomeness of our pork, but we are beginning to feel the first effects of such confidence, and a comparison of our export trade of the last four months with the exports of a like period of the preceding year will show a gratifying improvement. The following is a table giving the quantity and values of pork products exported to all European countries for the months of May, June, July, and August, 1892, as compared with the exports for the same months of the year 1891:

Statement showing the quantities and values of our pork products exported to all countries in Europe during the months of May, June, July, and August, 1892, as compared with the exports for the corresponding months of 1891.

Month.	Quantities.		Values.		Increase for 1892.		Percentage of increase for 1892.	
	1891.	1892.	1891.	1892.	Quantities.	Values.	Increase in quantities.	Increase in values.
	Pounds.	*Pounds.*			*Pounds.*		*Per ct.*	*Per ct.*
May	46, 975, 161	82, 086, 866	$3, 613, 324	$6, 333, 007	35, 111, 705	$2, 719, 683	$74\frac{3}{4}$	$75\frac{1}{4}$
June	46, 558, 489	85, 741, 208	3, 575, 006	6, 632, 868	39, 182, 719	3, 057, 862	$84\frac{1}{6}$	$85\frac{1}{2}$
July	59, 320, 966	83, 831, 502	4, 637, 502	6, 746, 523	24, 510, 536	2, 109, 021	$41\frac{1}{3}$	$45\frac{1}{2}$
August	54, 142, 072	84, 039, 342	4, 130, 520	6, 878, 156	29, 897, 270	2, 747, 636	$55\frac{1}{5}$	$66\frac{1}{2}$
Total	206, 996, 688	335, 698, 918	15, 956, 352	26, 590, 554	128, 702, 230	10, 634, 202	$62\frac{1}{6}$	66[illegible]

It will be seen from the foregoing table that the exports of our pork products for the four months of 1892 have been 128,353,731 pounds over the exports for the same period in 1891, or an increase of 62 per cent, while the increase in values for 1892 has been $10,634,802, or an increase of 66⅔ per cent. The increase in values is greater than the increase in quantity, for the reason that the prices for 1892 have been higher than the prices for 1891. The work of meat inspection has more than justified the sanguine hopes of its promoters and fully warrants the comparatively small expense incurred by the Government for its maintenance.

DIVISION OF ANIMAL PATHOLOGY.

The work of this division includes all scientific investigations in regard to the nature, prevention, and treatment of animal diseases.

The most important work of the year has been the completion of the investigations as to the nature of the Texas or splenetic fever of cattle, and the way in which the infection is carried and transmitted by animals from the infected district. This investigation has been extremely successful, and the mysteries connected with the spread of this disease are now satisfactorily explained. A special report upon the subject has been prepared.

The study of this disease, which has caused losses of great magnitude in the past, may justly be regarded both from a scientific and practical point of view as among the most important researches ever undertaken by the Department. The successful elucidation of the character of this disease makes it possible to intelligently formulate measures for its prevention and control.

On account of the continued declarations of the British inspectors that cases of contagious pleuro-pneumonia were frequently discovered among American cattle landed in Great Britain, considerable time has been given to the study of various forms of pneumonia in cattle. It has been deemed essential, therefore, that the different affections of the lung to which cattle are subject should be described and illustrated more carefully than heretofore, in order that any grounds for difference of opinion from a scientific point of view may be removed. The work of the year on such diseases has been of a preliminary character, with a view of making a convincing scientific report on the whole question.

Much scientific work has also been done in connection with the diseases known as tuberculosis and glanders. The losses from these diseases and their danger to human health and life make it extremely desirable that something should be done for their control. The great obstacle in the way of measures for this object has been the difficulty of diagnosing these diseases except with certain animals which are plainly affected. For example, in a herd of forty cattle three or four may be plainly affected with tuberculosis, four or five others may be suspicious, and some others which are actually affected may show no symptoms of the disease. It is evident that under such circumstances it would be necessary either to destroy the whole herd or to leave some affected animals to propagate the contagion. The same is true of glanders in horses.

Recent investigations show that the germs of these two diseases produce, during their multiplication, a chemical substance which, when properly administered to affected animals, increases their temperature so remarkably as to almost invariably reveal the presence of the malady even in the first stages. Experiments have been made to determine the best method of obtaining these valuable bacterial products in sufficient quantities to be used for the purposes mentioned. These experiments have been successful, and if Congress deems it best to authorize the Department to adopt measures for the control of either tuberculosis or glanders, or of both of these diseases, the laboratory of the Bureau is now in condition to supply this indispensable diagnostic agent.

Researches of great value have also been made in regard to the varieties and life history of the parasites affecting the domestic animals in this country. Many new species have been studied and their connection with various diseases has been traced. This is a wide field of investigation from which most important practical results may be confidently predicted. With the single exception of the Special Report on the Diseases of the Horse, there has been no more popular report issued from this Department than that on the Animal Parasites of Sheep. The numerous requests for this little volume, which are far beyond the ability of the Department to supply, demonstrate the widespread interest in the subject. Other reports of this nature are in preparation, but as the whole field must be worked over scientifically on account of the present lack of accurate knowledge, the progress is necessarily slower than with subjects which have received more attention from the scientific world.

The laboratory of the Bureau has also been engaged upon questions relating to the prevention of swine diseases, and in coöperating with the Division of Field Investigations to determine the nature of outbreaks of disease among all classes of animals in various sections of the country. There are many demands for this class of work, and it is usually of such an urgent nature and so important withal, that it must be given constant attention.

DIVISION OF FIELD INVESTIGATIONS AND MISCELLANEOUS WORK.

The work of this division was fully described in my report for the year 1891. Briefly stated, it consists in conducting the investigations in the field as to the nature of diseases affecting animals in different sections of the country, in collecting information as to the condition and needs of the animal industry, in replying to inquiries for information on subjects which come within the sphere of the Bureau work, and in supervising the expenditures and accounts of the whole Bureau.

QUARANTINE DIVISION.

Stations detaining cattle, sheep, and other ruminants, and swine imported from across the ocean, are maintained at the ports of Boston, New York, and Baltimore. The outbreak of foot-and-mouth disease in Great Britain, which began early in February, 1892, and which spread rapidly in spite of the preventive restrictions that were adopted, made it necessary to exercise the utmost vigilance at the quarantine stations, and finally to decline to issue permits for the importation of animals from affected countries until the disease had been suppressed. This caused a suspension of the importation of sheep from Great Britain for the greater part of the year; but as the disease was finally eradicated, permits for importation are again being issued. Foot-and-mouth disease does not exist in the United States and has not been in this country since 1884, and as pleuro-pneumonia has been eradicated after a long effort and with great expense, the necessity of a most rigorous system of inspection and quarantine is apparent to prevent the reintroduction of such plagues.

The quarantine stations are well supplied with buildings and fences, and the expense of keeping them in condition is very small. The animals recently imported and quarantined have been mostly sheep. The numbers which have passed through the stations for the fiscal year are as follows: Cattle, 36; sheep, 1,051; swine, 2; goats, 14.

No case of the importation of a dangerous disease has occurred during the year.

PUBLICATIONS.

It is with pleasure that I call attention to the "Special Report on the Diseases of Cattle and on Cattle Feeding," just issued by this Bureau, which is written on the same general plan as was the "Special Report on Diseases of the Horse," a work which has proved to be the most popular publication ever issued by the Department. The high class of the articles which comprise this second volume of the series on the diseases of farm animals and their scientific yet popular character make it of the greatest value to our farmers, and will certainly give a new impetus to the progress of veterinary science in the United States.

There is also just ready for distribution a magnificent "Special Report on the Sheep Industry of the United States," which treats exhaustively of the formation of our flocks, their management and improvement, and the present condition of the industry. This volume has been written with the object of gathering together the information indispensable for intelligent sheep-breeding which has been heretofore, for the most part, inaccessible. There is already a large demand for the work, and there can be no doubt that when it has been carefully examined by those interested in the sheep business it will prove to be an extremely valuable and popular publication.

There is also going through the press a "Special Report on Texas or Splenetic Fever of Cattle," which contains the results of the scientific investigations of this disease. These investigations have been remarkably successful, demonstrating that the disease is caused by a parasite which lives in the red corpuscles of the blood, and that this parasite is generally, if not always, carried to affected animals by ticks.

Such an intricate mode of transmission is very rare if it exists with any other disease, and the fact that the microscopic parasite may be transmitted through the egg from one generation of ticks to another serves to make the whole question still more complicated. The success in clearing up these and many other points, necessary to an understanding of the way in which the malady is transmitted, is one of the best examples of the value of the intelligent application of modern science for solving the mysteries of nature which in various ways affect our agricultural practice. That this disease is now understood and that the measures for its prevention may be hereafter placed upon a scientific basis is a matter for congratulation, both from a scientific and practical point of view. It should certainly be an encouragement to continue such investigations until the many other questions which are pressing upon us for solution can be disposed of in an equally satisfactory manner.

INVESTIGATION OF INFECTIOUS DISEASES OF DOMESTICATED ANIMALS.

By Dr. THEOBALD SMITH, *Chief of Division of Animal Pathology.*

These investigations have been continued along several lines during the year, as may be seen from the brief summary given below. The difficulty inherent in the study of these diseases is due partly to the perishable nature of the material which requires investigation; partly to their wide distribution and their occurrence at long distances from laboratories where much of the real study must be carried on; partly to their prevalence during certain short periods of the year. All these circumstances combined make it essentially necessary to carry on a number of investigations at once and to concentrate our forces on that disease which presents for the time being the greatest opportunities. It is also for the reasons given above that investigations may extend over a number of years before sufficient information has been collected to warrant its publication. Whenever possible, efforts are made to reproduce diseases at the veterinary experiment station near Washington, where both field and laboratory investigation may be brought to bear upon them. This is not always feasible, however, for many diseases of domesticated animals are either bound to certain restricted localities, or are associated with conditions which can not be reproduced artificially. In such cases the investigations must go on, often under great disadvantages, with much loss of time and with the prospects of uncertain results, because of the want of proper facilities.

TEXAS CATTLE FEVER.

The field investigations concerning the causation of this disease have been carried on from July to November of the past year.* At the same time a special report or bulletin has been prepared, which includes the details of the experimental work from 1888 up to the present. This bulletin contains chapters on the nature of Texas fever, its symptoms and pathological changes, and on the microörganism which produces it. It also contains chapters on the life history of the cattle tick and its precise relation to the disease; on immunity and preventive exposures; on the infectiousness of sick natives; and on the probability that Texas fever is a cosmopolitan disease, limited in its distribution by latitude rather than by continents. The practical deductions are brought together in a final chapter which, owing to its importance, is incorporated in part into the present summary. In the following pages a brief account of the work of the year is given. For detailed proof of the statements made the reader is referred to the forthcoming bulletin mentioned above.

THE CATTLE TICK THE CARRIER OF TEXAS FEVER.

In the investigations carried on up to 1892 the precise relation of the cattle tick to the disease had not been positively demonstrated. It was known from our former experiments that young ticks placed on susceptible cattle produced Texas fever. It was also shown in 1889 that when the ripe tick was prevented from falling to the ground, and

* This work was done with the coöperation of F. L. Kilborne, B. V. S., and E. C. Schroeder, M. D. V.

a future generation was thereby destroyed in the egg, so to speak, the disease did not appear. Owing to circumstances the confirmation of this important experiment was delayed until this year. Prior experiments in 1890 and 1891 had failed because the ticks had not been entirely removed. During the past summer, however, the fact was again demonstrated that when ticks are removed (picked off by hand) from Southern animals, the latter may freely mingle with susceptible Northern cattle without communicating Texas fever. Two experimental fields were set aside for this purpose. In each two Southern and two native animals were placed. From the Southern animals the ticks were picked off, as far as possible, just before they were placed in the field. They were examined from day to day for several weeks to remove any that had escaped notice, owing to their small size. In the general control field containing Southern animals from the same farms from which the ticks were not picked off all exposed natives were attacked with Texas fever, while in the two fields mentioned no disease appeared, although the blood of the exposed cases was carefully examined from time to time, so that no mild, transient attack should escape our attention.

Experiments with the cattle ticks have thus been carried on in three different directions:

(1) Adult egg-laying ticks have been scattered on pastures, and the natives placed on such pastures have contracted Texas fever in the absence of Southern cattle.

(2) Eggs have been incubated in the laboratory, and the young ticks placed on native cattle have produced the disease.

(3) When the cattle tick is prevented from attacking native cattle by being removed from the Southern cattle before it falls to the ground and lays its eggs, Southern and native cattle may freely mingle without the appearance of Texas fever.

These three lines of investigation point to the cattle tick as the carrier, and the only carrier, of Texas fever; yet we do not wish to maintain that the Texas fever virus may not be occasionally transferred through other still unknown channels. A case was referred to in the preceding report (1891), which gives some support to the assumption that this disease may be at times conveyed without ticks. On the whole it is safe to maintain that if Texas fever is transmitted without the tick, such transmission will probably be confined to one or a few animals and not become epizoötic, since every fact relating to the disease, especially the period of incubation, points to the tick as the exclusive carrier of the infection, so far as the territory north of the permanently infected region is concerned.*

THE TEXAS FEVER MICRO-PARASITE LIVES IN THE BLOOD OF HEALTHY SOUTHERN CATTLE.

The tick as the carrier of the Texas fever micro-parasite might perhaps be regarded at first thought as the true and only host of this organism, and that Southern cattle being insusceptible had little or nothing to do with the infection. This is not true, however, for the experiments of the past summer revealed a quite different condition of things. It was found on injecting the blood of Southern cattle into the veins or under the skin of Northern cattle that this blood produced Texas fever in the absence of ticks. Not only was the blood capable

* These results have thus far been tested and confirmed by R. R. Dinwiddie, veterinarian of the Agricultural Experiment Station of Arkansas. Bulletin 20, November, 1892.

of producing disease when the cattle were fresh from the Southern pastures, but even after they had been deprived of ticks for several months. In one case (a North Carolina cow brought to the station in 1889), the blood was capable of producing Texas fever though the animal had been away from Southern pastures for three years.

These facts make it all the more strange that Southern and native cattle may mingle on the same pasture and yet no disease appear when ticks are absent, although the micro-parasite of the disease is carried about, in exceedingly small numbers to be sure, by Southern cattle in their blood, and although it requires the transference of only a small amount of blood to start the disease among the natives.

PREVENTIVE EXPOSURE.

In the course of our investigations it was shown that native cattle passed through both mild and severe attacks and made a perfect recovery. By reëxposing such animals once or twice on succeeding summers certain general conclusions were reached concerning the possibility of exposing natives purposely to induce insusceptibility. The results warrant the general statement that there is acquired more or less insusceptibility after exposures. Thus, an acute attack is not followed by another acute attack, but the second exposure may be negative or lead to a mild form of the disease. A mild attack in fall may be followed by an acute attack the following summer, which, in some cases, may be fatal. It is probable that two mild exposures in two successive years may make the animal secure against a subsequent fatal attack, and it is possible to grade the severity of the attack, as is pointed out in the bulletin referred to, so as to prevent any deaths from occurring. This subject is again referred to in the following pages.

PREVENTION.

Texas fever, in the territory outside of the enzoötic region, is the result of the distribution of ripe egg-laying ticks by cattle from the enzoötic region. Hence, such cattle should not be allowed on uninfected territory during the warmer half of the year. It is also evident that during the same period all cars carrying Southern cattle contain a larger or smaller number of ticks which have dropped off during the journey and which are ready to lay their eggs. The sweepings of such cars, wherever deposited, may give rise to a crop of young ticks, and these, when they have access to cattle, will produce the disease. Wherever Southern tick-bearing cattle are kept within twenty-five to thirty days after their departure from their native fields, they are liable to infect such places, since it requires the period mentioned for the smaller ticks to ripen and drop off. But under special conditions even this period is too short, and the Southern cattle may remain dangerous a longer time. This would occur when such cattle remain in any one inclosure long enough (four to five weeks) for the progeny of the first ticks which drop off to appear on the same cattle.

The above points are covered in the regulations of the Department of Agriculture concerning cattle transportation. These regulations insist on the complete isolation of cattle coming from the permanently infected territory, between March 1 and December 1 of each year, and on the proper disinfection of the litter and manure from such cattle during transportation. Furthermore, such cattle can only be transported into uninfected territory for immediate slaughter during the prescribed period. These regulations, if properly carried out, would prevent the appearance of Texas fever at any time in those areas north of the enzoötic territory.

The only question which now presents itself is the efficiency of the prescribed disinfection. It has been shown that the infection resides only in the cattle ticks and their eggs; hence the destruction of these is absolutely essential to make the disinfection of any value. In the present report this question has not been touched upon; therefore, pending the trial of various disinfectants which is now going on, any discussion or any suggestions are of little value.

The harmlessness of Southern cattle, after being deprived of the cattle tick, brings up the very important question whether such cattle can not by some means be freed from ticks, so that their transportation may go on without any restriction during the entire year. There are several ways in which experiments might be undertaken. Cattle might be subjected to disinfecting washes of various kinds, or else they might be run through disinfecting baths which expose the whole body to the action of the liquid used. Such processes would require careful attention. The survival of a very few ticks might lead to serious consequences, since a single ripe tick averages about 2,000 eggs.

Cattle may be deprived of ticks on a large scale without the use of any disinfection, if the following plan be adopted: Two large fields in a territory naturally free from cattle ticks are inclosed. The tick-bearing cattle are put into the first inclosure and kept there about fifteen days. They are then transferred to the second inclosure for the same length of time. Thirty days after the beginning of their confinement they may be considered free from infection. The reason for this procedure is simple enough. The cattle drop the ticks as they ripen in the inclosures. By being transferred to a second (or even a third) inclosure they are removed from the possible danger of a reinfection by the progeny of the ticks which dropped off first. It is evident that such inclosures can only be used once a season, since the young ticks subsequently hatched remain alive for an indefinite length of time on the ground. Such inclosures must not be located where there is a possibility that the ticks might survive the winter.

For cattle which are introduced into the enzoötic territory two modes of prevention may be adopted. Either they are kept entirely free from ticks by confinement in stables or upon pastures known to be free from ticks, or else they are exposed to the infection in such a way as to become insusceptible to it after a time. The first method is open to the objection that ticks may at some time accidentally gain access to such cattle and produce a fatal disease. On the other hand, the second method seems the more rational provided it can be successfully carried out. We know that Southern cattle are insusceptible to the disease. Young animals also seem to be largely proof against a fatal infection, although they are by no means insusceptible. The repeated mild attacks to which they are subjected finally make the system indifferent to the virus. The introduction of young animals into the permanently infected territory, though not without danger, is far safer than the introduction of animals older than one year. The danger of a fatal infection increases with the age of the animal and is very great in cows over 5 or 6 years old, as is distinctly shown by the experiments recorded in this report.

The subject of preventive exposures has already been alluded to. It has been shown that while in general two mild attacks may not prevent a third attack, this will not be fatal. One very acute attack will usually prevent a second severe attack. Hence it is possible to prevent cattle, even when fairly along in years, from succumbing to a fatal attack by several preliminary carefully guarded exposures to a mild infection. This infection may be produced by scattering ripe ticks in an inclosure or by placing young ticks on cattle in the fall of the year. Protective inoculation of this kind should be carried on at some locality outside of the enzoötic territory carefully chosen for the purpose. A few years of careful experimentation would probably lead to an efficient method, which, when definitely formulated in all its details, could be applied in different parts of the country. Such experimentation should, of course, pay special attention to the relative susceptibility of the various higher grades of cattle—a matter which we have been unable to touch upon thus far.

What can the individual farmer or stock-owner do in the event that Texas fever has been introduced into his pastures? From what has been said thus far pastures which have been infected by Southern cattle or ticks from the litter and manure of infected cattle cars should be avoided during the entire summer season. While we know that young ticks may remain alive in jars for two or three months without food, it would be premature to conclude that such is the case on pastures, as the conditions are quite different. Yet everything seems to point to a long sojourn of young ticks on infected fields, and, pending the carrying out of experiments to test this question, we would recommend that native cattle be not allowed to graze on infected fields until after the first frosts, for even a mild attack in fall, before the ticks have been destroyed by frosts, is debilitating to cattle. The period of time during which infected localities remain dangerous varies, of course, with the latitude, and would be shorter the colder the climate.

The infection of stables, stalls, and other structures with ticks should be counteracted by thorough disinfection. The adult ticks and the eggs must be destroyed. As stated above, we know as yet very little concerning the agents which will destroy the vitality of the eggs of ticks, but the use of water near the boiling point may be sufficient, if liberally applied, to destroy the life of the embryos. In the case of litter and manure heaps, the thorough saturation with some strong mineral acid in dilution may accomplish the purpose. Ordinary lime, slaked or unslaked, densely sprinkled over infected places so as to form a continuous layer, may be recommended. The slow incrustation of the egg masses with carbonate of lime may be expected, provided the manure is under cover. Otherwise it will be washed away and may leave the eggs unharmed. In regions outside of the enzoötic territory, the absence of ticks may be accounted for by the severity of the winter; hence, in unprotected localities, disinfection is unnecessary after the winter has set in. But it may occur that in sheltered places the eggs will winter over and the ticks reappear the following spring. Hence all infected material should be freely exposed to the frost, even though treated with disinfectants beforehand.

TREATMENT.

If the disease is suspected in a herd, the animals should be searched thoroughly for the presence of small ticks, and the temperature of every animal taken with a clinical thermometer, with which every stock-owner should be provided. This, which should be 5 inches long, is inserted well into the rectum and held there three to five minutes. If the temperature is 104° to 107° F., fever is present. The combination of ticks and fever, or the presence of the former in a locality where they do not naturally exist, may be considered a sure sign of the imminence of Texas fever. Though there are at least two species of ticks regularly infesting cattle in the permanently infected territory, these remarks can apply only to the species described in the bulletin (*Boöphilus bovis* Riley, Curtice), since we know nothing as yet of the fever-producing capacity of the other species (*Amblyomma unipunctata*).

In case the ticks are found on the cattle they should be carefully removed and the cattle transferred at once to uninfected grounds. They should be repeatedly examined for ticks and all found destroyed. While the change of pasture and the removal of ticks may not prevent the attack nor cut short the disease after it has once shown itself, we feel certain that fewer animals will succumb to the disease. A single infection is sufficient to cause severe and prolonged disease, as is shown by the injection of infected blood; but the mortality seems to be lower than in natural exposures, where the infection is intensified with every additional tick.

We are unable to recommend any specific remedies to be applied after the disease has appeared, because none have been tried as yet. Quinine and its various preparations, fed or injected under the skin, may prove of value in destroying the parasite, or perhaps methylene blue, recently recommended for malaria, may be of some service. We hesitate, however, to do more than suggest these remedies, since their efficiency should first be carefully tested by well-planned experiments, which should only be undertaken on a large scale with a sufficient number of control animals and guided by a repeated examination of the blood.

The general indications to be followed in attempting to save diseased animals are perfect rest in a sheltered place. Sick animals should not be driven or excited, for the condition of the circulation is such that any effort may bring about rupture of blood-vessels and lead to speedy death. The heart, moreover, is always seriously involved, and should not be strained in any way. Again, the exposure of sick cattle in the sun's heat without shelter is liable to increase the already abnormally high temperature. We have, in fact, observed on unsheltered fields, during very hot days, a rise of from 2° to 3° F. in presumably healthy cattle during the day, which we must attribute to the effect of the sun's heat. A sheltered place, preferably in the open air, in which the sick animal remains free from the annoyances of other animals, is therefore best suited to its condition.

An abundance of pure water should be supplied to aid the overtaxed liver and kidneys in excreting their abnormal products in a more diluted condition. The food given should be readily digestible. It may be, on the whole, better to withhold food entirely, since the various digestive organs are in a congested state and not in a condition to do any work.

The disinfection of infected pastures is out of the question and must be left to nature in winter. They may, however, be used for sheep, since we have found these animals unharmed after grazing on them during an entire summer. It is highly probable that all other domesticated animals may run over such pastures with impunity, since Texas fever, outside of the bovine species, has not yet been observed.

CONCLUSIONS.

(1) Texas cattle fever is a disease of the blood, characterized by a destruction of red corpuscles. The symptoms are partly due to the anæmia produced, partly to the large amount of débris in the blood, which is excreted with difficulty and which causes derangement of the organs occupied with its removal.

(2) The destruction of the red corpuscles is due to a microörganism or micro-parasite which lives within them. It belongs to the protozoa and passes through several distinct phases in the blood.

(3) Cattle from the permanently infected territory, though otherwise healthy, carry the micro-parasite of Texas fever in their blood.

(4) Texas fever may be produced in susceptible cattle by the direct inoculation of blood containing the micro-parasite.

(5) Texas fever in nature is transmitted from cattle which come from the permanently infected territory to cattle outside of this territory by the cattle tick (*Boöphilus bovis*).

(6) The infection is carried by the progeny of the ticks, which mature on infected cattle, and is inoculated by them directly into the blood of susceptible cattle.

(7) Sick natives may be a source of infection (when ticks are present).

(8) Texas fever is more fatal to adult than to young cattle.

(9) Two mild attacks or one severe attack will probably prevent a subsequent fatal attack in every case.

(10) Sheep, rabbits, guinea-pigs, and pigeons are insusceptible to direct inoculation. (Other animals have not been tested.)

(11) In the diagnosis of Texas fever, especially in the living animal, the blood should always be examined microscopically, if possible.

TUBERCULOSIS IN CATTLE.

This disease occupies at the present time a very prominent place in the public mind, and rightly so, for it is identical with tuberculosis in man, of which vital statistics claim that it is responsible for the death of fully one-seventh of the human race. A general summary of the nature of this disease and its distribution among domesticated animals was presented in the report for 1889. The problem now before us, which has been advanced considerably by investigations over the whole world, is to determine the extent to which the milk of tuberculous cows is infected with the bacilli of this disease and the readiest means of detecting such infection. By examining the milk of presumably tuberculous cows at different stages of the disease we hope to gain some definite ideas as to the conditions under which milk must be regarded as positively dangerous. It is true that many sanitarians now regard the milk of tuberculous cattle in all stages of the disease as dangerous, and such a position is undoubtedly the safest. But until more stringent regulations are enforced concerning the regular inspection of dairy cows we must content ourselves with defining, if possible, the limits of danger. All authorities are, however, agreed that the milk of tuberculous cows suffering with tuberculosis of the udder or bag is positively dangerous, and from this point of view alone, if from none other, the careful inspection of dairy cows for any diseased condition of the udder becomes imperative. Our own investigations have shown that in cows in an advanced stage of tuberculosis the milk may contain tubercle bacilli, although the udder is free from any tubercular changes which can be detected by the naked eye at the autopsy.

Another problem depending on the former for its importance concerns the easiest and surest means of detecting tuberculosis in cattle. Koch's tuberculin seems to have largely bridged over the difficulty, and we shall, whenever opportunity presents, make test inoculations with tuberculin and endeavor to confirm by post-mortem examination the accuracy of the diagnosis. Preliminary trials have been sufficiently favorable to induce us to agree with former experimenters in regarding tuberculin as the best means at hand for the diagnosis of tuberculosis in cattle.

SPORADIC PNEUMONIA IN CATTLE.

During the winter of 1891-'92 the writer spent considerable time in the examination of various forms of pneumonia in cattle, from a bacteriological as well as pathological standpoint, to determine how far such forms of pneumonia could be distinguished from contagious pleuro-pneumonia, and what were the distinguishing characters. About twenty lungs or portions of lungs came under observation, among them a few of the last cases of pleuro-pneumonia. The importance of a thorough understanding of ordinary pneumonias is apparent now that contagious pleuro-pneumonia is a thing of the past in this country. The economic importance of being able to state definitely whether a given disease is contagious pleuro-pneumonia or not is second to none in comparative pathology. Such a differentiation is, however, only possible after a comprehensive investigation. More definite knowledge on this subject is particularly desirable in view of the vague ideas of European writers on this subject.

The presence of sporadic pneumonia in American cattle was determined by Nocard, in France, who described the lesions as similar to pleuro-pneumonia, but different in that they were associated with a certain bacterium. A culture of this bacterium was handed to me by Dr. Salmon, chief of the Bureau, last summer, and a careful examination proved it to be none other than the bacterium found by me for several years previous in cases of lung disease in cattle, and briefly referred to in the Report of the Secretary of Agriculture for 1889 (page 92). Nocard erroneously refers to this disease as the cornstalk disease, and also describes the bacterium as motile, although this is not the case.

To what extent certain kinds of bovine pneumonia are due to this bacterium, which, by the way, is not distinguishable from the swine-plague group of bacteria, we are not enabled to state positively at the present time. It is to be hoped, however, that the name cornstalk disease be given up when reference is made to bovine pneumonia, the causes of which may be a great variety of conditions, including the presence of certain disease germs.

THE CORNSTALK DISEASE OF CATTLE.

The investigation of this obscure malady has been taken up during the fall of the year. Dr. V. A. Moore was directed to study the disease in Iowa and adjoining States from a bacteriological and pathological standpoint, and Dr. F. L. Kilborne was associated with him to examine the external conditions under which the disease originates. The work is not advanced far enough for us to draw any definite inferences. We trust that when the material collected has been thoroughly studied some clue as to the nature of this disease may be forthcoming, so that another year may witness the complete elucidation of the causation of this widespread disease, and valuable suggestions as to its prevention in the future.

DISEASES OF HORSES IN THE WEST.

During September and October of this year E. C. Schroeder, M. D. V., was directed to investigate two horse diseases in the West, the former the so-called bottom disease affecting horses along the bottom lands of the Missouri River, in Iowa, South Dakota, and Nebraska, and the latter a peculiar affection among the range horses south of the North Platte River, in Wyoming.

Dr. Schroeder gives the following brief report of his observations in the field:

The bottom disease closely resembles Lupine poisoning in its clinical history and gross pathology. It has caused annual losses of greater or lesser consequence for more than thirty years, the losses during the present year reaching 1,800 horses of all ages at a low estimate. The affection commences early in spring and lasts throughout the summer and fall. Some horses die two or three days after showing the first spmptoms, others live two or three weeks, and still others—and they are the most common—linger two or three months, during which they are perfectly useless.

Regarding the Wyoming disease, owing to the lateness of the time of investigation, little or nothing definite could be learned beyond the fact that it has caused losses of such magnitude during the last four or five years, previous to which it had not been observed, that the ranchmen fear a total distruction of the horse-raising industry in the southeastern portion of the State if some check is not speedily found. This disease makes its appearance toward the latter half of summer, about the time the vegetation loses its moisture, and continues until the beginning of October. Few cases recover; death usually follows the first symptoms in a few days.

This disease, as well as the bottom disease, are well worthy of further attention on the part of the Bureau.

MISCELLANEOUS WORK.

In connection with these important subjects various other problems received more or less attention in the laboratory whenever time and opportunity were presented. Preventive inoculation, more particularly with reference to swine diseases, has been studied on the smaller experimental animals, and new methods tested. The successes which Prof. Metchnikoff, of the Pasteur Institute, claimed to have achieved in the preventive treatment of rabbits with reference to hog cholera have been tested in this laboratory. As far as they have been carried out, our experiments do not agree with his, as regards the results obtained. This discrepancy was cleared up by the careful study of a culture of the presumed hog-cholera bacillus kindly sent by Prof. Metchnikoff. The bacillus was not hog cholera, but swine plague. There has evidently been some misconception in the mind of this, as well as other European investigators, as to what the hog-cholera bacillus really is. Our own work, some years ago, clearly showed that rabbits are easily protected by the inoculation of sterilized cultures of the swine-plague germ, and made way for the belief that other methods would be equally successful; hence Metchnikoff has not presented anything unexpected, if we apply his results to the swine-plague group of bacteria.

In addition to this experimental work, the examination of diseased organs of various domesticated animals sent to the laboratory for diagnosis and suggestions as to prevention have taken up more or less time. Cases of actinomycosis, glanders, anthrax, rabies, and of various diseases of fowls have come under our observation.

INVESTIGATIONS CONDUCTED BY THE BIOCHEMIC LABORATORY DURING 1892.

By Dr. E. A. de Schweinitz.

MALLEIN.

During the year a great deal of the work in this laboratory has been directed to the preparation and study of mallein, and, in conjunction with Dr. Kilborne, to an examination of its practical value as a means of diagnosing latent glanders.

The French and German authorities, Nocard, Preusse, Tietze, and others, regard mallein as an invaluable aid in the examination of supposed glandered animals. The tests which have been made at the station of this Bureau, and, at our request, by a number of veterinarians in different parts of the United States, have given in all instances satisfactory results. By its use the latent disease has been detected in horses which, so far as every other means of diagnosis would indicate, appeared to be perfectly healthy. The autopsies have proved the correctness of the diagnosis with mallein.

The mallein, as prepared in this laboratory, is a glycerin extract from the cultures of the bacillus malleus. For practical purposes a glycerin bouillon is the most satisfactory culture medium for the growth of this germ, and it is from such cultures that all the mallein of this Bureau has been prepared.

As the biochemic laboratory is now ready to supply mallein to parties who are willing to give it a careful test and keep a record of their results, it should prove of great value to the veterinarians and horse-owners in the country, especially in those sections where glanders is prevalent. The detailed reports and tabulated results of the individual tests which have been made for us by Drs. Dinwiddie, Casewell, and Francis, and also at the station of this Bureau, have been already published in the American Veterinary Review, and a still more detailed report will appear in the annual report of this Bureau.

The directions which have been sent out with the mallein, to serve as a guide in testing it, are as follows: Make the test, if possible, with a healthy horse as well as with one or more affected with glanders.

Take the temperature of all these animals three times a day for one or two days before making the injection. On the day of making the injection take the temperature every two hours from early in the morning until late in the evening. Use for each horse one cubic centimeter of the solution as sent you, and make the injections beneath the skin of the shoulder with an ordinary hypodermic syringe. Be careful and thoroughly sterilize the syringe after injecting each horse, or better, use separate syringes for healthy and suspected animals. If the same syringe must be used, inject the healthy animals first and thoroughly sterilize after each of the other injections. Sterilize the thermometer in a solution of carbolic acid after taking the temperature of each horse. The temperature will begin to rise as a rule from three to four hours after the injection and reach its maximum eight to ten hours after the injection. On the two days succeeding the injection take the temperature three times a day. Note the general condition of the animal before and after the injection. After four or five days the injection should be repeated.

The solution of mallein should be kept always in a tightly-sealed bottle in a cool place. As prepared for shipment the mallein is diluted with an equal volume of glycerin—50 per cent—so that it will keep better.

A résumé of the results of the experiments which have so far been conducted is that the mallein has caused a rise in the temperature of all horses affected with glanders or farcy of from 3° to 5° F. In some rare cases the mallein will also cause a rise of temperature in healthy animals, but when the injection is repeated there is no rise. Coupled with the rise of temperature we have always noted in diseased animals a marked persistent swelling at the point of inoculation, increasing often on the day succeeding the injection, disappearing again four to five days afterwards. In the healthy animals this local swelling was either altogether absent or very slight, and had disappeared upon the day after the injection. In some instances the injections with mallein were repeated upon the same diseased animal a number of times. The reaction in temperature and swelling in these cases were always marked, while healthy animals, upon a second injection, showed no effect, and had apparently acquired an immunity.

The value of the mallein, however, as a means of diagnosis has been conclusively demonstrated, and, used under proper legal restrictions, would eventually result in the stamping out of this disease.

Just as mallein is a valuable diagnostic aid in glanders, so is tuberculin in the examination of suspected tuberculous cattle.

When we consider how this disease can be communicated to man from cattle by means of the milk or otherwise, how easily one diseased animal can infect an entire herd, the importance of a quick and sure means of early diagnosis is at once apparent.

TUBERCULIN.

Tuberculin, like mallein, is obtained from the products of the growth of the bacillus causing the disease, and when injected into diseased animals, causes a marked rise of temperature, while healthy animals are not affected.

With the view of preparing tuberculin for general use and studying its properties it seemed desirable to secure a culture medium as inexpensive as possible, and one which could be quickly made. Such a medium is obtained by adding to 1,000 c.c. of distilled water, 0.2 gram magnesium sulphate, 1 gram acid potassium phosphate, 10 grams ammonium phosphate, 70 c.c. of glycerin, and 1 gram peptone. The solution as first obtained in this way has an alkaline reaction, but can easily be made either neutral or even acid by simply boiling, as some of the ammonia is thus driven off. Upon this medium the tubercle bacillus multiplies well and rapidly.

In the preparation in the biochemic laboratory of considerable quantities of tuberculin we have used a neutral peptonized beef broth containing 7 per cent of glycerin, and its value has been satisfactorily tested upon tuberculous animals.

The experiments which have been conducted by the Bureau are confirmatory of those made abroad where Koch's lymph has been used. The injection causes no rise of temperature in healthy animals, while tuberculous animals show a rise of temperature of from 20° to 50° F. For purposes of comparison both Koch's tuberculin and that prepared here have been used upon the same animals, or in the same herd, with the production of almost identical results. Where the rise of temperature indicated diseased conditions of the animals they have been killed, and the autopsies proved the correctness of the diagnosis. In several instances, where the ordinary physical examination of the animal would have indicated perfect health, the post-mortem examination made in virtue of the reaction obtained from the lymph has demonstrated the presence of the insidious tubercle bacillus.

For better preservation our tuberculin is made up with an equal volume of glycerin, and in this solution it will retain its properties for sometime.

The injections of the tuberculin are made in a similar way to those with mallein, but in no instance has any local swelling been noticed from the tuberculin, while in the use of the mallein upon glandered horses the local swelling was equally as characteristic as the rise of temperature.

In preparing tuberculin and mallein, great care and precautions have to be observed. The culture media must be properly prepared and the active principles extracted when the growth has advanced to a certain point, while the utmost care must be used to have the lymph free from germs without having in anyway destroyed the active principle.

The Bureau is therefore prepared to furnish the means for diagnosing two of the most wide spread and dangerous diseases of domestic animals.

With the coöperation of the experiment stations and veterinarians of the country, these two diagnostic materials can be made of inestimable value.

DEHORNING COMPOUNDS.

Dr. Kilborne conducted some experiments during the year with three of the patent chemical dehorners found in the market, which we will designate as A, B, and C, with the results as given in the table:

No. of animal.	Age when applied.	Condition of horn.
A.		
	Days.	
76	42	Uninjured.
87	7	Do.
89	32	Do.
98	28	Killed.
B.		
77	45	Killed.
91	11	Do.
84	6	Do.
92	29	Do.
C.		
79	31	Uninjured.
86	11	Killed.
85	30	Uninjured.
99	26	Do.

These dehorners are chiefly a strong solution of caustic soda, and of the three, *B* dehorner seems to give the most satisfactory results. A dehorner was prepared in the laboratory and tried in comparison with *B*. It contained 50 per cent caustic soda + 25 per cent kerosene + 25 water. An emulsion of the kerosene and soda was prepared by heating and vigorous stirring and this was then dissolved in water. It was applied to the right horn of the calves, while dehorner *B* was applied to the left. Applied to the horns of a calf 23 days old both horns were dead in fourteen days, and have showed no signs of growth.

An ordinary solution in water of 50 per cent crude caustic soda stunted the horns, but did not kill them.

The kerosene emulsion appears equally as effective as dehorner *B*, and is of course considerably cheaper.

All these dehorners, however, to obtain the best results should be applied to the button before the animal is 30 days old.

These experiments are given, as they may prove of value to cattlemen. The dehorners, if carefully applied to the button and not allowed to come in contact with the adjacent skin, are practically painless to the animal.

REPORT OF THE CHEMIST.

SIR: I have the honor to submit herewith a report of the work done in the Division of Chemistry of the U. S. Department of Agriculture during the past year.

Respectfully,

H. W. WILEY,
Chemist.

HON. J. M. RUSK,
Secretary.

BLACK PEPSIN.

In the Report for 1891 was published a description of a preparation designed to increase the yield of butter. This preparation was sold at a high price and had the power of causing the incorporation of the casein, milk sugar, and other constituents of the milk with the butter fat. This was effected by producing a kind of an emulsion by which these bodies were held in suspension. The apparent result of the process was to double the yield of butter. It was pointed out at the time that this substance was pepsin and that the apparent increase in yield was in reality a delusion, as, of course, there is no method by which the actual content of butter fat in milk can be increased after the milk leaves the cow.

During the present year the Department has received numerous inquiries concerning the substance known and sold as black pepsin, which is used for the purpose described above. In reply to these inquiries the information has been of a uniform character, viz, that this substance has essentially the properties ascribed to it, but that its use in all cases must be regarded as a fraud and hence avoided.

One sample of the black pepsin above referred to has been examined by the Department and found to consist essentially of a mixture of crude pepsin with sugar. It is hoped that farmers will not be deceived by the claims of persons desiring to sell this compound, inasmuch as butter made in this way will soon spoil and is practically not butter but simply an incorporation of butter with about an equal weight of other substances. The making of such butter is also practically an adulteration of a food product and should be prohibited by law.

BANANA MEAL.

The Department has received during the past year numerous letters making inquiries respecting the use of banana meal as food. A sample of banana meal was furnished by Mr. Francis J. Geis, of New York, and a chemical analysis thereof was made. The results of the analysis are as follows:

		Per cent.
Moisture		11.44
Ether extract		0.39
Alcohol extract (80 per cent)		5.94
	Per cent.	
Of which { Reducing sugar	1.18	
Of which { Sucrose	0.08	
Cold-water extract		5.33
Fiber		1.11
Ash		3.04
Starch		59.35
Albuminoids		5.25
Digestible fiber and other undetermined carbohydrates		8.15
Total		100.00

Perhaps the most important result of the analysis is in showing the large percentage of starch which the banana meal contains. Evidently, as will be seen from the description following, the bananas were harvested for the purpose of making this meal while still quite unripe, otherwise the percentage of sugar would have been greater and the percentage of starch less. The amount of sugar present in the meal is quite insignificant, amounting in all to only 1.26 per cent, while the amount of material soluble in 80 per cent alcohol is much larger, showing probably a carbohydrate related to the sugars, and possibly of a sweetish taste, but not responding to the ordinary test for sugars. One important point to which attention should be called in the analysis is the fact that almost the whole of the material is digestible. The amount of indigestible fiber as determined by analysis is only a little over 1 per cent and the amount of ash a little over 3 per cent. According to the analytical data less than 5 per cent of the whole material is indigestible.

Practically, in this country, the only locality in which bananas can be sucessfully grown is found in the southern part of the Florida Peninsula. Bananas grow luxuriantly in South Florida, and have ample time for the maturation of their fruit. There are large areas south of a line drawn eastward from Tampa in which bananas could be successfully cultivated. The ease with which they grow, the little care which is required for their cultivation, and the magnitude of the harvest are points which demand for banana culture a respectful consideration. It is not possible to say with the data now at hand that banana culture in southern Florida will prove financially remunerative; that is a matter on which an expression of opinion is withheld. It is only desired to call attention to the data obtained for the purpose of further determining the possibilities of remunerative culture. What little is known of banana culture we have been compelled, of course, to take from foreign sources, and this is included essentially in what follows:

When only partially matured, in the milky state, these fruits contain a considerable portion of starch, and, roasted or boiled, form a very nourishing food, capable of being substituted for bread; when further matured they contain more sugar and are eaten as an accompaniment to meat, and when fully ripe the starch is largely changed into gum or sugar, and they are then eaten raw or sliced and cooked in the form of fritters.

As might be supposed with so important an article of food, many methods are adopted with a view of preserving the banana, as it quickly perishes after becoming ripe. Banana figs are preserved in a manner closely resembling that adopted with the ordinary fig. When fully ripe, the bunches of fruits are removed from the plants and exposed to the sun until they commence to wrinkle; the skin is then removed, for if not peeled, a disagreeable flavor is imparted. They are still exposed to the sun until an efflorescence of sugar appears on the surface, when they are pressed into masses and wrapped with leaves of the plant or placed in boxes and kept dry. They have been kept in good condition in this way for many years. This method can only be adopted in climates that are very dry. In damp tropical regions they are prepared for drying by first rapidly boiling the ripe fruit for a short time in water that contains sulphate of lime; without this precaution, in moist climates, the fruit becomes damp instead of drying.

The farina of the banana, or plantain meal, is prepared by cutting off the fruit before it is ripe, and, while in its starchy condition, slicing it and drying in the sun. This, coarsely ground and sifted, forms a farina highly esteemed in South America; but as the quality of the flour depends chiefly upon the rapid drying of the cut slices, the preferable mode is to dry them in an oven. If knives are used in slicing the fruit, they should be nickel plated, as the acid acting upon steel or iron colors the fruit. When the drying process is thorough the slices are hard, brittle, translucid, and of a horny appearance, and when ground furnish a white, sweet meal, with a smell like fresh hay, and it is a very palatable and easily digested food. Macaroni made from it falls to pieces when put into warm water, and bread can be made only by adding some kind of meal that contains more gluten. The fresh pulp furnishes about 40 per cent of dry farina, and it is stated that the produce of bananas compared to that of wheat is as 133 to 1, and to that of potatoes as 44 to 1, and 1 acre of ground would furnish over 20,000 pounds of meal.

In some parts of South America the fruits are peeled, grated, and the moisture expelled by pressure; the mass is then baked in an oven and afterwards ground into a coarse kind of flour, which is inferior in nutritive properties to that obtained from the dried slices. Bananas baked in their skins, then peeled and boiled in water, are considered good for coughs and inflammation of the lungs. The Malays use a variety of this fruit, which possesses considerable tonic properties, to arrest diarrhea. The bananas are generally very astringent when half ripe and eaten raw, on account of the gallic acid which they contain. In the Antilles large quantities of potash are obtained from the ashes of the plant, which are used to wash linen.

Many spirituous drinks, as well as vinegar, are made from the banana. Banana wine is obtained in Cayenne by pressing the fruit through a sieve, after which it is made into cakes, dried in the sun, and dissolved in water when wanted for use. Bananas soaked in brandy impart to it a taste of the fruit. Vinegar is also made by suspending the fruit in baskets, where it liquefies and the juice, which is collected, soon becomes vinegar.

All of the species of Musa furnish fiber, and, since the stem, when the fruit has ripened, decays, or is cut down, the fibrous material is obtained without detracting from the food value of the plant.

When the stem is cut down, young suckers from the root take its place, which, in the course of a few months, attain a fruiting condition. In none of the varieties esteemed for their fruits are there any seeds discoverable, though at times minute black points may be observed in the pulp, disposed in longitudinal rows, which are probably the feeble traces of seeds not yet quite extinguished by cultivation, the black perisperm being the last to disappear.

In tropical countries where they are grown for the trade, they are planted in rich bottom lands and receive very little cultivation.

The number of bunches of bananas imported into the United States from Central America in the different years named below is as follows: In 1887, 5,914,472; 1889, 9,092,557; 1890, 12,582,550. The value of the imports of bananas into the United States during the year ended June 30, 1892, was $5,000,390.

FOOD ADULTERATION.

During the past year the work of the Department in the investigation of food adulteration has been directed chiefly to the examination of canned and preserved foods. An examination was not only made of the contents of the cans, but also of the materials of which the cans were composed and the solder employed in sealing them.

In European countries the character of the tin which is employed in making the cans is carefully observed under the statutes governing the matter. On account of the generally poisonous effect of lead salts it is prescribed in some European countries that the tin used in canning must not contain over 1 per cent of lead. In this country there is no provision of law regulating such matters, and the result is that canners use tins without any regard at all to the composition of the tinning material. It is supposed by them, doubtless, that the tin used is practically pure; whereas it has been found by the investigations which have been made, that it sometimes contains over 12 per cent of lead. Several instances have come under our observation where the tin employed as a coating for the plate used in the manufacture of the cans contained over 10 per cent of lead. The danger which might arise from the use of this kind of material is manifest. The natural acids of fruits and vegetables, and even of meats, may act upon the lead as a solvent with the formation of lead salts highly injurious to health. As is well known, the solder of commerce contains usually from 40 to 60 per cent of lead. It is, therefore, highly important that this solder should not come into contact with the contents of the can. Nevertheless, it is a very common occurrence to find nodules of the solder in the can, no care whatever being exercised to prevent the melted solder from running into the contents of the can. This is a matter which should also be carefully observed, and the solder should be so employed as to be entirely out of contact, or practically so, with the contents of the package.

Canned meats have also been carefully examined for the detection of ptomaines, or, in other words, nitrogenous bases, which are formed during the decomposition of flesh. No such bases have yet been found, although they doubtless sometimes exist. It is probable, however, that such bases are formed in the most part subsequent to the opening of the can, and therefore there would be more danger in eating canned meats which had been open for some time than those which had been freshly opened. The microörganisms which are active in the formation of such nitrogenous bases would naturally not be in action in the contents of the can, inasmuch as such contents are presumably sterilized after the air is excluded. On opening the canned goods, however, and the exposure of the contents to the air, microörganisms would be at once seeded, and their development might go on with astonishing rapidity. Canned goods, therefore, should not be preserved for any great length of time after opening before their consumption.

Careful examination was also made for preservatives used in canned goods. In some forms of canned goods, such as condensed milk, it is customary to add large quantities of sugar; in fact, sugar may be added to many of the canned substances. The addition of a preservative of this kind can not be regarded with distrust unless it be added in such quantities to a very expensive material as to materially diminish its cost. When, however, the question of such preservatives as salicylic, benzoic, or boric acid, hydronaphthol, and bodies of this class, and especially sulphites and saccharin, is considered, the matter is quite different. All these bodies, with the possible exception of saccharin, are certainly injurious to health when taken even in small quantities for a long time, and they should be rigidly excluded from canned materials. Some of these preservatives have been found in many instances, although they do not exist in a very large percentage of canned goods.

Particular attention has been paid to the examination of green-colored peas, beans, and other vegetables, for copper. It is a common custom to use some kind of a copper salt, presumably the sulphate, in canning such materials for the purpose of preserving or intensifying their green color. The consumer may be certain when he is eating very green canned peas, beans, or anything of that kind, that he is consuming large quantities of copper. We have uniformly found large quantities of copper in all such goods, and have recovered it in every instance, where the attempt has been made to do so, in the metallic state. While the use of copper adds greatly to the appearance and attractiveness of such canned materials, it must be condemned on hygienic grounds, as the frequent consumption of canned goods which have been colored with copper might be very prejudicial to health. These remarks are made with the full understanding that the occasional consumption of a small quantity of copper, or even of lead, tin, or a preservative such as those mentioned above, may occasion no ill effects whatever; it is only when such substances are consumed constantly and for long periods of time that they may become dangerous from the cumulative effect which they may produce.

The amount of analytical work which has been bestowed upon this class of foods is very great indeed, and laborious researches have been undertaken, not only for the purpose of determining and detecting the different forms of adulteration which may exist, but also of showing in what way such adulterations can best be detected. The data in detail of this work will soon be published as Part 8 of Bulletin 13, on "Food and Food Adulterants."

ADULTERATION OF HONEY.

Since the publication of the special report on honey adulteration in Part 6 of Bulletin 13, a large additional amount of work has been done on this subject in conjunction with Prof. A. J. Cook, of the Agricultural College of Michigan.

Some question arose among dealers in honey in regard to the accuracy of the methods employed in determining honey adulteration, and the object of the work alluded to above was to determine in a measure the reliability of the methods employed. The investigation, however, did not stop at this point, but was carried considerably further, with the intention of determining, if possible, a method by means of which honey derived from the plant-louse, or the exudations therefrom, might be distinguished from that from pure floral honey. To this end fifty-six samples of honey were collected by Prof. Cook and forwarded by number to the Department for chemical examination. No description whatever accompanied these samples, and they were examined without knowledge of their origin or nature.

The examination consisted in the determination of water, ash, percentage of invert sugar, percentage of sucrose, and polarization at different temperatures. In every instance abnormal honeys—that is, those not derived from pure floral exudation—were detected. In one or two cases, however, a genuine floral honey was included in the list of suspicious honeys. On inquiry it was found that such honeys had been rapidly gathered, and were deemed suspicious on account of containing more than 5 per cent of sucrose.

The general results of the investigation serve to confirm the conclusions of previous work, viz, that a pure floral honey gathered and stored by bees always shows a left-handed polarization at ordinary temperatures. Such honey contains an average of about 17 per cent of water, 72 per cent of invert sugar, and from 1 to 2 per cent of sucrose. Occasionally the percentage of sucrose rises above these figures, but the figures given are the average.

When honey has been mixed with glucose the percentage of invert sugar is at once diminished, due to the fact that glucose consists largely of maltose and dextrin, maltose furnishing a smaller percentage of reducing sugar and dextrin none at all. Such honeys, moreover, are always strongly right-handed at ordinary temperatures and remain so after inversion. On the other hand, a honey which contains an abnormal proportion of sucrose may have a right-handed polarization at ordinary temperatures, but after inversion it becomes strongly left-handed, showing the nature of the adulterant.

Honeys which are derived from the plant-louse are, in general, slightly right-handed. In one instance it was found to be strongly so, and this right-handed polarization continues after inversion. Such honeys also have an abnormally low percentage of invert sugar and, as has been observed in the few cases which have been examined, an abnormally high percentage of ash.

As a result of the work so far, the following may be regarded as a temporary criterion for judging a honey derived from the plant-louse, as distinguished from a pure floral honey: The plant-louse honey will have an abnormally high percentage of ash, an abnormally low percentage of invert sugar, and a polarization near zero at ordinary temperatures, or slightly right-handed and persisting after inversion.

It is well known that pure invert sugar at a temperature of 88° C. is without effect upon the plane of polarized light. Hence a solution of pure invert sugar polarized at that temperature would indicate zero on the scale of the polariscope. Advantage was taken of this fact to determine the residue of right-handed bodies in the honeys examined at a temperature of 88°. Forty-two of the samples mentioned above were polarized at 88°, and with the uniform result, with two exceptions, of a right-handed polarization. The degree of right-handed polarization, however, varies widely, being smallest for pure floral honeys, largest for honeys adulterated with glucose, and a medium polarization for honeys of plant-louse origin. The highest right-handed polarization at 88° obtained was 53.53°. This was of a sample which was strongly adulterated with glucose. One sample polarized zero at 88°, and was therefore presumably a pure solution of invert sugar. Two samples showed a left-handed polarization at 88°, indicating that they contained an excess of levulose. They were probably made by draining a granulated honey, leaving the dextrose undissolved.

The general result of this work establishes the fact that the chemist can in almost every instance distinguish a pure floral honey from any sophistication of any kind, with the possible exception of adulteration with pure inverted sugar.

Work on this line of investigation will be continued with the object of discovering some method by means of which the last form of adulteration may be also detected with certainty.

EXPERIMENTS WITH SUGAR BEETS.

The experimental work with sugar beets begun in previous years was continued during the past year in the same general lines as those already pursued. The work of the Department was divided into two main divisions: The first division consisted in the continuation of the experimental work at the station of the Department at Schuyler, Nebr.; the second consisted in the distribution of high-grade beet seed to farmers who had applied therefor, accompanied with instructions for planting, cultivating, and harvesting the beets, and taking samples for transmission to the chemical laboratory at Washington.

The work at the experiment station consisted of two distinct lines of investigation. The first of these referred to the production of sugar-beet seed from a crop of mother beets saved from last year, and the second was devoted to the cultivation of the different varieties of sugar-beets in plats of appropriate size, with the determination of their sugar content at various periods of maturity, and the total weight of beets produced. In connection with these, an interesting experiment was undertaken in determining the actual cost of the production of a single acre of beets, the data of which will be found farther on.

THE PRODUCTION OF SEED.

The beets which were used for the production of seed were preserved from the crop of 1891 in carefully constructed silos. Beets of normal form and a weight of a pound or a little more were those which were selected for preservation. At the time the beets were placed in the silo a given number representing the average of each variety was taken and analyzed. The weight of the beets was also determined. The object of this work was to determine as nearly as possible any loss in sugar or in weight which might take place during the winter.

On the 26th of March, 1892, the silos were opened and the work of examining the mother beets was commenced. When the silos were opened, the beets were found in an excellent state of preservation. The varieties which were preserved were the following: (1) Vilmorin's Improved; (2) Dippe's Kleinwanzlebener; (3) Desprez; (4) Lemaire; (5) Ferdinand Knauer; (6) Kleinwanzlebener Elite.

A comparative analysis of the beets at the time the silos were opened showed that they had lost during the winter an average of 2.85 per cent of sugar. In the analysis of the beets, therefore, 2.85 per cent of sugar was added to each determination in order to make the comparison directly with the beets as they were stored. In all, 4,455 mother beets were analyzed by boring a hole about three-fourths of an inch in diameter diagonally through the beet and taking the pulp thus obtained for the analysis.

The beets were then divided into various classes according to the percentage of sugar which they contained. The classification of the different varieties according to this method is given in the following table:

Number of beets of each variety containing the given percentage of sugar.

Variety.	11 per cent.	12 per cent.	13 per cent.	14 per cent.	15 per cent.	16 per cent.	17 per cent.	18 per cent.	19 per cent.	Total.
Vilmorin	38	161	268	295	170	50	4			986
Kleinwanzlebener	37	115	196	245	211	53	8	1		886
Desprez	144	337	331	243	78	10	3			1,146
Lemaire	44	93	127	99	59	8	3	1		434
Knauer	58	166	169	128	79	32	4	2		838
Elite	32	72	93	76	50	30	8	3	1	365
Total										4,455

All beets which fell below 11 per cent of sugar were rejected and not used for the propagation of seed.

All the beets which were preserved for seed were then divided into three classes. The first or extra quality consisted of those beets showing a content of 17 per cent of sugar and above; the second class, grade No. 1, consisted of all those beets having a sugar content varying between 15 and 17 per cent; the third class, grade No. 2, consisted of all those beets having a sugar content of from 11 per cent to 15 per cent. The seeds were harvested early in August and with the following results:

Variety.	Area planted.	Seeds collected.	Calculated yield per acre.
	Rods.	*Pounds.*	*Pounds.*
Vilmorin	20.0	117	936
Dippe's Kleinwanzlebener	20.0	128	1024
Desprez	24.0	92	613
Lemaire	10.3	66	1056
Knauer	15.0	126	1344
Elite Kleinwanzlebener	9.0	66	1173
Total	98.3	595	Mean...1025

Actual value of seed produced (595 pounds at 15 cents) $89.25

The Department has reason to be satisfied with this first attempt in this country to produce graded beet seed, such as has been produced for so many years and with such happy results on the beet-seed farms of Europe. All the seed of the extra quality, of course, is saved solely for the purpose of producing mother beets for further seed production. The seed of the first and second grades will be used for general planting for the production of the two grades of sugar beets.

On account of the newness of the work and the difficulty of securing skilled labor therefor, no attempt was made to determine the actual cost of the production of the seed. Its value, however, at the rate of 15 cents per pound, shows that an acre of ground may be made to yield a large sum of money when planted to mother beets.

Aside from the importance of the production of beet seed as an economical measure, it must not be forgotten that there is also much to be expected from the acclimatization of the beet to the conditions of the seasons in different parts of the country. It is only reasonable to expect that beet seed which is produced for a number of years, for instance in the vicinity of Schuyler, will be able to produce a beet better adapted to the climatic conditions of that locality than beet seeds imported from Europe. By the careful selection of high-grade beets and the propagation of seed therefrom, it is to be expected that the average content of sugar in the field beets will be more firmly established and increased. At the present time, with the imported seed and at the period of perfect maturity, we have been able to produce beets with an average content of about 14 per cent of sugar. With seed produced on the spot in the manner indicated, it is not too much to expect that this content of sugar may be increased fully 1 per cent in the field as a whole.

During the season which has just passed, a much larger number of mother beets has been selected, and it is proposed during the coming spring and summer to produce beet seed on a larger and more elaborate scale than that which is indicated briefly in the report above.

CULTURE WORK.

The cultivation of the different plats in beets was conducted on the principle of rotation, the plats which were in beets last year having been seeded to cereals, and all the plats of the station so adjusted as to bring each one in beets once in four years.

The first planting was made on April 30, it having been delayed until that day by the cold and wet spring. The month of May was extremely wet and cold and quite unfavorable for the vigorous growth of the young beets. June was favorable to rapid growth, which continued until the middle of July. After the middle of July and until the harvesting time the meteorological conditions were of an extreme character. The temperature for the latter half of July and the whole of August was very high, and during this time there was very little rainfall. The mean temperature for July and August for 1891 was 70.05° F. For the same period during 1892 it was 74° F. The rainfall from May 1 to November 1, 1891, was 26.6 inches; for the same period in 1892, 14.1 inches. Thus it is seen that the season of 1892 was much warmer and drier than the season of 1891, and therefore more unfavorable to the development of the beet.

The beets also suffered from an insect pest during the season of 1892, which produced serious ravages. The insect—a caterpillar (*Eurycreon sticticalis*)—attacked the beets during the latter half of July. By the use of arsenical insecticides the ravages were checked, but not until great damage had been done and many caterpillars had transformed. A second generation was thus produced and attacked the crop at a later date. During the second attack the whole of the foliage of the beets attacked was consumed by the caterpillars. The growth of the beets was therefore checked and kept at rest until time for the development of a new crop of foliage, which latter was of course developed at the expense of the original beet.

YIELD.

As a result of all these unfavorable conditions the yield of beets per acre was much less in the season of 1892 than in the season of 1891. The yield of each variety per acre and the maximum percentage of sugar in the juice is given in the following table:

	Tons per acre.	Sugar in juice.	Sugar per acre.
		Per cent.	*Pounds.*
Vilmorin	12.5	15.6	3,900
Dippe's Kleinwanzlebener	15.0	16.0	4,800
Desprez	16.8	13.0	4,368
Lemaire	15.8	14.6	4,614
Elite Kleinwanzlebener	16.0	15.2	5,120
Original Kleinwanzlebener	18.6	16.1	5,989

In explanation of the above table, it is necessary to say that the maximum content of sugar in the juice is taken from the series of analyses which yielded the highest results during the analytical season; therefore the table shows what the variety would have yielded in sugar if harvested at the most opportune time. Of course, in a manufacturing campaign it is not possible to harvest each variety of beets at the time of its greatest content of sugar, and therefore the yield of sugar as given in the above table is much larger than would actually be obtained in practice.

In regard to the percentage of sugar in the beet, the content was fairly comparable with the season of 1891. The yield in tons per acre is decidedly less. A comparison of all the varieties of the two seasons is given in the following table:

	1891.	1892.
Weight of beets per acre ... tons	21.77	15.8
Yield of sugar per acre ... pounds	6,060	4,800

COST OF THE PRODUCTION OF ONE ACRE OF BEETS.

In the data which follow is given the total expense of the production of a single measured acre of beets, in which an accurate account of every expense attendant upon the planting, culture, harvesting, and delivering of the beets was kept. The result, while not particularly encouraging, must be interpreted in the light of the fact that it is not possible to produce a single acre of any crop with as much economy as a larger area could be produced proportionately. Further than this, attention must be called to the fact that no preparation had been made at the station for harvesting the beets by means of a mechanical lifter. Inasmuch as the rest of the work was done on small plats and had to be done carefully by hand, no provision had been made for harvesting after the manner employed in large fields. The cost of harvesting, therefore, as given in the itemized account, is fully double what it would be in ordinary beet culture. The itemized cost of the production of one acre of beets is as follows:

1891:		
Oct. 1.	Light plowing of ground	$1.68
Oct. 25.	Deep plowing of ground	2.00
Oct. 25.	Subsoiling of ground	2.00
1892:		
April 28.	Disk harrowing of ground	.33
April 29.	Twice harrowing, at 17 cents	.34
April 30.	Rolling	.17
April 30.	Cost of seed (17 lbs., at 15 cts.)	2.55
April 30.	Drilling seed	.52
April 30.	Rolling after drill	.17
June 2.	Horse hoeing	.62
June 8-10.	Thinning out (65 hours, at 12½ cents per hour)	8.12
June 17.	Hoeing by hand (50 hours, at 12½ cents)	6.25
1892:		
June 21.	Horse hoeing	$0.62
June 27.	Horse hoeing	.62
June 30.	Horse hoeing	.62
July 7.	Soiling up the beets (29 hours, at 12½ cents per hour)	3.62
	Total cost of production	30.28
	Harvesting by hand	13.50
	Transporting 12½ tons beets 3 miles, at 50 cents per ton	6.00
	Rent of land, at $2.50 per acre	2.50
	Total cost of planting, cultivating, harvesting, and delivering to factory one acre of beets	52.28

In so far as the actual cost of the production of the beets is concerned, the figure given above, of $52.28, may be taken as the maximum cost of the production of 1 acre of beets by the most careful and approved methods. There is, of course, no doubt of the fact that in field culture where such great care is not exercised the cost may be materially diminished. As has already been mentioned, this is especially the case with the item of harvesting, from which at least one-half may be deducted as indicated above. Nevertheless the actual figures are given just as the expense account was paid at the station. Included, of course, in the cost of harvesting is the cost of topping the beets, which might not be inferred simply from the item as given. The cost of transporting the beets to the distance of 3 miles includes the loading of the beets into the wagons, hauling the distance, and unloading by means of a shovel into a car. Where beets are dumped directly at the door of a factory this cost may be materially diminished.

The price received for the beets was $4 per ton, making the total price received $50. This deducted from the cost of production shows an apparent net loss of $2.28 per acre. When, however, the fact is considered that if the farmer had done this work himself and paid himself and his team the liberal wages allowed, it is seen that he would have come out very well considering the outlay.

It was, of course, a great source of regret to us that the very acre of beets which we had selected as a test of cost of production should happen to be the one which was most seriously damaged by the caterpillars. The foliage of the beets on this acre was completely destroyed by the caterpillars during their first and second attacks; otherwise there is no doubt of the fact that the yield per acre would have been at least 6 tons more and shown a handsome profit instead of loss per acre. These, however, are accidents which must be allowed for, and it is useless to try to deceive the public by the statement that every farmer who practices beet-growing will make a profit per acre. The business is just like that of any other farming occupation—sometimes it will prove highly remunerative and at other times it will be practiced at a loss.

This Department has no desire to induce farmers to enter into the culture of the sugar beet by any high coloring of the returns which they will receive or any diminution of the labors which the farmer will have to undergo. With the most careful culture and with attention to every detail the farmer may as well acknowledge the fact that it will cost him, in round numbers, in the neighborhood of $50 to produce a single acre of beets and deliver it a distance of 3 miles to a factory. Where he farms on a larger scale, and especially after a year or two of experience, there is no doubt of the fact that this expense can be reduced to $40 per acre or perhaps lower. More than this can not now be promised as regards the economy and cheapness of beet production.

Taking all the plats of the experimental station for the season, it is found that the mean yield per acre was 15.8 tons, which, at $4 per ton, would amount to $63.20 per acre. The cost of production for the yield of 15.8 tons would have been no greater than for the yield given, viz, 12.5 tons per acre, that is, $30.28. The cost of harvesting and delivering to the railroad station would have been greater, viz: for transportation, $1.50 extra, and for harvesting and topping, $2.50 extra, making the total extra cost for the increased yield $4. This, added to the $52.28, would make the total cost $56.28, which, deducted from the price of the beets, $63.20, would leave a net profit per acre for the whole station of $6.92. To avoid any misconception on the part of the reader, let it be said that this does not, of course, represent the actual cost of the small plats which were grown upon the station, which was very much greater than the amount mentioned above. The illustration is given only to show what the financial result would have been had the whole station been cultivated for factory purposes as the 1 acre was. A profit of $6.92 would be at the rate of nearly 20 per cent on a valuation of the land at $40 per acre. This is certainly a profit which would be satisfactory to most persons.

It is seen, however, from the above how rapidly the profits of a farmer will diminish if he allows the yield per acre to fall below 15 tons. On the contrary, it must be granted that when the yield does fall below 15 tons it is due to lack of care and experience in culture, and thus the actual cost of production is diminished to avoid expense. Nevertheless it seems certain that farmers who conduct the culture of their beet fields in such a way as to secure only 5 or 6 tons per acre must necessarily operate at a loss.

In regard to the price obtained, it may be well to say that the beets not used for mothers were sold to the beet-sugar factory at Grand Island, where the price paid for beets is $4 per ton for beets polarizing from 12 to 15 per cent. The beets delivered by us to the factory polarized nearly 15 per cent, and so were very little inferior to those which would have fetched $4.35 per ton.

On the whole, the culture experiments for the season must be regarded as quite satisfactory when all the adverse circumstances are taken into consideration. The data given at least represent with absolute accuracy the operations which were performed and are therefore extremely valuable to the farmer and the manufacturer as a basis for estimating the probable cost and profit or loss of engaging in beet-sugar culture. The full data of the culture experiments were published in Bulletin 36 of the Division of Chemistry, which was issued in March, 1893.

GENERAL DISTRIBUTION OF SEED BY THE DEPARTMENT.

During the late winter and early spring of 1892, 4,000 pounds of imported beet seed were distributed by the Department to various parts of the United States, to the addresses of those who had made written application for such seed during the previous year. The varieties distributed were Vilmorin's Improved and Kleinwanzlebener. In all, 8,159 packages of 7.8 ounces each were sent out to 2,316 addresses. Accompanying each package were printed directions for preparing the land, planting the seed and cultivating it, and for taking samples for transmission to the Department for analysis.

Attention was called in the last annual report to the unsatisfactory results attending this method of experiment. It was difficult to obtain control on the part of the farmers of the experimental conditions, and the reports which have been received are as a rule fragmentary and unsatisfactory. In addition to this, inasmuch as a considerable time must necessarily elapse between the harvesting of the beets and their reception at the laboratory for analysis, more or less change will take place in the constitution of the beets. This change consists essentially in the loss of water by evaporation during transportation in the mails; so when the beet is received it is often shriveled, and by experiment it has been demonstrated that it may lose as much as 15 to 20 per cent of water in extreme cases. The result of this loss of water is to increase the apparent content of sugar in the juice of the beet and thus give rise to misleading results. In the interpretation, therefore, of the analytical results obtained from the analysis of these beets, the above fact must be borne in mind. In general, the more distant the locality the greater the loss by evaporation would be. Nevertheless the results may be regarded as in a measure comparable and indicating in a general way the possibilities of beet culture in the various localities of the country. The value of the work, however, appears to be so small from a practical point of view that it is recommended that further experiment in this direction be discontinued.

Results of the work by States.

State.	Number of samples.	Average content of sugar.	State.	Number of samples.	Average content of sugar.
		Per cent.			*Per cent.*
Arkansas	3	9.41	New Mexico	11	15.34
California	4	14.72	New York	4	15.43
Colorado	129	14.82	North Carolina	1	8.99
Idaho	1	14.65	North Dakota	6	12.86
Illinois	18	10.93	Ohio	42	11.62
Indiana	18	11.23	Oregon	8	14.24
Iowa	11	10.93	Pennsylvania	2	10.75
Kansas	18	11.07	South Dakota	30	13.12
Kentucky	2	8.86	Tennessee	1	9.42
Michigan	37	14.11	Virginia	6	11.95
Minnesota	22	12.17	Washington	14	14.52
Missouri	2	8.09	West Virginia	2	11.29
Montana	1	10.93	Wisconsin	12	12.72
Nebraska	15	14.15	Wyoming	3	15.20
Nevada	9	15.92			

Some interesting suggestions may be derived from the study of the data which are given above. In general, the data confirm the previous publications of the Department relating to the area in which sugar beets can be successfully cultivated. This area, however, appears to be gradually extending. The most remarkable extension of it which is indicated is in the so-called arid regions. Beets which have been grown upon irrigated land in Wyoming, Idaho, Colorado, and New Mexico are uniformly of high character and rich in sugar. It is evident that there is perhaps no crop which can be so successfully cultivated upon irrigated land as sugar beets. The cost of irrigated land makes it necessary that some crop should be grown which will yield a large return. Land which it has cost from $50 to $100 per acre to irrigate can not be seeded with financial success to such crops as will yield a net profit of only $4 to $5 per acre. Such land should be made to yield at least a net profit of from $10 to $15 per acre in order to pay a proper interest on the first cost of the soil. There is no crop yet which has been introduced into the arid regions which gives such promise of producing the above result as the sugar beet. The market for sugar can not be overstocked, hence there is no danger of blocking the market in case all the lands which have now been recovered by irrigation should be planted in beets. It would be quite different if they were planted with potatoes or some similar crop, whose overproduction might glut the market. It is no wonder that capitalists are looking with interest to this new opening for investment.

Climatic conditions, as has already been stated in previous publications of the Department relating to sugar beets, are of the utmost importance not only in the growing of the crop, but in the harvesting thereof. In the irrigated lands of our arid regions we have a complete control of climatic conditions. In the first place, there is during the growing season almost unbroken sunshine, a condition essentially favorable to the production and storage of large quantities of sugar. In the second place, the high altitude of the plateaus of the arid regions gives a summer which is not too warm for the proper growth of sugar beets. In the third place, the control of the water for irrigating purposes renders it possible to stimulate the growth of the beets during the earlier periods of the summer, while the withdrawal of the water prevents any second growth after the beets have matured in the autumn. In the fourth place, the dry autumnal weather is most favorable to harvesting the crop, and the period of frosts is so well known as to permit of the entire harvest being made before any danger of freezing occurs. It is believed that in no other place in the world can be found such a favorable agreement of climatic conditions for the production of not only large crops of beets per acre, but also of beets rich in sugar and of high purity.

Another fact which is worthy of notice is the continued success of beet culture upon the Pacific coast. The few samples received from the Pacific coast continue to sustain the high character of that locality for the production of sugar beets. Fortunately this experimental evidence has been thoroughly proved by the results of practical work. The beet-sugar factories during the present year have scored a phenomenal success. From the incomplete records on file in the Office of Internal Revenue, it is evident that the State of California alone during the present season has made over 20,000,000 pounds of beet sugar in three factories. Such a result is well calculated to encourage further investment of capital in the production of beet sugar.

A further study of the data reveals the fact that the Northern, Central, and Eastern States of the country are also well suited for the production of sugar from the sugar beet. From New York to the Dakotas the results are strikingly favorable.

The work of the Department, now extending over a period of three years, in testing in the manner described the possibilities of beet culture in the United States is now so complete as to leave the matter practically in the hands of investors. The Department can do no more than has been done to show the course which capital should pursue. It remains for the business men of our country to take hold of the matter of the production of our own sugar in such a way as to insure its speedy success. As far as can be seen there is no longer any reason to hesitate. The experimental ground has been thoroughly worked out both at the experimental station of the Department and by the State experiment stations, and by the general work of the Department in distributing beet seed to farmers in all localities. The case has been well made out. Numerous failures, it is true, have shown that there is always danger of disaster, but the uniform preponderance of successful effort shows conclusively that, with properly directed effort, and with properly invested capital and properly conducted operations, success is as reasonably certain in this business as in any other legitimate business in this country.

EXPERIMENTS WITH SORGHUM.

The work of the Department in continuation of the experiments for the improvement of sorghum as a sugar-producing plant was continued during the past year in Kansas at Sterling and Medicine Lodge.

At the Sterling Station 175 acres of land were leased for the culture work. The object of getting so large an area of land was to enable the different plats to be planted at a sufficient distance apart to prevent crossing when it was not desired. The land was plowed from 4 to 5 inches deep, harrowed once and in some instances twice.

Planting was commenced on the 8th of April and ended on the 30th of June, thus continuing over a period of eighty-three days. Two hundred and eighty-seven small plats were planted; most of them with seeds from selected seed heads of greatly superior quality. One hundred and nine large areas were planted with mixed seed from high-grade cane. The small plats were planted by hand while the larger were planted by drill. An average of 2 pounds of seed was planted per acre. Some replanting was necessary. The ordinary cultivation was given, the hoe being used on some plats to reduce the plants to a proper number per acre.

The season was rather favorable to the production of cane, and the best crop which has been secured by the Department at Sterling was grown. The quality of the canes was also satisfactory. The experience of the work shows that earlier plantings require a longer period to reach maturity than the later ones, which might be inferred from the character of the season.

The main object of the year's work was to reduce the number of varieties by selecting a few superior ones. The so-called varieties of sorghum are based upon very small botanical differences, not sufficient to distinguish them botanically but simply agriculturally; hence a very great many varieties may be produced, but they are so nearly alike that it does not seem necessary to establish them by long years of careful selection. The few superior varieties already established, which are quite distinct in their nature, offer all the inducements necessary for the continued propagation of a high-grade sorghum cane.

In general the experience of the work at the station has shown that hand-planting gives a much more uneven and irregular stand of cane than machine-planting; but there is no other way of planting selected seed heads except by hand, as it would be too much trouble to put so small a quantity of seed into a drill for planting purposes. It is in general advised to roll the land as soon as the canes appear, as it makes it possible to cultivate closer and thus diminish the amount of hand labor required.

TESTS OF VARIETIES.

As a general result of the work four varieties have been selected, out of all which have been investigated, for the continuation of improvement work in the future. These varieties are Folger, Collier, McLean, and Colman.

Folger is the best early maturing variety. It undoubtedly originated in a cross of Amber and Link, as reversions may be found in its canes to both these varieties, but the general type of the variety is now firmly established. It has all the advantages of early maturation of the Amber cane and is superior to it in every respect—in yield per acre, sugar content, and general sugar-making qualities.

The Collier variety is recommended as the best variety for the more northern latitudes in which sorghum is grown for sugar. It has an abundance of foliage which is quite persistent and very resistant to frosts. The canes are quite slender, yet it always stands up well, because the seed heads are light. It has a high content of sucrose and a fair purity. It ripens reasonably early and can be planted as late as June 15, in favorable localities.

The McLean variety has been grown at the Sterling Station for three years. It gives quite large canes and grows very tall. It seems well suited to the climate of Kansas and has always since its introduction shown a high percentage of sugar. The type is not yet firmly established, inasmuch as when the seed was originally received from Australia it consisted of two distinct types, and the pure McLean type has not yet been as firmly established as could be desired.

The Colman variety was originated at the station in 1888 by a cross between Amber and Kansas Orange. At first the type was very variable, but now it has become firmly established, and there is no variety of sorghum which has been grown which gives as good results in the sugar-house as the Colman.

The analytical work at Sterling embraced the analysis of average samples from the different plats to determine their value for sugar production, together with the usual analysis to determine the selection of seed heads by the character of the juice of the cane bearing them. The analytical results have been collected into tables showing the various properties of the different plats which were in cultivation.

The number of days required from the time of planting until the standard varieties reached 11 per cent of sugar is as follows:

	Days.
Colman	135.
McLean	135.
Collier	140.
Folger	142.

The dates on which the leading varieties reached 11 per cent of sucrose are as follows:

Folger	Aug. 29.
McLean	Aug. 30.
Collier	Sept. 5.
Colman	Sept. 7.

The number of days required for each of the leading varieties to attain a purity of 70 per cent is as follows:

	Days.
Colman	135
McLean	139
Collier	144
Folger	149

The dates on which the leading varieties attained a purity of 70 per cent are as follows:

McLean	Sept. 4
Colman	Sept. 7
Collier	Sept. 9
Folger	Sept. 12

The relative position of the leading varieties, based on analysis of average samples, for the maximum per cent of sucrose is as follows:

	Per cent sucrose in juice.
Collier	18.50
McLean	17.24
Colman	16.93
Folger	15.57

The dates on which the leading varieties reached their maximum percentage of sucrose, as based on the analysis of average samples, are as follows:

Folger	Sept. 26
McLean	Sept. 28
Colman	Sept. 29
Collier	Sept. 30

The relative rank of the leading varieties in respect of minimum glucose, based on the analysis of average samples, is as follows:

	Per cent reducing sugar in juice.
McLean	0.44
Collier	0.49
Colman	0.50
Folger	0.91

The dates on which the leading varieties showed their minimum percentage of reducing sugar, as determined by the analysis of average samples, are as follows:

Colman	Sept. 25
McLean	Sept. 26
Folger	Sept. 27
Collier	Sept. 28

The relative position of the leading varieties in respect of the maximum purity, based on the analysis of average samples, is as follows:

	Purity.
Collier	78.19
Colman	77.95
McLean	76.80
Folger	74.75

The dates on which the leading varieties reached their maximum purity, based on the analysis of average samples, are as follows:

McLean	Sept. 22
Collier	Sept. 27
Folger	Sept 27
Colman	Sept. 27

The relative position of the leading varieties, based on their mean percentage of sucrose, from the analysis of average samples, is as follows:

	Mean percentage of sucrose.
Collier	18.43
Colman	17.79
McLean	16.92
Folger	14.87

The relative position of the leading varieties as determined by their mean purity, from the analysis of average samples, is as follows:

	Mean purity.
Colman	77.99
McLean	77.47
Collier	76.02
Folger	72.88

The mean value of the leading varieties in respect of maximum sucrose, for five years' experiment, is as follows:

McLean .... Rank 1
Colman .... Rank 2
Collier .... Rank 3
Folger .... Rank 4

The relative rank of the leading varieties for five years, based on the means of their minimum glucose, is as follows:

McLean .... Rank 1
Collier .... Rank 2
Colman .... Rank 3
Folger .... Rank 4

The relative rank of the leading varieties for five years, based on the mean of their maximum purities, is as follows:

McLean .... Rank 1
Colman .... Rank 2
Collier .... Rank 3
Folger .... Rank 4

From the total number of seed heads selected for propagation from the leading varieties, during the season of 1892, the following data are taken:

Percentage of total number falling within the limits given below.

[Percentage of sucrose in juice.]

Variety.	Below 11 per cent.	11 per cent.	12 per cent.	13 per cent.	14 per cent.	15 per cent.	16 per cent.	17 per cent.	18 per cent.	19 per cent.	20 per cent.	21 per cent.	Number of selections.
Colman	1.26	0.74	1.39	3.81	6.68	11.28	29.41	32.09	10.59	1.65	0.79	0	8,773
Collier	0.01	0.05	0.15	0.80	1.93	7.13	17.00	28.83	29.98	12.85	1.20	0.01	5,316
McLean	0.10	0.24	1.29	6.05	15.31	21.48	23.71	22.74	8.23	0.69	0	0	3,711
Folger	0.87	2.42	11.73	32.35	38.50	13.52	0.55	0.02	0	0	0	0	11,467

Percentage of total number falling within the limits given below.

[Purity coefficient in juice.]

Variety.	Below 70 per cent.	70 per cent.	71 per cent.	72 per cent.	73 per cent.	74 per cent.	75 per cent.	76 per cent.	77 per cent.	78 per cent.	79 per cent.
Colman	15.21	2.67	3.87	4.73	5.92	7.94	10.90	13.47	14.10	11.81	5.47
Collier	10.69	2.99	4.62	5.43	8.70	12.49	15.29	14.27	12.00	7.11	3.19
McLean	6.57	3.28	4.92	7.61	11.03	15.10	15.96	14.66	10.79	6.27	1.99
Folger	53.58	5.96	11.11	7.76	4.59	2.24	0.90	0.48	0.21	0.06	0.05

Variety.	80 per cent.	81 per cent.	82 per cent.	83 per cent.	84 per cent.	85 per cent.	86 per cent.	87 per cent.	88 per cent.	89 per cent.	90 per cent.
Colman	2.21	1.09	0.33	0.14	0.03	0.04	0.02	0.02	......	0.01	0.02
Collier	1.29	1.50	0.11	0.18	0.05	0.09	......	......	......	......	......
McLean	0.86	0.40	0.43	0.13	......	......	......	......	......	......	......
Folger	0.02	0.01	0.01	......	0.01	......	0.01	......	......	......	......

Experiments were also made to determine the relative keeping qualities of the different varieties. They were cut and placed in small piles in a shady place, covered with trash, and this trash was kept moist.

Table showing the keeping qualities of the different varieties.

Variety.	Date.	Sucrose.	Glucose.	Purity.
		Per cent.	*Per cent.*	*Per cent.*
McLean	Oct. 6	19.20	0.51	78.40
	Oct. 29	15.45	7.10	62.90
Collier	Oct. 6	20.10	0.31	76.80
	Oct. 29	17.21	6.92	66.04
Colman	Oct. 6	18.70	0.62	79.20
	Oct. 29	17.81	4.00	74.36
Folger	Oct. 6	17.70	1.03	76.70
	Oct. 29	15.28	4.23	76.17

From the above table it is seen that it is not always safe to depend upon the deterioration of the sucrose alone in regard to observing the qualities of the cane. In each instance it is seen that there was, while not a great loss of sucrose, yet a tremendous increase in glucose and decrease in purity. The natural drying out of the cane would maintain the sucrose content up near the normal, while the sugar-producing quality of the cane was greatly deteriorated.

The following is a statement of the average analysis of the different varieties of cane from the time they were first grown by the Department up to the present. The great increase in the sugar content and the purity for the year 1892 must be regarded as due largely to climatic conditions, and it is not probable that this high character of the cane will be preserved.

Variety.	1888.			1889.			1890.			1891.			1892.		
	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.
	Sucrose.	Glucose.		Sucrose.	Glucose.		Sucrose.	Glucose.		Sucrose.	Glucose.		Sucrose.	Glucose.	
Collier	12.31	0.73	71.69	14.91	0.75	76.95	15,95	0.59	74.77	14.80	0.90	73.80	18.50	0.49	78.19
Colman	.....	.....	......	14.58	1.15	75.55	14.88	0.84	76.38	15.60	0.73	76.30	16.93	0.50	77.95
Folger	.....	.....	......	14.08	2.03	76.54	14.12	1.75	74.91	14.60	1.35	73.30	15.57	0.91	74.75
McLean	.....	.....	......	.....	.....	......	15.22	0.52	76.00	16.40	0.55	77.40	17.24	0.47	76.80

The above data, while they show variations and occasional reversions and retrogradations, yet indicate most clearly a gradual, and in some cases rapid, improvement in the character of the variety. There is a tendency to the production of a larger quantity of sucrose, a smaller quantity of glucose, and a higher purity. This is due solely to the principle of selection, by means of which an attempt is made to propagate only such individual samples of any given variety as have in a high degree the characteristics necessary for successful sugar-growing.

The amount of analytical work which was accomplished at Sterling is only faintly indicated by the above selections from the work. The analytical work was commenced on the 20th of August and continued until the 1st of October. The working force in the laboratory consisted of twenty-seven men. In all, 37,403 seed selections were made, and 1,772 analyses of average samples. The average number of analyses made per day was 1,399. Only about 25 per cent of the total number of canes brought in for selection passed the first test of specific gravity, and the total number of canes which were milled separately and the specific gravity test taken was 156,700.

EXPERIMENTS IN MOLASSES-MAKING.

In addition to the experiments in the improvement of the sorghum cane carried on at Sterling, considerable work was done in determining the varieties best suited to the manufacture of molasses, and the best methods of manufacture from the farmer's point of view. While this work was not intimately connected with sugar production, yet it will prove of some interest to the small farmer who grows only a small area of cane solely for the purpose of supplying himself or his neighbor with molasses. The results of chemical analysis alone would be sufficient to show that some varieties of sorghum are much better suited to sirup-making than others. The development of varieties of cane especially for sugar production would, in some respects, unfit it for the manufacture of molasses alone, for the reason that the certain granulation which would ensue after the molasses is boiled to the proper density would render it unfit, commercially, for table use. In all, about 4,000 gallons of sirup were made during the experiments, and the quality of much of it was equal to the molasses made from sugar cane by the open-kettle process. Unfortunately, all of the molasses made showed a tendency to crystallize and some became converted entirely into mush sugar. This fault could easily be foretold from the character of the cane worked.

Different methods of clarification were tried for the purpose of making a high grade of molasses. Among these were clarification with lime, clarification with lime and clay, clarification with lime and tannin, clarification with lime and some acid, and cold clarification with acid.

First, in regard to the lime process, it may be stated that when lime is employed it is not used to saturation, but the juice is left distinctly acid so that the bright color of the molasses may be preserved. The clarification made in this way must, therefore, be imperfect as far as any good effect of the lime is concerned. Lime always tends to darken the resulting product, and therefore its use in the manufacture of molasses must be generally condemned.

Experiments were also made, as indicated above, with the combination of lime and clay. In this case about 1 per cent of bisulphite of lime solution is added to the fresh juice as it comes from the mill. A thick creamy mixture of lime and clay is added to the boiling juice. The addition of clay is necessary to secure a rapid subsidence of the flocculent matter. The resulting molasses is usually of fine flavor and color.

The lime and tannin process is one which has been long in use, having been described as long ago as 1847. It consists in the use of tannic acid in some form added to the fresh juice before any other clarifying agent is used. Clarification with the use of tannic acid has also been tried in the Louisiana Sugar Experiment Station, and in general the results are regarded as favorable. In this process it appears that lime removes one class of impurities, the tannic acid removes another class, and the resulting juice is clear and bright.

The process which rests on the combination of lime with an acid has been practiced also for many years. Phosphoric acid is the one which is preferred on account of the perfect precipitation of the added lime which is secured. This process secures a sirup of bright color and fine flavor. This process has been tried in all sugar-producing countries and gives apparently good results; yet it has not come into general use, inasmuch as in sugar-producing countries it is no longer an object to secure a light-colored product, but a large yield without reference to color.

The method of combining lime with carbonic acid has been thoroughly worked out by the Department, and with excellent results in so far as the yield of sugar is concerned. There is probably no known method by which so large a yield of sugar can be obtained from a given quantity of juice as by the application of the treatment employed in beet-sugar factories known as carbonatation or saturation, namely, the addition of a large excess of lime and its subsequent precipitation by means of a current of carbonic acid.

With sorghum juice, cold clarification has some decided advantages. Especially when these juices have been expressed by a mill, the starch grains, which they contain, will have opportunity to subside during cold clarification. If hot clarification be employed, the starch grains will soften and be distributed in a pasty mass uniformly throughout the whole of the juice. The addition of clay, of course, hastens the precipitation of all suspended bodies mechanically. It is doubtful whether the clay has any specific effect upon the clarification itself, but it acts simply as a mechanical carrier by means of which the subsidence of the flocculent matters is hastened. The fact that clay added to cold juice, which has been properly limed, gives a better separation of the impurities, a brighter, clearer liquid, which is more easily filtered and which gives less scum during evaporation, may be easily verified by laboratory experiments and also by work in a factory.

The process which gave the best results during the experimental work consisted in liming the cold juice until a good clarification was secured, adding lime when necessary until the juice was decidedly alkaline and the color red, the criterion being the proper clarification and not the color. This was followed by the addition of clay mixed to the consistency of a batter in sufficient quantity to increase the density of the well-stirred liquid about one degree Baumé or two degrees Brix. The whole mass was then allowed to settle, the time required being from one to two hours. The clear liquid was then drawn off from the surface by a swing valve, proper care being taken to leave all the settlings in the tank. The clear liquid was run into a clarifying tank; phosphoric acid was then added until the liquor was slightly acid, as determined by litmus paper. It was then heated nearly to the boiling point and the scums thoroughly removed. The juice was again allowed to settle for half an hour to an hour and drawn off again from the surface downward by a swing valve, care being taken not to remove any of the settlings. The light-colored and bright juice is then filtered. With such a clear liquid filtering seems unnecessary, yet it gives increased brightness to the molasses. No pressure was used in the filter-press and the cloths did not require frequent changing. The clarified liquid was then sent to the evaporating tank and reduced to the consistency of molasses.

This method gives a good product, but of course there is a great waste, inasmuch as the settlings could not be filtered, but had to be thrown away. When the object is to secure a high-grade molasses for household use, without reference to the economy of manufacture, the process could doubtless be used to good advantage. The cost of the phosphoric acid, it was estimated, was not over one-third of a cent per gallon.

The process of liming the juice may be more minutely described for the benefit of those who are not accustomed to it.

Cream of lime is prepared by mixing a well slaked lime with water to the consistency of a cream and filtering it through a fine sieve to remove all large particles. It is highly important that no large particles of undissolved lime be present in the cream. This cream of lime is added slowly to the cold juice as it comes from the mill and thoroughly mixed. Blue litmus paper, which has been made red by dropping it in the fresh juice, should be immersed in the lime juice. When the reddened litmus paper shows a slightly blue tinge of color it indicates that the juice is slightly alkaline. If this is not the case more lime should be added until the juice becomes alkaline. A test-tube should now be filled with the limed juice, placed in the light, and allowed to remain at rest for five minutes. The liquor as seen in the test-tube should be bright, clear, and transparent. If it is not, more lime should be added to the juice and the test should be repeated. With some juice it is necessary to add lime until it becomes strongly alkaline and reddish in color; while other juices liming to the neutral point or to slight alkalinity gives a proper result. In all cases cream of lime must be added until the juice becomes clear and bright in order that a good clarification may be secured.

Two points should always be borne in mind: If too little lime be used the juice will not be well clarified, and if an unnecessary amount of lime be used it will require excessive use of phosphoric acid to remove it. Practice will soon determine very nearly the amount of lime required, but the exact proportion should always be finally determined by the appearance of the limed juice in the test-tube.

Experiments show that the yellow or red clays are best suited for this purpose. They should be well mixed to a uniform batter with water and strained to remove all coarse particles. Enough of the clay should be added to the limed juice to increase its density sufficiently to cause a rapid settlement of the particles. The amount of clay depends upon many factors and can easily be determined by a few experiments. In general, from 1 to 2 pounds of clay to 100 pounds of juice are found sufficient. As soon as the juice has been limed and clayed and well mixed, it can be tested by means of the test-glass as indicated for the liming, and if it does not settle with sufficient rapidity an additional amount of clay can be added. A tank 36 inches deep filled with cold limed and clayed juice should give about 30 inches of clear juice and 6 inches of settlings in from one to two hours. The time depends upon the temperature, the density of the juice, and the quantity of the clay. When the clear juice has been drawn from the settling tank, leaving the impurities with the clay, the lime, having done its work, should be entirely removed from the juice by the addition of phosphoric acid. One hundred and eight gallons of the acid phosphate of calcium, sometimes called superphosphate of lime, were used in the experiments. A preparation of phosphoric acid known as clariphos, essentially an acid calcium phosphate, may also be used. About 1 gallon of acid phosphate to 400 or 500 gallons of juice should be employed. The amount of acid required depends upon the quantity of lime which was used in the clarification, and for this reason it is desirable to use no more lime than is necessary to secure the desired results. The phosphoric acid combines with the lime, forming tri-calcium phosphate, which is insoluble, and is at once precipitated, thus removing both the lime and the acid present in the juice. The natural organic acids which were originally present in the juice are thus set free and produce the required acidity for the production of a light-colored and highly flavored product. It is important that both the phosphoric acid and the lime should be entirely removed, and for this reason no excess of acid phosphate should be employed. The proper method of determining this is also in a test-tube, in which it can be determined whether or not the precipitation is incomplete. Time should now be given for the phosphate of lime which is formed to settle, and this is easily accomplished in much less time than was required for the original clarification. A tank 36 inches deep gives about 34 inches of clear juice and 2 inches of settlings in about one hour. Attempts to filter the settlings or sediments were unsuccessful. The settlings from the lime and clay clarification, together with the settlings from the acid phosphate clarification, should be run into a sirup tank, diluted with an equal volume of water, and again allowed to settle and the clear liquor drawn off, by which means much of the waste which would otherwise occur can be avoided. By a proper arrangement of the swing-valve the liquor can all be drawn off from the surface downward and thus secure a complete separation of the settlings from the clear liquor. The clarified liquor can be easily filtered through fine cloths without pressure. Though filtering is not as necessary with clear and bright juice as it is with cloudy juice, yet it gives greater brightness to the molasses by removing all the fine particles which escape subsidence in the ordinary way.

The clarified juice prepared in the manner above can be evaporated in any convenient way which the farmer and small manufacturer have at hand. It is only important that the evaporation should be rapid and is best conducted in a thin film and in pans with several compartments with a continuous flow. An example of the method of the work may be seen from the following data:

September 29, tank No. 1 contained 480 gallons sorghum juice which showed a total solid, by means of a Brix spindle, of 21 per cent. The juice was limed to slight alkalinity and clay batter added until the total solids as indicated by the spindle amounted to 22.5 per cent. The liquor was then allowed to settle for one hour, ten minutes after which 440 gallons of clear juice were drawn off, and to this clear juice one gallon of acid phosphate of calcium was added, the temperature raised to the boiling point, and the mass skimmed. The whole was then allowed to settle for forty minutes, after which the clear juice was drawn off and filtered. The settling of the sediments required one hour. The skimmings were then mixed and diluted with water and resettled, giving a clear juice showing 9 per cent total solids. The clear juice was then evaporated to molasses, giving a light colored and fine flavored product.

EXPERIMENTS AT MEDICINE LODGE.

Experiments in the culture of sorghum were continued at Medicine Lodge, Kans., during the season of 1892.

The spring was very cold and wet, followed by an excessively hot and dry summer. The rainfall for April was only .49 inch; May, 4.65 inches; June, 2.85 inches; July .76 inch; August, 2.42 inches; September, .84 inch; October, 3.44 inches. The first killing frost was very early, having fallen on the 8th of October. The summer was excessively hot, and this, conjoined with the small rainfall, caused the crop to suffer severely from drought.

The alternate plats of the experimental station were planted with the different varieties of cane, the others being left in fallow. In addition to the acreage thus secured on the land leased by the Department, 50 acres of land were leased from neighboring farmers, who agreed to plant the varieties of cane furnished them, according to the directions of the superintendent, for a stipulated sum. It was also agreed that no variety of sorghum should be cultivated within 300 yards of any other variety. In this way all accidental mixing of varieties was avoided. The seed bed of the land upon the station was prepared by soiling and subsoiling—a thorough preparation of the surface for planting.

The planting was done chiefly with individual seed heads grown at Sterling during the year 1891. This kind of planting was of course accomplished by hand. In some blocks the planting was done with a hand-drill from mixed seeds of high-grade cane grown at Sterling during the previous year. The cultivation was careful and thorough and of the usual character. Hand thinning and hoeing was practiced once early in the season, the rest of the cultivation being by horse power. Owing to the heavy rains of May some of the first plantings did not come up and replantings were made necessary. The planting of the cane commenced in April and continued until June. The agricultural results obtained on the plats at the station were as follows:

On block 5, Folger was planted April 20. It was cultivated eight times by horse power and gone over five times with the hoe. It made a good and vigorous growth from start to maturity. It was harvested and delivered to the mill from September 8 to 10. The total tonnage of topped cane—that is, the canes with the seed tops removed—from the block was 21.5, showing a yield of 10.75 tons per acre. From this plat 2,255 seed heads were saved by selection for subsequent planting.

On block 35 of the station Folger was also planted. The method of preparation of the soil and cultivation were as given above. It was planted on the 27th of April and harvested from October 17 to 20. The total weight of cane obtained was 15 tons, showing a yield of 7.5 tons per acre. No seeds selections were made from this block.

Block 17 was planted with Collier cane on the 22d of April. It received the same cultivation as above. It was harvested October 7 to 12, yielding a total tonnage of topped cane of 16, or 8 tons per acre; 2,405 seed selections were made from this plot.

Block 47 of the station was also planted with Collier cane on the 2d and 3d of May. It was harvested October 11 to 13, yielding 25 tons of topped cane, or 12.5 tons per acre; 3,110 seed selections were made from this plot.

Block 29 of the station was planted in McLean cane on the 24th of April. It was harvested October 16 and 17, yielding 12.25 tons of topped cane, or 6.13 tons per acre; 217 seed selections were made from this plot.

Block 11 of the station was planted with Colman cane on the 21st of April. It was harvested from the 14th to the 16th of September, yielding 20.75 tons of cane, or 10.38 tons per acre; 2,379 seed selections were made from this plat.

Block 41 of the station was planted also with Colman cane on the 30th of April. It was harvested from September 20 to 30, yielding 19.5 tons of cane, or 9.75 tons per acre; 2,374 seed selections were made from this plat.

Block 23 of the station was planted with Link on the 23d of April. It was harvested October 6 and 7, yielding 14.50 tons of topped cane, or 7.25 tons per acre; 1,343 seed selections were made from this plat.

The agricultural details of the 50 acres grown by different farmers will be given in Bulletin No. 37, published April, 1893.

In general, it may be said that the agricultural data were satisfactory, considering the extreme drought of the season. The corn crop in the vicinity of Medicine Lodge was almost a complete failure. The sorghum crop, while not equal to that of previous years, gave fairly good returns to the farmer.

The excess of cane not used for experimental purposes was delivered to the sugar mill at the standard rates per ton. The price per ton paid for topped cane by the factory was based upon the average polarization of each load. After each load of cane was weighed sample canes were taken at random from different parts of the load, passed through a small mill, and the juices of the mixed canes polarized. The rates paid were as follows:

	Per ton.
Under 10 and not over 11 per cent	$1.50
Under 11 and over 10 per cent	1.50
Under 12 and over 11 per cent	1.70
Under 13 and over 12 per cent	2.00
Under 14 and over 13 per cent	2.10
Under 15 and over 14 per cent	2.20
Over 15 per cent	2.30

The actual data as gathered from the sales at the mill are given in the following table:

Money value of varieties.

Variety.	Average tonnage.	Average sucrose.	Average price per ton.	Average revenue per acre.
Orange	13	14.1	$2.20	$28.60
Colman	9.02	15	2.30	20.75
Variety No. 160	9	15.6	2.30	20.70
Folger	8.72	13.9	2.10	18.31
Amber	8.50	13.6	2.10	17.85
Collier	7.11	15.1	2.30	16.35
Link	6.98	15.7	2.30	16.05
No. 161	6.63	16.3	2.30	15.25
No. 112	6.50	16.8	2.30	14.95
India and Orange	6.11	15.6	2.30	14.05
African	6.83	12.5	2.00	13.66
Planter	6.06	14.2	2.20	13.30
McLean	6.01	14.4	2.20	13.22
Average	7.52	14.2	2.20	16.53

The mean tonnage per acre, as shown by this table as delivered to the mill, was 7.52. This may be regarded as two-thirds of a normal crop, and shows that, even under the disadvantages of a very dry season, good farming applied to sorghum in the vicinity of Medicine Lodge can be made to pay a remunerative return.

SEED SELECTION WORK AT MEDICINE LODGE.

The work of seed selection at Medicine Lodge was carried on essentially as has already been described for Sterling. Samples for selection were taken in the following way: Each plat at the time of sampling was visited by the sampler, who took with him a wagon and team, and driver. Passing through the field the sampler would cut at random those stalks which gave the best appearance as judged externally. The stalks taken represented those which were healthy looking, of full normal growth, and in general possessing, as far as could be judged by the eye, the best qualities. The smaller and less developed stalks were purposely omitted from all selections, although it is well known that such small growths often contain the highest percentage of sugar in the juice. The object, however, of a seed selection of sorghum for sugar-producing purposes is not alone to secure a juice rich in sucrose but also to develop a strong, healthy, and vigorous plant capable of resisting high winds, prolonged drought, and other seasonal dangers. It is also important that the plants developed for sugar-making purposes be of rather a large size, so that the expense of growing and handling may be diminished and the tonnage per acre be increased.

The samples which were to be analyzed in the morning run were taken late in the afternoon, so that they might be brought to the laboratory by 7 or 8 o'clock in the evening. The samples which were to be examined during the afternoon were cut after the dew had entirely dried out in the morning, usually between 9 and 10 o'clock, so that the load of samples might reach the laboratory by 1 o'clock.

As the stalks from each particular seed head were selected they were placed in a pile and a label attached thereto by the attendant, and this bundle of stalks was then placed in the wagon. In this way the progeny of each particular seed head selected for propagation was brought to the laboratory separately.

The method of preparing the samples for examination was simple and effective. The stalks were stripped of their leaves and were then brought to the attendants of four small Pioneer mills driven by a shaft from a common horse power. Each stalk was run through the mill separately. In order to hasten the time of passing through, the butt of the stalk was first presented to the rolls. As soon as it was caught and was passing through the attendant cut the stalk into three pieces, putting each piece in separately, and preserving the seed head with about 18 inches of stalk attached thereto.

The juice from the mill was collected in a tin vessel holding about a quart. This was removed from underneath the mill, the seed head laid across its top, and it was passed on to the desk, where the specific gravities were taken roughly by means of a Brix spindle. The standard of each variety having been fixed at a certain percentage of total solids this percentage was roughly determined by means of a spindle, and the samples falling below this standard were rejected and the seed heads belonging thereto thrown away. When the sample reached, or went above, the standard fixed, it was passed on to the tagger, who attached to the vessel containing the juice a gum label with a given number, and tied to the seed head a shipping tag bearing the same number.

The samples of juice were then passed to the total-solids table, where the total solids were determined with accuracy by calibrated Brix spindles, and the temperature at which the total solids were determined was noted. The seed heads thus preserved were collected together in bundles and hung from the rafters of the building.

The juices were then passed to the laboratory, where they were prepared for polarization and polarized in the usual way.

The analyses of average samples—that is, of considerable quantities of cane cut from a given plat, taking every stalk within the space harvested—were carried on in the same way, with the exception that, in addition to the total solids and sucrose, as determined by the polariscope, the percentage of reducing sugar was also determined.

The number of analyses per day averaged about 1,600, and the number of stalks ground per day was about 5,000, practically two-thirds of the stalks on an average being rejected as not coming up to the standard fixed.

The total number of seed heads selected for the reproduction of high-grade cane was 49,912. Of this 32,849 were selected from plants having a distinct pedigree—that is, from plants whose pedigrees could be traced back through individual seed heads for several years.

Seventeen thousand and sixty-three seed heads were selected from plants whose pedigree was not distinct, but in general derived from mothers of high sugar-producing qualities.

The average percentage of sugar in the juice of the selected seed heads from pedigreed seed (32,849 in number) was 17.22 and the average purity from these samples 76.5.

The following are some of the data obtained with the four varieties which were discussed in the data from Sterling.

Variety.	Number of selections.	Average percentage of sucrose.	Average purity.
Collier	5,506	18.99	77.13
McLean	2,193	18.42	77.99
Colman	6,553	15.79	72.10
Folger	2,255	15.53	72.20

The relative rank of the different varieties, as determined by the mean of the maximum sucroses and purities of average samples, has also been calculated from the analytical data. Of course this relative standing must not be taken as absolutely fixed, on account of the fact that some of the varieties furnished a larger number of samples for selection than others, and therefore a strict comparison can not be made among them from the data obtained. In general, however, the value of the different varieties may be quite accurately approximated from a study of the analyses.

According to the data obtained the first rank in maximum sucrose is held by the Collier cane, the second by the McLean, the third by the Colman, and the fourth by Folger.

In respect of maximum purity the first rank is again taken by Collier, the second by McLean, the third by Colman, and the fourth by Folger. Thus it is seen that whether determined by maximum sucrose or maximum purity the relative standing of the four varieties is as given above.

Interesting data were also obtained in contrasting the qualities of the parent plant, and the progeny of each variety planted from special pedigreed seed traceable through several years.

In the work of seed selection an indefinite number of canes is selected in the field, and, as has already been said, only those are taken for seed selection whose juices exceed a certain arbitrary density. Such canes may be regarded as of superior characteristics and are selected because of the tendency of plants, as well as animals, to transmit their peculiarities to their progeny.

In the case of Folger, 106 parent canes, grown at Sterling in 1891, were compared with 1,879 of the progeny of these canes grown in Medicine Lodge in 1892. The average percentage of sucrose in the parent canes was 15.31, and in the progeny 15.53. The average purity of the juices of the parent canes was 73.14, and of the progeny 72.2.

Of the Collier cane forty-nine parents were compared with 1,993 of their progeny. The results were as follows:

Parent canes.		*Progeny.*	
Average sucrose, per cent	17.17	Average sucrose, per cent	20.00
Average purity	75.50	Average purity	78.50

Of the Colman cane fifty-one parents were compared with 1,781 progeny.

Parent canes.		*Progeny.*	
Average sucrose, per cent	15.80	Average sucrose, per cent	16.07
Average purity	75.92	Average purity	71.04

Of the McLean cane forty parents were compared with 793 progeny.

Parent canes.		*Progeny.*	
Average sucrose, per cent	17.5	Average sucrose, per cent	18.73
Average purity	76.0	Average purity	78.50

Taking all the varieties examined, including the four varieties mentioned above, 730 parents were compared with 19,301 progeny. The mean result for all the samples was the following:

Parent canes.		*Progeny.*	
Average sucrose, per cent	16.08	Average sucrose, per cent	17.03
Average purity	75.70	Average purity	74.02

From the whole number of seed selections a certain number was selected for special propagation at the station the coming year. These selections were made from those canes showing the best qualities for sugar production of the whole number examined. For the four varieties which have been mentioned the data are as follows:

Variety.	Total number of heads selected for propagation.	Average sucrose.	Average purity.
		Per cent.	
Collier	330	20.06	82.5
McLean	391	19.2	81.7
Colman	273	17.12	80.9
Folger	516	16.18	77.4

The selections for propagation, including those mentioned above, numbered 2,520; the average percentage of sucrose being 17.88, and the average purity 80.48.

The other selections, although not of the highest grade, are considered suitable for planting for general commercial purposes, while the 2,520 mentioned above, are those which would be selected for the continued intensive culture of cane, looking to the development of high sugar-producing qualities. When it is remembered that forty seed heads on an average will plant 1 acre, it is seen that the area which could be planted with the seed heads selected for propagation would be a little over 63 acres. Of course, it will be understood at once that the Department itself would not think of planting any such area, but would select from those seed heads put aside for special propagation, the very best for the special work in the improvement of the cane.

The amount of analytical work which was done in connection with the selections above mentioned can be seen from the following summary:

Total number of polarizations made	50,720
Total number of single stalks ground	150,000
Total number of glucose determinations made	923

The amount of work which was done by the Department during the past year in the development of the sorghum cane is far greater than that of any other previous year, owing to the fact of the operation of two separate stations instead of one. In addition to this, each of the stations did a much larger amount of work than has ever before been done by a single one. It is not believed that it is necessary that the work should be continued in more than one station. Nevertheless the attention of the different State experiment stations should be called to the fact that the Department has secured this large number of specially selected and pedigreed seed heads for propagation, and it would be well for all those States whose climate and soil are suitable to the culture of the sorghum to continue the work on the lines indicated by the results obtained by the Department. In this way a variety of cane, or varieties of cane, might be secured which would be especially suitable to the locality where grown.

The U. S. Department of Agriculture has gone to the expense and labor of not only indicating the method by which such work should be accomplished, but by doing it on a scale which has never been equaled by any similar undertaking anywhere in the world, not even excepting the beet-sugar seed production farms of Europe.

EXPERIMENTS IN THE CULTURE OF SUGAR CANE.

Experiments in the culture of sugar cane were carried on by the Department at Runnymede, Narcoossee post-office, Florida.

The station at Runnymede has only just been commenced, and as a result the work done is only of a preliminary character. The object of the work is to determine the variety of cane which is best suited to the different soils which are found in the Florida peninsula, and also in the improvement of those promising varieties which are found adapted to growth in that locality.

Two kinds of soil are used for the experimental work, namely, the vegetable mold or muck soils from the reclaimed swamp lands or lake borders, and the upland or sandy soil, which is the prevailing soil of the peninsula.

Attempts were made to secure the proper ditching and drainage of the vegetable mold in order to secure a good crop on the first year, but the results were not satisfactory. The small area of cane which was grown on the vegetable mold was very poor in quality and the results were not at all promising. It is hoped that much better results may be obtained after a more thorough drainage and culture of the soil are secured.

The cane which was grown on the upland or sandy soil was, however, much more successful and promising. The cane which was grown on the upland or sandy soil, while it does not yield a large tonnage per acre, is exceedingly rich in sugar, and by reason of the fact that it lives entirely through the winter without danger of freezing, it is permitted to mature and thoroughly develop its normal content of sugar. Canes which are left growing upon the sandy soil during the winter almost invariably tassel before the opening of the spring, and for this reason reach a complete state of maturity and develop a maximum percentage of sucrose. In one variety of ribbon cane grown upon the sand and cut after eleven months from the time of the last harvest, it was found that the percentage of sucrose was 15.41 with only .28 per cent of reducing sugar, and the juice showed a purity of 93.4. Such a cane as this when manufactured by the best modern processes would yield fully 250 pounds or perhaps 260 pounds of sugar per ton.

In all about eighty varieties of sugar cane have been planted on the station. Most of these were procured from the Louisiana Sugar Experiment Station through Dr. W. C. Stubbs, they having been originally secured by the U. S. Department of Agriculture for him through our consular agents in tropical countries. Very few of these varieties have shown promising results upon the station. Among those most promising may be mentioned the Betran or Panaché variety, which showed a sugar content of 12.08 and a purity of 82.2. The Papua variety showed a sugar content of 13.03 and a purity of 84.1, and the Green or Otaheite variety showed a sugar content of 13.46 and a purity of 84.7.

The soil of the station is now better prepared for culture, and during the coming season more extensive experiments will be made in the growing of the different varieties for sugar-making purposes.

In addition to the experiments with sugar cane other experiments have also been made on the different kinds of soil looking to the production of a forage crop suitable for stock, and to the growth of other tropical and semitropical products. Among the crops which have been tried with promise are tobacco, pineapples, and cassava.

Especial attention has been given to experiments with cassava in the vegetable mold, inasmuch as it has not heretofore, to my knowledge, been grown upon such a soil. The first year's results are promising, although it is not possible to say yet that the cassava plant will do as well in the vegetable mold as it will in the sand. Particular attention is called to the possibilities of the culture of the cassava plant, both as a source of food for animals and as a possible source of starch or glucose. It grows in great luxuriance in almost pure sand and seems certain to make a crop in almost any kind of a season, whether it be wet or dry. Additional attention will be paid to this plant during the coming season.

Experiments are also in progress in the growth of olive and peach trees, and in the culture of oranges and other citrous fruits. It is believed that a continuation of the work at the station will result in great benefit to the people of Florida and other semitropical portions of the United States.

MISCELLANEOUS WORK.

The miscellaneous work of the Division of Chemistry has decreased considerably in the past few years on account of the fact that it was impossible to do all the work of this kind which was presented. Most of the miscellaneous work is upon subjects which do not relate in any way to agriculture. Chief among these may be cited the requests for the assay of ores for the precious metals and for the analysis of mineral waters which are supposed to possess medicinal properties. The Division of Chemistry is not furnished with a complete assay outfit, and hence the work attending an attempt at an assay is a matter of no mean importance. It would be well for those interested in the matter to take note of this and thus avoid the expense of sending mineral substances for assay. It is the uniform practice of the division, however, to examine the minerals sent, and if they can be determined by inspection or a simple qualitative analysis, this is always done, and the results communicated to those interested. When a complete quantitative chemical analysis, however, is required, it is the uniform custom of the division to decline work of this kind, as it is in no sense germane to agriculture.

Only a few exceptions are made to this rule, namely, in the analysis of minerals which by their decomposition afford valuable ingredients to soils, and the examination of mineral waters which in any way affect the practice of agriculture, either when used for irrigation or for live stock. Matters of this kind fall properly within the domain of agricultural research. In general, however, those who seek information of this kind are referred to the agricultural experiment stations of the several States, which are in a far better position to judge of the importance of the work and its value to the farming interests than can possibly be done here.

There is another class of miscellaneous work which is of a different character, namely, that relating to the investigation of natural and artificial fertilizers. A considerable quantity of this kind of work has been done for persons who are not in a position to secure it otherwise, and in cases where the completion of the work gives promise of some benefit to agriculture. Especially is this the case where samples are sent by farmers who are in rather straitened circumstances and who may be made the victims of fraud in the purchase of artificial fertilizers. When convenient such work, of course, is referred to the several State stations, but in many instances exceptions are made in the case of farmers when it is difficult for them to secure work of this kind in their own States. The amount of work in this direction must be limited, as otherwise the capacity of the division would be exceeded.

REPORT OF THE ENTOMOLOGIST.

INTRODUCTION.

SIR: I have the honor to present herewith my annual report as Entomologist for the calendar year 1892. I have treated in a general way of the work of the division for the year and have added short articles upon a few of the more interesting of the insects which have attracted attention or have been particularly studied during the year. The reduction of the appropriation by $10,000, which took effect July 1 last, has reduced the opportunities for field investigation, and has necessitated the discharge of several of the field agents and office assistants.

The correspondence of the division has always been large, and increases every year. During the year 1892 more than four thousand communications have been answered by letter and many by circular, and more than four thousand species of insects have been examined and named for station entomologists and for other workers. This determination work occupies very much of my own time and of that of several of the office assistants, and while it is a legitimate part of the work of the division, there is nothing to show for it in the published records, and it renders the reduction of the force extremely inopportune. In the summary of the work of the field agents no allusion has been made to that of Mr. Koebele, in California, for the simple reason that his time has been entirely occupied with the mission to Australia, referred to in my last annual report, and a report upon which has been made by him to you. As to the practical outcome of this mission there is a difference of opinion among California fruit-growers, and a report on a recent examination by Mr. Coquillett of the status of the importations is now in my hands and will soon be published.

The publications of the division during the year have been Bulletin No. 26, Reports of Observations and Experiments in the Practical work of the Division; Bulletin No. 27, Reports on the Damage by Destructive Locusts during the Season of 1891; and Insect Life, Vol. IV, Nos. 7, 8, 9, 10, 11, 12; Vol. V, Nos. 1, 2, and 3. In addition to these publications, Bulletin No. 28, The more destructive Locusts of America north of Mexico, and Bulletin No. 29, Report on the Boll Worm of Cotton (*Heliothis armiger* Huebn.) have been submitted for publication, and Bulletin No. 30, Reports of Observations and Experiments in the Practical Work of the Division during 1892, is ready for submittal.

The mailing list of Insect Life has been revised during the year by the issue of circulars and return cards, and the comments upon the publication by persons receiving it have been of the most gratifying nature. An inquiry as to the occupations of the readers of Insect Life indicates that the publication reaches the class of people for whom it is primarily designed, viz, farmers, fruit-growers, and horticulturists, working entomologists, students, and persons of other occupations who, at the same time, possess farms or gardens, and are, therefore, interested in the subject of injurious insects.

Respectfully submitted.

C. V. RILEY,
Entomologist.

Hon. J. M. RUSK,
Secretary.

THE WORK OF THE SEASON.

In my last annual report I gave particular attention to the subject of injurious locusts on account of the unusual abundance of these insects in different parts of the country. After looking the ground over with some care, I ascertained that in the majority of cases the insects concerned in the damage were local nonmigratory species, and that circumstances were such that a decided falling off in the amount of injury was to be expected for the present year. The Rocky Mountain locust, the destructive migratory species of the Western States, was present in a few localities in North Dakota and Minnesota, but the energetic work instituted by the authorities of these two States resulted in preventing any serious injury. The present year very few reports have been received. Field agents have been sent to different parts of the territory infested last year and their reports show that the outlook on the whole is very satisfactory. The subjects which have most engaged the division during the year are mentioned in the following paragraphs:

INTERNATIONAL EXCHANGES.

In my last report it was shown that small supplies of Vedalia had been sent during 1891, on specific application, to South Africa, New Zealand, and Egypt. In the first two cases they were sent for use against *Icerya purchasi*, and in the last for experiment with the Egyptian Icerya (*Icerya ægyptiacum*), a closely allied species. Up to the time of the printing of the report, however, no success has been obtained, all of the insects arriving at their destination in a dead or dying condition. Profiting by these experiments, however, other sendings were made during the winter of 1891–'92 and all have been successful.

On page 234 of the last Annual Report is mentioned the visit of Hon. T. A. J. Louw, of the South African Legislative Assembly, to this country, and the fact that we had supplied him, through our California agent, Mr. Coquillett, with a large number of living Vedalias. We are now able to announce that Mr. Louw succeeded in carrying these insects to Cape Town in good condition and that they have been colonized under the most favorable auspices. Mr. Louw carried over two boxes, one of which he kept in his cabin and the other in the ice box of the steamer. His route was from California back to New York and thence by steamer to Cape Town, probably via Liverpool. A supply of food was taken along and the ladybirds which he kept in his cabin were fed from time to time. Almost all of the insects in the box which was placed in the cold chamber survived the journey, as well as the others which were constantly tended. They were disposed of as follows: A small number were placed in the open air on an infested tree in the Cape Town Botanic Gardens and the larger portion was divided into two parts, one of which was placed in an infested orange tree at Stellenbosch and kept under wire, while the other was taken to an estate called "Fernwood," owned by a Mr. Rudd, where a glass house similar to that used in California has been erected around an orange tree.

Still another successful sending to South Africa was accomplished by Mr. Koebele, who forwarded a package by mail from Australia. Four living specimens only survived the journey, but even this small number properly cared for will soon amount to a formidable host.

Personal acknowledgments of the indebtedness of the Colony to this Department, and particularly to the Entomologist, have been received from Mr. Louw and from the secretary for agriculture of Cape Colony.

Owing to the dying out of Vedalia in New Zealand, during the season of 1891, the Icerya appeared in large numbers at several localities, and particularly at Nelson. A vigorous search was made in New Zealand for living specimens of the predatory ladybird, but at the time without success, and I was appealed to by Mr. R. Allan Wight to send over a supply. The first attempt to comply failed from the opening of the package by the custom and post-office authorities, who repacked it in such manner that the insects escaped. A second sending was started with great care. Mr. Coquillett made up the package in Los Angeles and personally accompanied it to San Francisco, placing it in charge of a responsible person on board the steamer, who cared for it on the journey and transmitted it at once to Dr. B. Locking, of Nelson. The package arrived intact, and upon being opened was found to contain twenty living beetles besides larvæ in different stages of growth. Recent advices state that subsequent to the arrival of this package living Vedalias were found in another portion of the Colony, and were also transmitted to Dr. Locking through Mr. Wight. In the meantime, however, our American specimens had multiplied rapidly and the scale insects were fast being destroyed. At a public meeting of horticulturists held at Nelson resolutions were passed thanking this Department for its courtesy in this matter.

Although the journey to Alexandria, Egypt, is not as long as the circuitous route which Mr. Louw took with the insects in his care, great difficulty has been found in transmitting the Vedalia in good condition to that country. Several experiments by mail failed during the early part of 1891, evidently owing to the warm weather. In December a sending was made with great care, the box being transmitted by mail from Los Angeles to Washington and thence carried by messenger to New York and placed in charge of the butcher on board the *Etruria*, with instructions to place it in the hands of the Liverpool agents of a large European company of forwarding agents. Owing to almost criminal negligence, however, on the part of this company, this experiment, which had been planned so carefully and which had been started at considerable expense, failed. The journey from New York to Alexandria should have occupied only sixteen days, but in reality it took over a month, and the package was evidently retained in Liverpool or London for ten days or more, and probably kept in a warm room. The result was that when our correspondent, Rear-Admiral R. N. Blomfield, R. N., opened the package at Alexandria, not a single living insect was found. Immediately on receipt of this information we instructed Mr. Coquillett to forward a series of packages, one every week, for a number of weeks, by direct mail from Los Angeles to Alexandria. Plenty of food was inclosed with each package, and owing to this fact and to the fact that the experiment was undertaken during the cool weather, several of these shipments arrived in better condition, and living Vedalias were liberated in the Alexandria gardens and sent to Cairo, where they were taken charge of by Prof. Williamson Wallace, of the College of Agriculture. In the early fall of 1892 we received a communication, through the kindness of Rear-Admiral Blomfield, from Mr. J. H. Marsden, of Alexandria, who reports that the Vedalia is now becoming very generally distributed in that region. Mr. Marsden started near Bulkley Station a small colony of about a dozen specimens taken from the gardens of Nubar Pasha, where the original specimens had been placed by Rear-Admiral Blomfield. These were placed on a rosebush infested with Icerya and soon reproduced. Fearing that their progress might be retarded, owing to the rapid disappearance of the Icerya, search was made, and a branch of an orange tree, apparently covered with it, was found, but on careful examination it was seen that all of the scale insects had been killed; and, all of the orange trees in this garden being found to be in similar condition, difficulty was experienced in obtaining any living scales to serve as a fresh food supply. The Vedalias, however, were abundant in all stages. Thus in this short time Mr. Marsden feels confident the Icerya has been practically exterminated in that locality.

The success of the importation from Australia and New Zealand to California has attracted widespread attention, and I have been in constant receipt of applications for Vedalia from individuals in different parts of this and other countries. These persons have not understood, however, that so far as has been ascertained the Vedalia will feed only upon bark-lice of the genus Icerya, and there is nothing to be gained by carrying it to places where these scale-insects do not occur.

TWO DANGEROUS IMPORTATIONS.

(*1*) *The potato tuber worm* [Plate I, Fig. 1].—In Insect Life (Vol. IV, pp. 239–242, April, 1892) an insect is described which has been imported into California either from Australia, New Zealand, or, possibly, from China, and which threatens considerable damage to the potato crop. This is the potato tuber worm (*Lita solanella* Boisd.). The larva of this insect was found by Mr. Koebele at Alameda, Cal., in a boiled potato, and upon examination he found others in raw potatoes. Later, chrysalides were collected and the moths were bred, while larvæ were found mining the leaves as well as the stems and the tubers.

I noticed from a recent stylographic circular, issued by Mr. T. D. A. Cockerell, from the Museum of the Institute of Jamaica, that this species occurs in parts of the island of Jamaica. Mr. Cockerell does not seem to have studied the early stages, but suspects that the insect breeds in a native solanaceous plant known as "Soushumber." He states that it flies in myriads to the lamps at Kingston in the evening during the summer, and that his specimens were determined by Lord Walsingham as being identical with or closely allied to this species. A correspondent of the division, Mr. W. A. Webster, of Bakersfield, Kern County, Cal., has sent in specimens of stored potatoes completely ruined by the larva of the insect. Mr. Webster informed me that these specimens were obtained from a Chinese gardener, and that he was strongly impressed with the possibility that the insect was imported from China. It was undoubtedly the first season that the insect had been found near Bakersfield. A review of the literature on the species shows that it is noted as a pest in New Zealand, Tasmania, and different parts of Australia, as well as in Algeria. According to Australian writers, the eggs are deposited upon the stalk near the ground, and the larva works its way down to the potatoes. Breeding continues after the potatoes have been harvested, and any number of generations may be produced in storage. The caterpillars form channels through the flesh of the tuber, concealing themselves with excrement fastened together with silk, soon breaking down the substance of the potato and completely ruining it. The larval life lasts from two to three weeks, and the cocoon is spun usually just outside. The pupa state continues two weeks longer, when the moths emerge. Forty or more larvæ may inhabit a single potato, and the insect is very prolific. The damage done in seasons of abundance is very great. In Algeria during a single season three-fourths of the potato crop has been destroyed, while Mr. J. G. O. Tepper in 1881 stated that in the vicinity of Adelaide, South Australia, the insect causes the destruction of hundreds of tons of potatoes every year. Mr. R. Allan Wight, of Paeroa, New Zealand, has contributed a note upon the New Zealand occurrence of this insect to No. 3, Vol. v, Insect Life, in which he states that, in his opinion, the insect is native to New Zealand, although it may also be an original inhabitant of Australia. In his opinion it originally fed upon a species of "flag" (*Typha angustifolia*), and it is supposed that the potato-feeding habit originated in the use of this flag as a thatch for potato houses.

The undue presence of so serious a pest in California calls for energetic measures. All infested potatoes, wherever found, should be immediately destroyed, and receptacles in which they have been stored should be treated with kerosene. Sound potatoes should be carefully stored in tight rooms. Mr. Wight's experience in New Zealand leads him to recommend a plan which has been attended with success, and which consists in harrowing the potato stalks up in heaps and burning them before taking the roots, having previously planted full depth and hilled the crop well. The young larvæ hatching from the eggs laid on the stalk, according to Mr. Wight, are in no hurry to reach the tubers and feed for some time on their way down.

While preparing this report the September, 1892, number of the Agricultural Gazette of New South Wales comes to hand, and in it Mr. A. Sidney Olliff reports this insect as destroying tobacco at Tamworth, in New South Wales. There seems to be no doubt as to the truth of the statement, as an adult insect has been reared from tobacco and Mr. Olliff, who is the Government entomologist, is perfectly competent to decide as to the identity of the species. The larvæ were found to be burrowing within the stems and larger leaves of the tobacco plants and were found to particularly affect the tips. In one case specimens were found burrowing in the midrib of the leaf. If this species will attack tobacco as well as potato there is no reason why it will not breed in any solanaceous plant, in which case it will be very difficult to stamp it out if it once obtains a foothold in this country, as, in fact, it appears to have done already.

(2) *The olive Pollinia.*—The other recently imported insect has also been found in California. It is a well-known European scale-insect (*Pollinia costæ* Targ.), which is injurious to the olive and which is particularly difficult to treat on account of its covering pellicle, which adheres with extreme closeness to the bark of the tree. The insect would, in fact, under ordinary circumstances, and particularly when

smut fungi are present in quantity, hardly be recognized as an insect. Its pellicle gives it something of a resemblance to a Diaspine or scale-bearing bark-louse, but it belongs in reality to the Lecaniinæ, since its covering is wax and does not contain the cast skins of the insects. Moreover, the characters of the last segment of the insect itself indicate plainly its true relationship. It is peculiar in the fact that after the second stage it is totally devoid of legs and the antennæ are represented simply by minute tubercles. The mouth parts are very difficult to perceive and the eyes are lacking. Under a low power of the microscope it is apparently nothing but a little formless structural globule of animal matter, lacking all external organs. The damage which it does to olive trees in Europe is considerable. It usually collects in small masses, sometimes isolated, but more often joined together into considerable patches, resembling an extensive exudation of the sap of the tree. The masses are whitish in color, but they are generally covered with quantities of black smut, so that they have an appearance of being blackish. They are most abundant upon the young twigs and at the axils of the leaves and branches.

So far as I am informed, this insect occurs in California only upon certain olive trees imported direct from Italy about five years ago and which are now growing in a portion of Los Angeles County. These trees are unhealthy in appearance and, unless active remedial measures are instituted, will probably die. California's growing olive industry will probably warrant the extermination of these particular trees if it should be found that the insect can not be destroyed by fumigating. It will be a difficult insect to kill by the use of washes. It is not known to have any other food plant than the olive. In this species and *Lecanium oleæ* California has the two principal scale-insects of the olive. The other species affecting this plant in Europe are *Phillippia follicularis* Targ., *Aspidiotus villosus* Targ., and *Mytilaspis flava* Targ.

THE INTRODUCTION OF HESSIAN FLY PARASITES.

The experiment described upon pages 235–237 of my last annual report, which consisted in the bringing over from England of Hessian fly puparia ("flax-seeds") infested by a well-known European parasite (*Semiotellus nigripes* Lind.=*Entedon epigonus* Walker) and placing them in favorable localities under the eye of certain well-known entomologists in this country has, so far, had no tangible result. Specimens were sent to our agent, Mr. F. M. Webster, La Fayette, Ind.; Prof. S. A. Forbes, Champaign, Ill., and Prof. A. J. Cook, Agricultural College, Mich. A part of Prof. Forbes's supply was sent by him at our request to Mr. James Fletcher, at Ottawa, Canada. Messrs. Webster, Cook, and Fletcher have been unable to report any positive success. Prof. Forbes succeeded in rearing an entire generation in this country the first season (1891), and his entire supply of this generation was either liberated in the adult state or carefully placed within the infested puparia in favorable locations in the open field. Details as to the placing are given upon page 236 of the last report. The present season Prof. Forbes reports that, although careful search has been made in the wheat fields in which the adult parasites were liberated and in which the infested Hessian fly puparia were placed, no specimens of the imported parasites have been found. This negative result, while unsatisfactory, must not be taken as an indication that the experiment has been an entire failure. It is quite possible that the parasite may exist in the fields without being discovered, as it is very minute, and as the numbers liberated were very small in comparison with the numbers of the Hessian fly. It is quite within the bounds of possibility that the parasites may breed for a few generations without sudden multiplication and then during an exceptionally favorable season may rapidly multiply and become an important factor in the destruction of the Hessian fly. Mr. F. Enock, who collected and sent over the infested puparia used in this experiment, was unable to repeat the sending the present spring, but hopes to be able to do so the coming season.

SPREAD OF THE HORN-FLY.

In my last report it was shown that this new torment to cattle had made its appearance in two localities in Ohio, in Oldham County, Ky., and in certain localities in Mississippi, and reference was made to an unverified rumor of its occurrence in Iowa. That the insect, however, was much more widely distributed during the summer of 1891 cannot now be doubted in view of its injurious occurrence over so large an extent of country during the present year. In 1891 in many localities it occurred in such small numbers as to be hardly noticed by stock-owners. During 1892 it has spread northeast into Connecticut, Massachusetts, Vermont, and New York, and there are two reports of occurrences of it in Canada, while to the southeast it has appeared in every State down to and including the State of Florida. In the west it has reached Texas, Oklahoma, and South Dakota. The intervening territory is rather generally occupied by the fly, although there are points at which it has been unusually abundant, doubtless to be explained by the introduction of cattle which carried the fly with them. In the States of New Jersey, Maryland, and Virginia, where the insect was so noticeable four years ago, it has occurred in greatly reduced numbers. This is certainly not due to remedial work on the part of the owners of cattle, but is probably the result of the work of parasites and natural enemies. Upon page 248 of my report for 1890 eight distinct species of parasitic Hymenoptera are mentioned as bred from cows' dung containing among other Dipterous larvæ those of this fly. There are also a number of predaceous insects which frequent the older dung in search of these dipterous larvæ.

Bulletins have been issued during the year from experiment stations in localities in which the insect has just made its appearance, notably in Florida, Oklahoma, and Canada. No additional observations have been made on the life history or habits of the insect, the writers either following or confirming the accounts given in the publications of this division.

THE OX BOT.

[Plate I, Fig. 2, and Plate II.]

It has given me much pleasure to clear up during the year the life history of *Hypoderma lineata*, the common ox bot-fly of this country. It has recently developed that the old European species, *Hypoderma bovis*, supposed to be the common bot-fly of both Europe and America, occurs in this country only as a rarity, if at all. The eggs of the American species and the method of oviposition have heretofore been unknown, but the present year accurate observations have been made by a correspondent of the division, who was specially requested to study this matter on account of his advantageous location near the extensive cattle ranches along the Pedernales River in Texas. The oviposition was noticed during the first week in March. Flies approached very swiftly and deposited their eggs on the sides, belly, tail, near the anus, and on the front legs. They remained on the animal from five to ten minutes. The eggs, as shown at Fig. 2, *a*, Plate I, were found fastened to individual hairs in clusters of four to six. The structure of the lower portion of the eggs is well adapted for clasping the hair. It consists of two lobes forming a bulbous enlargement, which is attached to the egg by a broad but rather thin neck. When removed from the animal and placed in moist situations the eggs fail to hatch, and an examination of alcoholic specimens which had been placed in the alcohol as soon as collected show that the larvæ were already fully developed. It thus appears that the larva is ready to hatch when the egg is laid.

Several points in connection with these observations are of great importance in view of the theory first propounded by Dr. Cooper Curtice, formerly of the Bureau of Animal Industry, to the effect that the larvæ of the ox bot do not penetrate through the skin from the point at which the eggs are laid, but are licked from the hair into the mouth of the animal, penetrate the walls of the œsophagus, and then work through the subcutaneous tissue of the cow and subsequently become encysted at the point under the skin through which they eventually bore and from which they finally emerge.

These points may be summarized as follows:

Eggs are laid indiscriminately on the flanks, legs, and tail of the animal, and the delicate newly-hatched larvæ, on the old supposition, would have to crawl from these points to the back and penetrate in the location where the warbles are always found, which is a practical impossibility. The egg-laying season is coincident with the shedding season, and cattle have a great habit of licking themselves at this particular time, thus taking a great deal of hair, not only into the mouth, but into the stomach as well. Eggs do not hatch when removed from the animal and placed in advantageous circumstances; the larva is ready to hatch when the egg is laid.

Taking these facts in connection with the observations of Dr. Curtice, first published in Insect Life (Vol. II, pp. 207–208) and afterwards in the Journal of Comparative Medicine and Veterinary Archives (Vol. XII, pp. 265–274), it may be said to be practically proved that the life round of the ox bot of the United States is briefly as follows:

The eggs are laid by the adult flies in the early spring upon almost all parts of the body. The cattle licking themselves remove the eggs and hairs, for this is the shedding season. The eggs hatch by virtue of the warmth of the mouth, and the newly-hatched larva, provided with a number of spinous points and anal hooks, penetrates through the walls of the œsophagus. It then molts, loses the spines, and becomes almost entirely smooth with the exception of some very minute spines around the anal portion. Its skin is underlaid with strong muscular bands fitting it for pushing its way through the tissues. In this stage its development is very slow, and it gradually works its way through the subcutaneous tissue, traveling for nine or ten months, until it has reached a favorable point upon the back, where it molts again, assuming the familiar spiny appearance of the mature larva, becomes encysted by virtue of the inflammation of the tissue, and from this inflammation and from its own growth forms a decided lump under the skin. After another molt the skin of the animal is penetrated and eventually the larva issues through this hole and falls to the ground to transform to pupa. The pupa state lasts but a few weeks, when the perfect fly emerges.

A full detailed account of these observations has been published upon pages 302–317, Vol. IV, of Insect Life, and an extra edition of the article has been published for distribution among stock-raisers.

THE ROSE SAWFLIES OF THE UNITED STATES.

I have concluded during the year some observations upon the sawfly larvæ, commonly called slugs, which infest the foliage of the rose in this country, and have published a full statement in Insect Life (Vol. V, pp. 6-11). Instead of a single species, we have now three at work in different parts of the country. For the purposes of this report it will suffice to give a brief summary of the habits of the three species, which may be recognized from the figures upon Plate III, referred to in the text.

The American rose slug (*Monostegia rosæ* Harr.).—This is the old and well-known species, and the only one which, up to within the last few years, has been recorded as affecting the rose in this country. It was originally found in the Eastern States, but has now become widely distributed by being transported from place to place in connection with rose plants. It is single brooded, the flies emerging in May, or about the time the rose is in full leaf. The eggs are circular and are inserted singly in the edge of the leaf, on the under surface. The larva is about one-third of an inch long, and slug-like, the thorax being swollen; but it is not slimy, as is the case with many other allied sawfly larvæ. It feeds only at night, and always on the upper side of the leaf, skeletonizing it rather than eating the entire substance. During the day it remains at rest, concealed on the under surface of the leaf.

The larval period lasts from fourteen to fifteen days, when the larva abandons the damaged plant and enters the soil, where it constructs a fragile earthen cocoon. In this it remains dormant until the following spring, transforming to pupa shortly before the emergence of the adult insect in May. The appearance of the adult insects is somewhat irregular, and hence the larvæ are found on rose bushes over a period of five or six weeks.

The bristly rose-worm (*Cladius pectinicornis* Fourcr., [Plate III, Figs. 1 and 2]).—This species is found in Europe as well as in this country, and was probably introduced from abroad at some time prior to 1833, since it was mentioned by Harris, in his catalogue of this date, under the specific name of *isomera*. Some time in the early seventies it was found near Farmington, Conn., feeding upon *Clematis virginiana*, and in 1880 it was found doing considerable damage in the District of Columbia. It is now the principal enemy of the rose in this vicinity, and occurs also in New York, Indiana, and Missouri.

This insect produces three, or in some cases four, broods annually. The eggs are inserted in the upper side of the petiole of the leaf, and are placed in rows close behind each other, three or more together. The full-grown larva attains a length of 16 millimeters, and ranges in color from a dirty yellowish green to a glaucous green with a dorsal line of a slightly darker green. The head is greenish yellow and is covered with orange sculpturing. The whole larva is sparsely covered with stiff hairs or bristles, especially at the side. When quite young it skeletonizes the leaves, leaving whitish blotches, but as it grows older it devours irregular holes all over the leaf, eating the entire substance, until frequently nothing is left but the stronger ribs, the larva remaining all the time concealed on the under side of the leaf.

When full fed it does not leave the plant, at least in the case of the earlier broods, but forms its cocoon, which is composed half of silk and half of some glutinous substance intermixed, and is spun tightly to the lower surface of the leaves or other objects, usually surrounded by an irregular fringe. The fall brood spins up among the fallen leaves and other rubbish at the base of the bushes.

The coiled rose-worm (*Emphytus cinctus* L., [Plate III, Fig. 3]).—This species is also European, and has been imported, very probably, more recently than the preceding form. It was found to be injurious in Boston and Cambridge during the years 1887–'89, and specimens of what is undoubtedly the same species were described by Norton, in 1867, as *E. cinctipes* from specimens taken in Maine and New York. It is also recorded under the latter name in Cresson's Catalogue, from Canada.

This insect is double-brooded, and in southern latitudes produces a third brood, the appearance of the worms extending from May to October. The eggs are placed singly to the number of from three to seven on the under surface of the leaves. The larva is easily distinguished from either of the other two by being smooth and by having its yellowish brown head marked with a broad brownish black spot. The body is nearly linear, the under part swollen at the anterior extremity, and is dark green above, with the sides and legs grayish white. On reaching full growth the larvæ bore into the pith of stems of dead rose branches or other plants, in which they pupate, or, in the case of the fall brood, hibernate. The larva eats the entire substance of the leaf, feeding along the edges with the body curled beneath it, and when at rest it remains curled up in a ball on the under side of the leaf.

Remedies.—All three of these species are amenable to the ordinary remedy for sawfly larvæ, viz, the application of powdered hellebore in water spray. A mixture of 2 ounces of hellebore to 2 or 3 gallons of water will be of sufficient strength to effect the destruction of the larvæ. In the case of the two newer species, *Cladius pectinicornis* and *Emphytus cinctus*, thorough treatment of the first will prevent the appearance of the later broods, and very frequently hand-picking will be sufficient to check the insects, if carefully done in the case of the first brood. Where a strong solid stream of water is available, as in most city rose gardens, the slugs can easily be washed from the bushes, and in most cases will be unable to return, as was shown by Mr. Howard in 1888.

THE STRAWBERRY WEEVIL.

[Plate IV; Figs. 1–5.]

One of the most interesting occurrences of the year was that of the strawberry weevil (*Anthonomus signatus* Say), a detailed account of which has been given in Insect Life (Vol. V, pp. 167–186). It was reported as causing serious injury to "Sharpless" and other staminate varieties of the strawberry in portions of Maryland and Virginia, and in Delaware.* Very general injury to blackberries, both cultivated and wild, was also noticed in the vicinity of Washington. The injury is accomplished by the female beetle partially severing the stalk below the flower bud, in which she inserts an egg, causing it in time to drop off. Attack is begun as soon as the buds come to maturity and continues until the berries ripen. The insect undergoes all its transformations in the severed bud, appearing as a perfect beetle about five or six weeks after the egg is deposited. This brood deserts the strawberry beds soon after issuing, appearing on other flowers in bloom at this time, and soon disappearing. It is probable that hibernation begins at this time and that there is only a single annual generation. The principal food of the in-

* Reported in Bull. No. XVIII, Del. Coll. Agl. Expt. Station.

sect was found to be pollen, and the reason for the severe attacks upon certain varieties of strawberry, and the comparative immunity of other varieties, was found by Mr. Chittenden, who has had charge of the work, to be directly due to the quantity of pollen developed.

Four species of parasites of this insect were reared, two of which occur in such abundance as to be considered very useful auxiliaries in restraining the multiplication of the species.

This pest has hitherto baffled all attempts to subdue it, next to nothing of substantial value having been even suggested for its suppression. The facts ascertained this year concerning its life history, however, show that it can be successfully dealt with.

The first requisite is clean culture. All old strawberry beds and blackberry plants, wild and cultivated, in the neighborhood of the bearing vines should be destroyed. The parasites may be encouraged by collecting the injured buds, and confining them in a box or barrel covered with fine wire gauze or bobbin-net of a mesh small enough to retain the weevils, but of sufficient size to permit the escape of the parasites. A few rows of early-flowering staminate varieties might be planted among beds of later-bearing plants to serve as traps for the hibernating brood, which could then be destroyed by beating them from the flowers into pans of water to which a few drops of kerosene has been added. In a similar manner wild bergamot could be planted around the strawberry beds, to be utilized as a lure for the new brood. A perfect preventive may be found in completely covering the beds with frames of muslin or some similar light material. This covering will not only exclude all other injurious insects, but is a positive benefit to the berries, which ripen a week or ten days earlier, being superior in size and quality. In addition it secures the plants against frost. A covering of old newspapers to be held down by stones or clods of earth has been suggested, and it is possible may prove of some value. The insect in all its stages, also one of its parasites, and specimens of its work on the strawberry, are shown at Plate IV, Figs. 1–5.

EXPERIMENTS WITH THE EUROPEAN WHITE GRUB FUNGUS.

For some years certain European investigators have been working at the problem of the practical utilization of the diseases of injurious insects, and particularly of a fungus disease of the European white grub, which is the larva of the common cockchafer (*Melolontha vulgaris*). MM. Brefeld, Cienkowsky, Metschnikoff, Prillieux, Delacroix, Giard, Dufour, and others, have all worked in this direction. The particular fungus which has been shown to produce the best results is *Botrytis tenella=Isaria densa*. Promptly upon the heels of scientific investigation, and almost too promptly we fear, commercial enterprise has followed. MM. Fribourg & Hesse, 26 Rue des Écoles, Paris, have been offering for sale culture tubes of *Isaria densa* for the practical destruction of the white grub since the summer of 1891. The circulars issued by this firm give the practical directions for using the fungus spores which they have secured upon a large scale and put upon the market at the rate of 50 centimes per trial tube, the commercial article costing 6 francs. The experiments recorded by Dufour in the Chronique Agricole cast some discredit upon the practical use of the fungus, and show that while the disease may be disseminated to a certain extent by infecting the soil with artificial cultures, or with fragments or entire specimens of diseased larvæ, the larger percentage of treated larvæ resist the disease even in the laboratory, while in the field the proportion of affected larvæ is considerably less.

In the early spring of the present year, as the result of some correspondence with Mr. H. S. Greenough, of Boston, and the Hon. William Vernon, of London, I received from the latter gentleman, then in Paris, three large tubes of the spores of this fungus, with which we have experimented during the season. A portion of the supply was divided between the field agents of the division, Prof. Herbert Osborn, at Ames, Iowa, and Prof. Lawrence Bruner, at Lincoln, Nebr., while the remainder was retained in Washington and was tested by Mr. Mally. The tests were all careful and thorough, from a practical standpoint, and the results were altogether unfavorable.

It must be premised that *Melolontha vulgaris* does not occur in this country, and that the insects upon which the experiment was tried, while rather closely related to this species and considered, in fact, as its vicarious representatives, do not, in fact, belong to the same genus. I doubt, however, whether this fact had anything to do with the nonsuccess of the experiments, and am inclined to agree with M. Jean Dufour that a practical and successful application of this particular parasitic fungus has not yet been attained.

Prof. Osborn made four tests with the material, following the printed directions. Two tests were made in the laboratory in small glass root cages, and two in outdoor arrangements. In the first laboratory experiment about twenty larvæ were treated, of which ten were inclosed in a root cage and ten were placed outdoors. Examination later in the season showed no result. At the same time other treated larvæ were placed in sterilized earth in a root cage and kept in the laboratory. Of these, one specimen was later found to be covered with a small cyst of earth filled with a mycelial growth, and the larva itself was covered with a dense white growth of mycelium. Later another test was made both in laboratory and field. Twenty-three treated larvæ were inclosed in a glass root cage filled with sterilized earth. A month later three live grubs were found and five beetles. A number of the larvæ were observed on the surface, and died a few days after treatment. There were no signs of mycelium, however, and it is probable that they had been slightly injured before or during collecting, as they were picked up in furrow after the plow. The outdoor experiment gave no result. The only successful inoculation, therefore, was a single larva in a laboratory cage, and this specimen did not communicate the disease to another in close proximity to it.

Two very careful experiments were conducted at the Department in Washington, which are summarized by Mr. Mally as follows:

Experiment 1.

June 1.—Some of the white powdery substance called *Botrytis tenella* was poured into a sterilized glass dish. Two small and three large grubs were rolled in this powder until profusely covered with it. They were then placed in small cavities about an inch in depth in the pots of growing corn. The earth was moist, almost to excess at first, and the grubs became well dampened while making their burrows in it. When dropped into the small cavities enough of the powder was thrown in to form a white coating of the walls.

To keep the earth moist and the air in the pots damp, a double layer of thick wet cloth was kept over the tops of the pots constantly. The cloths were held down by strong rubber bands, and these, as also the earth, were moistened as occasion required. The temperature of the room in which this and experiment No. 2 were carried on, according to a Fahrenheit thermometer, ranged as follows: June 1, 90°; June 2, 83°-88°; June 3, 83°-92°; June 4, 88°; June 6, 90°; June 7, 88°. During a temporary absence, from June 8 to July 1, no further record of temperatures was kept, but the moistening of the earth and cloths was kept up during the interval.

July 2.—The earth in the pots was carefully examined. Three living grubs were found at a depth of 1 to 2 inches. They were active, and apparently in the best possible condition. Not even a trace of the decayed remains of the other two were found. This indicated that they had died soon after June 1, and probably as the result of so much handling and transferring. The corn roots had mostly all been eaten. The earth had been thoroughly burrowed through, as was shown by the numerous excrementary pellets found in all parts of it. The living grubs, therefore, in such close quarters, certainly at some time came into contact with the dead or dying specimens, or the excrement and earth through which the unhealthy individuals had burrowed. This suggests that either the two missing grubs did not die of the *Botrytis* disease, and, therefore, no further infection resulted, or that they died of a disease which was not contagious The earth and grubs were again placed in the pot and more corn planted, this time without the precaution of disinfecting the grain.

July 13.—The corn had sprouted and was growing well; earth moist, and in good condition. Two of the grubs were still as active as ever, while the third was found to have been parasitized, and a large Dipterous puparium was found partially embedded in the larval skin in the cell. The parasitic pupa (No. 700) was taken to rear. It was now forty-three days since the beginning of the experiment, and no results. It was, therefore, discontinued.

Experiment 2.

June 1.—A second portion of the white powder was dissolved in a small quantity of sterilized neutral beef broth such as was used in the regular bacteriological work. One small and three nearly grown grubs were thoroughly drenched with this *Botrytis* charged liquid and then placed in a pot exactly as has been detailed for experiment 1. All other conditions were the same as in the first and need not be enumerated again. The use of the broth was for the purpose of ascertaining whether it would facilitate germination of the spores or make their adherence to the grubs more certain.

July 1.—The pot of earth was examined. The corn roots had been eaten and the earth gone through as in experiment 1. Three active and healthy appearing grubs were found. In a cell about a half inch distant from a living grub the fourth one was found dead. It was black, mostly decayed and dried up beyond all recognition, except the head and portions of the skin. No fungoid growth of any kind was found, but the remains were densely covered with living specimens of a robust, fat, white mite. It seemed quite evident that the mites had been responsible for the death of the grub. If not, and death was due to a disease, it certainly was not contagious, for living grubs were all about it within a half inch. The living specimens with earth were replaced, and more corn planted.

July 13.—Corn growing, and the grubs all lively. Experiment discontinued.

Check on Experiment 1.

June 1.—A pot of growing corn, the same as that of experiment 1, and subsequently treated exactly similar in all details, was stocked with four grubs, just as taken from the sod, preventing, as much as possible, exposure to Botrytis or other disease. The pots of the check experiments were kept in another portion of the building. Temperature, according to a Fahrenheit thermometer, as follows: June 1, 84°; June 2, 82°–88°; June 3, 81°–84°; June 4, 84°; June 6, 80°; June 7, 80°. In the first check one of the large grubs had one leg bitten off. This wound was sufficient to cause its death by June 3.

July 2.—Earth examined and two living grubs found. The third was found dead in its cell literally swarming with a small white mite, looking much like the one noted in experiment 2. The remains of the grub also appeared the same, the important point being that no fungus growth appeared, and none of the living infested, so far as could be determined. The living with earth were placed back in the pot and more corn planted.

July 13.—Corn growing well and the grubs lively. No results and the check discontinued.

Check on Experiment 2.

June 1.—This was prepared and subsequently cared for exactly as in experiment 2, except that the four grubs were given a thorough bath in the neutral beef broth, free of all germs, to ascertain what effect the broth in itself would have upon the grubs.

July 2.—Upon examination all the grubs were found active and apparently in the best possible condition. They were placed back in the pot, as had been done with the others.

July 13.—No additional facts were to be noted and the check was discontinued.

It will thus be seen that the substance tested gave absolutely no effect and produced no practical result at Washington.

NEW OBSERVATIONS ON THE ELM LEAF-BEETLE.

No insect enemy of the elm equals in the severity of its attack in the Middle Atlantic States the imported elm leaf-beetle (*Galeruca xanthomelæna*). In 1883 I published a reasonably full account of the life history of this insect and of the remedies to be used against it, in Bulletin No. 6 of this division. In 1886 this matter was republished as a portion of Bulletin No. 10, which treated of certain shade-tree pests, and in the fall of 1891 the original bulletin was again reprinted with a short appendix treating of the number of annual generations and of the best methods of applying arsenical poisons to tall trees. The statement made by Prof. J. B. Smith before the Washington meeting of the Entomological Club of the American Association for the Advancement of Science in August, 1891, to the effect that he had found this insect single-brooded in the State of New Jersey, the females having entered winter quarters in the early part of August, induced me to go carefully over my own notes and the published records with a view of verifying the original statements in regard to this important matter. I was thereby led to the conclusions given in the appendix of the second edition of Bulletin No. 6, viz, that whatever the facts may be in the latitude of New Brunswick, N. J., there are at Washington, D. C., certainly two annual generations and probably three.

The present season the most careful study has been made of the life history of this insect, with a view of verifying these conclusions. Large numbers of the insects have been reared in the Insectary, and careful notes have been made of daily observations upon unconfined individuals upon the numerous elm trees in the Department grounds at Washington. It results from this study that my former observations have been verified in full. There were this year on the Department grounds at Washington three generations of this insect, and the eggs were laid as late as October by beetles which had not gone into hibernating quarters. The facts observed up to that time were reported in a paper read by me before the Entomological Club of the American Association, at Rochester, N. Y., on August 18. The reading of this paper was followed by the statement of Prof. Smith of his own observations during the present season at New Brunswick. His study seems to have been well planned and most careful, and confirmed his observations of the previous year. The beetles had already at that time gone into hibernating quarters in large numbers, while careful dissections of adult females indicated that the eggs were in so early a state of development that there was not the slightest likelihood that they would be deposited this year. In the discussion which followed the reading of these papers, it was agreed that the facts indicated normally a single brood in New Jersey, and at least two broods at Washington, D. C., and suggested the desirability of an investigation of the intervening territory in order to ascertain where double-broodedness began. I also gave my opinion that the species would be found exceptionally double-brooded in New Brunswick, and this anticipation has since been confirmed by the receipt of a communication from Prof. Smith about the 1st of October, in which he stated that newly-laid eggs had recently been found upon elms at New Brunswick. The practical bearings of this work upon the number of generations in reference to the proper time for spraying will be readily understood.

It is a curious fact that in spite of the extraordinary abundance of this species in many of our Eastern cities through a long series of years, there are no published records of any natural enemies in this country, although in Europe several parasites and predaceous insects have been found. The close study of such large material the present year, however, has resulted in the finding of several natural enemies of the species at Washington. The larvæ, pupæ, and adults of the common spined soldier-bug (*Podisus spinosus*) were found feeding upon the adult beetles, while the adult of this insect was also found sucking the eggs. A small capsid bug, known as *Camptobrochis grandis* Uhler, was also found sucking eggs, while the larva of some lace-winged fly of the genus Chrysopa was found feeding upon both larvæ and eggs. Late in September the larvæ of one of the soldier beetles, *Chauliognathus marginatus*, were found in considerable numbers destroying larvæ and pupæ near the surface of the ground, where the larvæ had descended for hibernation. Early in the spring, in the same situation, were found in large numbers the larvæ of two dipterous insects which were destroying the pupæ. So abundant were these dipterous larvæ that every Galeruca pupa of several thousands that were placed in the breeding cage was destroyed by them. From these larvæ two species of Diptera were reared, one being the not uncommon *Cyrtoneura stabulans*, to which I have referred upon page 108 of the Fourth Report of the U. S. Entomological Commission as feeding upon the cotton worm. The other, Dr. S. W. Williston, to whom it was referred, has been unable to place generically. He states that it agrees with the species of Homalomyia, except in the structure of the middle legs. These flies and the Camptobrochis referred to above are shown at Plate V. Figs. 1–4.

WORK OF THE FIELD AGENTS.

The reports of the field agents of the division on the work of the season will be published in bulletin form, but a summary of the work is herewith given.

Ohio.—The work of the Ohio agent, Mr. F. M. Webster, was interrupted at the close of the fiscal year, July 1, by the reduction in the appropriation, and he has failed to send in any report of the work done during the first six months of the year.

California.—Mr. D. W. Coquillett, stationed at Los Angeles, Cal., has been engaged during a large part of the season in caring for the insects sent from Australia and New Zealand by Mr. Koebele. Every effort was made to colonize such of the specimens as arrived at Los Angeles in good condition in such a way that they would breed uninterruptedly. Careful observations were made upon the habits and life histories of the species received, and upon these points he reports in full, describing with great care all of the early stages of each species studied. He has also, with considerable difficulty, kept up a good supply of *Vedalia cardinalis*, the difficulty arising from the fact that this beetle has almost brought about a complete extinction of its only food, the fluted scale (*Icerya purchasi*). The necessity for keeping this beneficial insect alive in some quantity arises from the possibility that at remote points the fluted scale will begin once more to increase, in which case the sending abroad for a new supply of Vedalia would be avoided. This propagation of Vedalia under adverse circumstances has enabled us during the season to send out living specimens in considerable numbers to South Africa, New Zealand, and Egypt, as indicated in an earlier portion of this report. Mr. Coquillett also reports upon the increased use of the hydrocyanic acid gas treatment for scale insects in California. The sheet fumigator described in Insect Life (Vol. IV, pp. 328–329), being less expensive and easier of operation, is becoming more widely used than any other kind. During the season the Los Angeles County authorities have purchased seventy of them, and have authorized the fumigation of trees at cost to the owners. The cities of Riverside and Anaheim have also purchased fumigators and have treated infested trees. Certain species of destructive span-worms have also been carefully studied, particularly a species occasioning considerable injury to the foliage of the English walnut trees grown in Santa Barbara County, and one which late breeding has shown to be the well-known fall canker-worm (*Anisopteryx pometaria*), which damaged orchard trees in Alameda and Santa Clara counties. Some attention has also been paid to the codling-moth, and it has been shown conclusively that this insect is three-brooded in California.

Nebraska.—The Nebraska agent, Mr. Lawrence Bruner, has, as in previous seasons, paid special attention to destructive locusts. Last year, as will be remembered, he made an extensive trip through the West in order to investigate the cause of the many alarming rumors of destructive locusts, and the results of this trip were published in Bulletin No. 27 of the division in the latter part of May. While considerable damage was shown to have been done in certain localities, the outlook for the present season was considered to be, on the whole, favorable. These predictions have been verified. There has been some local injury during the summer, and in Nebraska several species hatched out in rather large numbers. Later, however, as was expected, they became more or less infested with parasites of different kinds, which reduced their numbers to a great extent. The fungus disease (*Empusa grylli*) and the locust mite (*Trombidium locustarum*) were especially efficacious. Mr. Bruner has also continued his investigations of the insects injurious to the sugar beet, upon which he reported in full two years ago. He has found several new enemies of this plant, the principal ones being a small Hemipteron (*Hadronema militaris*), and the larva of a pyralid moth (*Loxostege sticticalis*). The life histories of all these insects have been worked out in full. During the early part of the season the chinch-bug was reported in numbers along the southern boundary of the State of Nebraska, but heavy rains about the end of September and subsequently have greatly reduced the fear of serious damage.

Iowa.—The Iowa agent, Prof. Herbert Osborn, reports that the common crop pests were almost entirely absent during the early part of the season in Iowa. Later in the summer and autumn, plant-lice, bill-bugs, the potato-stalk weevil, the diamond-back moth, cabbage plusia, the imported cabbage-worm, the army worm, the clover-seed caterpillar and a grass crambid (*Monophila noctuella*) became quite abundant and were studied. Careful observations have been made upon the winter conditions of the strictly grass-feeding species of leaf-hoppers, notably the three important species, *Deltocephalus inimicus*, *D. debilis*, and *Diedrocephala mollipes*, and it has been ascertained that all three deposit eggs in the autumn in the leaves and stems of grass, and that these eggs remain over winter, hatching in the spring. It results from this hibernation that burning over grass lands in the late fall or early spring, or whenever the grass is dry enough, will very greatly reduce the numbers of these injurious creatures. The report contains careful summaries of the life histories of these three species.

Missouri.—Miss Mary E. Murtfeldt, whose work was also ended with the fiscal year on account of the reduced appropriation, reports that the severe rainfall and low temperature of the spring and early summer in the lower Mississippi Valley produced noticeable effect upon insect life. Wheat fields and corn lands which were inundated during April and part of May seem to have entirely escaped attack from chinch-bugs and bill-bugs. An exceptional absence of the Colorado potato-beetle is ascribed to the same cause. Aside from miscellaneous observations of considerable value Miss Murtfeldt has carefully studied a new enemy of the Osage orange, viz, a Pyralid moth new to science, and which I have described on page 158 of Vol. v, Insect Life, as *Loxostege macluræ*. She has also ascertained an important point in the life history of the cabbage curculio (*Ceuthorhynchus rapæ*), an insect which occasioned much loss and annoyance to market gardeners in parts of Missouri by boring into the crown and roots of young cabbage and cauliflower plants, either in the hotbeds or just after they are set out. As this insect does not trouble cabbages after the heads begin to form it is important to ascertain what becomes of it during summer and autumn. From experiments conducted this season she concludes that the insect returns to its original food plant, the wild pepper-grass (*Lepidium virginicum*). She succeeded in obtaining young larvæ in the stems of the latter plant in July, but as the plants did not thrive indoors she was unable to carry the insect through all of its stages. A quite serious attack upon spinach, the author of which has not before been known, is due to a small beetle, *Disonycha collaris*. As both beetle and larva drop to the ground upon the slightest disturbance they are not always associated with their destructive work. The bristly rose-worm (*Cladius pectinicornis*), to which I have already referred, was very numerous and destructive in rose gardens in the vicinity of Kirkwood.

APICULTURE.

The experiments in apiculture conducted under the direction of the Entomologist, by Mr. J. H. Larrabee, acting under a commission from this Department at the Agricultural College, Michigan, and by the coöperation of the college authorities, were closely connected with the practical work of the apiary. In the breeding of queens careful selection was continued. The cross between Carniolan bees and Syrians proved the past season, as heretofore, very satisfactory. The Tunisian bees, or so-called "Punics," were tried, but found to be so nervous and irritable under manipulation, and the capping of their comb honey presented such a soiled appearance, that they cannot be recommended as desirable for introduction into our American apiaries.

Temporary removal of the queen to prevent swarming was tested on a limited scale, and, though the yield of honey appeared to be lessened thereby, Mr. Larrabee thinks the plan an advantageous one under certain circumstances. The experiment reported on last year to determine the amount of honey consumed by bees in secreting one pound of wax, was repeated this season and with greater care. The conditions were also more favorable, and Mr. Larrabee is confident that the work of others who may try to solve the same question, if carefully conducted, will lead to practically the same result—viz, 8 pounds of honey consumed in the secretion of 15½ ounces of wax.

Continued observations were made on honey plants under cultivation, the chief result being a confirmation of the opinion expressed last year, that it will not pay to plant for honey alone.

A number of experiments in evaporating or ripening honey taken before it had been sealed over by the bees were made. Solar heat was found best, and, to prevent injury to the flavor by overheating under glass, ventilation should be given. Through the early removal of honey from the hives the yield is increased, the time of the bees not being taken up with the evaporation and sealing of the product, and Mr. Larrabee concluded, after his experiments, that the possibilities in connection with its proper evaporation outside of the hive as well as in preventing granulation are very promising. In feeding back extracted honey to secure the completion of unfinished sections, $11.40 at current market prices for honey was obtained as the pay for the labor of giving 338 pounds to five hives. Two colonies furnished with foundation only in the sections gave a product valued at $1.81 over and above cost of honey fed. In each case the feeding was done daily during twelve days. During the time of fruit bloom the weather was rainy and otherwise unfavorable, so that the bees flew but little and could have had but slight influence upon the fertilization of the blossoms. An almost total failure of the fruit crop in that part of Michigan is noted.

THE PEA AND BEAN WEEVILS.

[Plates VII and VIII.]

The frequent call for information regarding the habits of these two insects and the best remedies to be used against them led to the publication of a general article on pages 297–302, of Vol. IV, Insect Life. As so often happens, in reviewing carefully the known facts concerning these insects it was found that there was still something to be learned about them and that the note-books of the division contained facts not yet published. Some further studies were made during the latter part of the season and results have been published in Insect Life (Vol. IV, p. 392, and Vol. V, pp. 27–33). The facts may be thus summarized:

THE PEA-WEEVIL.

(*Bruchus pisi* Linn.).

The eggs of the pea-weevil are deep yellow in color, 1.5 millimeters long, three times as long as wide, fusiform, pointed in front, blunt behind, but larger near the anterior end than at the posterior end. They are fastened by means of a gummy substance to the outside of half-grown or full-grown pods. The young larvæ hatching from the eggs are furnished with six short, stout, temporary thoracic legs, each composed of only three apparent joints. The first is stout and resembles the coxa, the second is slender and probably represents the femur and tibia, and the third is the tarsus, and is a mere spatulate pad. Upon the prothorax there are series of six strong retrorse spines, in front of which are two plates strongly toothed along their exterior border, particularly outward. Both these plates and the legs are evanescent, but they assist the larva in obtaining its normal position within the pea. Ordinarily this newly hatched larva bores through the pod, entering the pea which happens to be opposite and then casts its skin, after which it appears as a footless larva of the curculionid type. Frequently, however, instead of immediately entering the pea, the larva mines along the inside of the pod for some distance, moving rapidly and with ease. This doubtless occurs whenever the egg hatches before the peas are sufficiently developed, the larva living as a miner until the pea is nearly full-grown. But one larva can develop in a single pea. The oft-repeated statement that the larva avoids the germ of the future sprout is only partially true, as the plumules and radicles are often more or less eaten, and but a very small percentage of buggy peas make good plants. Before transforming to pupa the larva cuts so closely to the skin of the pea as to leave a mere circular spot, thus facilitating the final exit of the beetle. It then lines the interior of its excavation with a smooth thin layer of paste, excluding all excrement, and then transforms to the pupa state. Sometimes many of the beetles will issue in the fall of the year, but the majority remain in the peas during the winter. There is but one annual generation and so far as known the beetles will deposit only upon the green pods in the field. To avoid planting live weevils with the peas, and thus bring about their spread, seed peas should be kept over a year, in which case all of the beetles will have issued and died. Recent experiments, particularly by Prof. E. A. Popenoe, of the Kansas State Experiment Station, have proved that it will not pay to use damaged peas for seed, as the resulting plants are almost invariably poor and sickly.

THE BEAN-WEEVIL.

(*Bruchus obtectus* Say.)

The eggs of this species instead of being laid on the outside of the pod and singly, as in the case of the pea-weevil, are inserted within the pod either through a slit or hole made by the jaws of the parent beetle or through the partial opening of the pod caused by drying and splitting. The perforation is almost always made along the ventral suture of the pod and the eggs are most abundantly found within the pods which have already turned yellow and which contain fully-developed beans. The newly-hatched larva resembles rather closely the corresponding stage of the pea-weevil. Its temporary legs, however, are longer, particularly the tarsal joint, which is very slender and as long as the preceding joint, and is turned out into a spatula-like foot bearing a spur at at the heel. The spinous plates on the prothorax have each but four slight teeth, while the anal segment bears four horny pointed tubercles. I have never found this larva to be a miner. It immediately seeks to enter the bean, and, although perfectly capable of piercing a hole for itself, it seems to prefer to enter through one which has been previously made. Once inside the bean, however, it diverges from the track of its predecessor and makes a roundish burrow for itself. Unlike the pea-weevil, a large number of bean-weevils will frequently infest the same bean, and upwards of twenty have been found in one of the large varieties of bean. The first molt occurs immediately after the bean has been entered and the larva assumes the normal apodous form. Upon reaching full growth each larva continues to burrow to the outer skin of the bean and may be located from the resulting semitransparent spot. It then retires within its burrow and transforms to pupa. The beetle, upon issuing from the pupa skin, gnaws its way out at a point just beyond the semitransparent spot just mentioned, cutting a circular hole and issuing by pushing this back. Unlike the pea-weevil, the bean-weevil continues to breed in confinement. Stored beans will, therefore, soon be completely ruined unless remedial measures are instituted. The number of generations depends upon the temperature, and an irregular development is soon noticed in storage, and all stages of the insect may be found at one time. Those individuals which can readily escape at the proper time of the year fly to the fields and resume what is probably the original and most normal method of egg-laying within the bean pods.

There is more need for a direct remedy in this case than with the pea-weevil, although the same insecticide will answer for both insects. The now well-known bisulphide of carbon treatment is one which has proved universally successful not only for these insects, but for all others infesting stored grain. It consists in placing this liquid in shallow vessels in tight bins inclosing the infested grain or in moderately tight rooms of limited capacity. In bins the amount to be used has been determined for wheat at approximately one and a half pounds to a ton of grain. With beans or peas we may add slightly to the amount of insecticide. For a room in which peas or beans have been stored and in which it is desired to kill the weevils which have been present, the evaporation of one pound of bisulphide to each 1,000 cubic feet of space will probably be sufficient.

In the course of a summer's study of these insects it has become necessary to definitely fix the scientific name of the bean-weevil, about which up to the present time there has been much difference of opinion among entomologists. A technical discussion of the momenclature would be out of place in this report, but I may briefly state that although the insect has for a number of years been very generally referred to as *Bruchus obsoletus* Say, on the authority of Dr. George H. Horn, who made a special study of the genus, Mr. E. A. Schwarz has succeeded in finding what is undoubtedly the true insect of this name as originally described by Say, and this shows that our bean-weevil, as I contended in 1870 in the Third Report on the Insects of Missouri, is not that species. The bean-weevil has been described under various names, of which *Bruchus obtectus* Say has priority. *B. obsoletus* was found by Mr. Schwarz in the District of Columbia breeding in the pods of *Tephrosia virginiana*, a wild leguminous plant, doubtless the same on which Say found it. A figure of this plant as well as of the true *B. obsoletus* are shown upon Plate VII.

THE SUGAR-BEET WEB-WORM.

(*Loxostege sticticalis* Linn.)

Order LEPIDOPTERA; family BOTIDÆ.

[Plate VI, Figs. 1, 2, and 3.]

The present season has been marked by the appearance in very injurious numbers in parts of Nebraska of a comparatively new enemy to the sugar beet. Our first intimation of its appearance was through the Division of Chemistry of the Department. In connection with its work upon beet sugar this division has established a station at Schuyler, Colfax County, Nebr., and in the middle of July one of the experimental plats at the station was suddenly attacked by a multitude of small caterpillars, which riddled the leaves and occasioned considerable alarm. The fact was at once reported to the Department, and the advice sent to spray with Paris green or London purple was anticipated by an assistant, Mr. C. B. Edson, who was temporarily in charge during the absence of Mr. Walter Maxwell. Later communications from Mr. Maxwell gave the history of the outbreak and its treatment. It seems that the caterpillars were first noticed on July 22, and when

Mr. Maxwell returned on July 25, he found that the visitation was practically over, very few worms being found.

The suddenness of the attack is well indicated by a report which Mr. Edson prepared for Mr. Maxwell. On the morning of July 21 a few holes were observed on the leaves. These were attributed to one of the little leaf-beetles. The next morning the farm foreman reported worms on the beets, and examination showed that four plats were more or less infested. In the afternoon one plat was seriously damaged, and by night half of its foliage was destroyed, the remaining three plats being also quite seriously damaged. Paris green, Persian insect powder, and white hellebore were applied to a limited number of plants late in the evening. The Paris green was applied in the proportion of one teaspoonful to a gallon of water, and the insect powder and white hellebore were sprinkled as powders by hand over the beet tops. The next morning it was estimated that the Paris green had killed 10 per cent of the worms on the plants to which it had been applied, the Persian insect powder 50 per cent, and the white hellebore none. On account of lack of facilities for distributing the powder on a large scale, the Paris green solution was then sprinkled over plat A in the morning and plat B in the afternoon, 6 pounds of the green being used on 2 acres in the same proportion as in the preliminary experiment of the night before. In the evening the number of worms had apparently increased at least 20 per cent, according to Mr. Edson's statement, except upon plat A, where the Paris green was beginning to operate. On the morning of the 24th the work of the caterpillars on plats A and B was checked but not stopped. Fifty per cent of the insects were dead upon plat A and less upon plat B. Check plats were still being injured. In the evening a comparatively small number of healthy caterpillars could be found upon the plats treated with Paris green. The next morning on no plant could more than one or two worms be found and many were entirely free. The untreated plats, however, were in much worse condition than the evening before. At noon more Paris green was secured, and one of the untreated plats was sprinkled. July 27 the damage was over.

Mr. Edson in his report calls attention to the extreme activity of the caterpillars and their seemingly incessant work. They chose the top leaves first, but when these were exhausted they worked toward the bottom and eventually ate the stem and footstalk of the leaf. When two caterpillars met they would strike viciously at each other with their heads a number of times, and frequently the caterpillar struck the leaf in the same way when unmolested. The efficacy of the Paris green treatment was abundantly proved, but the caterpillars were nearly full grown at the time of the first application and disappeared within a very few days even upon the untreated plants.

Mr. Lawrence Bruner, who has paid particular attention to the insects injurious to the sugar beet, gave some study to this species. From his report it appears that a few of the caterpillars were noticed during the summer of 1891 upon beets growing in the vicinity of Grand Island, Norfolk, and some of the adjoining towns which supply beets for the two factories in Nebraska. The present summer they again made their appearance in these same localities as well as at the Government station at Schuyler. More damage was done at the latter point than at any of the others. After the disappearance of the destructive brood a special inspection of the beet plats at the State Experiment Station at Lincoln resulted in the finding of a number of specimens of the caterpillar, and a little later it was found that at Norfolk, Pipe

Center, and Genoa a number of fields had been stripped of their leaves. Other localities where beets were planted for the first season were visited, and while the worms were found, they were in much smaller numbers than where beets had been grown last season. The following facts were gathered by Mr. Bruner from conversation with various persons interested in the cultivation of the beets.

The web-worms were most abundant at a distance from sheltered localities bordering groves, and were most numerous upon high ground, hilltops, and slopes, rather than upon flat ground. They were never plentiful on a piece of ground planted to beets for the first time, unless it adjoined one that was cultivated in beets the year before. They were more abundant in the middle of large fields than in small ones, and also in fields that were allowed to run to pigweed (*Amarantus* sp.) the preceding year than in fields where these weeds were kept down. Sandy soil was apparently more favorable to their increase than heavier soil.

LIFE HISTORY.

The life history of the insect has been followed through only a part of the season, but there are certainly two annual generations, and probably three if not four. The July brood is a short-lived one, and but two weeks are required between the maturity of the caterpillars transforming the latter part of July and the appearance of the moths, which couple and soon lay eggs for another generation. The caterpillars of the July brood transform to chrysalids almost immediately after entering the ground. Such, however, was not the case with the caterpillars of the last brood. With this the chrysalis state is normally not assumed for some time, and probably not until the ensuing spring. Cocoons received September 19 from Mr. Edson, at Schuyler, Nebr., contained larvæ which were full grown but somewhat shrunken, and these, at the date of writing (December 5), are still in the larval condition. Mr. Bruner, however, in breeding-cage experiments, finds that some of the August brood issue as moths during September and October, and he suggests that it is barely possible that there is another set of caterpillars produced by these stragglers during the fall, if the weather permits; but, as already shown, the majority of the August brood remain unchanged until the following spring. From the larvæ of the injurious brood received July 28 and August 2, the moths issued August 6, 8, and 12, while August 15 moths were received from Schuyler together with beet leaves bearing eggs.

The eggs (Plate VI, Fig. 2, *a*) are pale yellow, faintly rugose or indistinctly faceted, slightly polished, somewhat iridescent, almost circular and very flatly convex, and are deposited either singly or in a row of from two to five or more—in the latter case overlapping each other like scales.

The young larvæ are whitish in color, with polished black head and piliferous spots. The full-grown larvæ (Plate VI, Fig. 3, *a*, *b*, *c*) are yellowish white with a broad black mediodorsal stripe, and a still broader subdorsal stripe, the two fine lateral lines being also black. The piliferous warts are pale with a black ring, and the head is yellowish or marbled with black. The hibernating caterpillars make a burrow beneath the surface of the ground, but line it with silk, constructing an inner cocoon (Plate VI, Fig. 2, *d*), which is long, slender, slightly curved, and about three times as long as the larva itself. A somewhat similar cocoon (Plate VI, Fig. 2, *c*), but a little over half the length, is constructed by the midsummer brood.

This insect is a close ally of the so-called garden web-worm, which was treated in the report of the Entomologist in the Annual Report of the U. S. Department of Agriculture for 1885, on pages 265–270. The moth (Plate VI, Fig. 1) is somewhat darker in general effect, and the difference in the markings may be seen by comparing Fig. 1, Plate VI, with Fig. 3, Plate VI, of the 1885 report. The caterpillar is also darker, and the preponderance in the longitudinal markings shows a decided difference from the normal form of the ordinary garden web-worm. It also differs in the apparent absence of the spinning habit in the immature larva.

It is one of the insects which, during my early visits to Kansas, and particularly in 1873, was not uncommonly found on *Amarantus blitum*, and was reared to the imago from larvæ upon this plant.

THE SHOT-BORER OR PIN-BORER OF THE SUGAR CANE.

(*Xyleborus perforans* Woll.)

Order COLEOPTERA; Family SCOLYTIDÆ.

[Plate VI, Fig. 4.]

INJURY IN THE WEST INDIES.

Our neighbors in some of the British West Indies have been considerably exercised during the season by the appearance in great numbers of a small Scolytid beetle in sugar cane. This insect has apparently done a great deal of damage, and considerable energy has been displayed in investigating its habits and in an attempt to remedy the evil. Although the question of specific identity in the group of Scolytidæ to which this beetle belongs is a very difficult one, there is every reason for the belief that the same insect occurs in this country, and I have, therefore, felt much interest in the investigation of the insect, and have, through correspondence, endeavored to ascertain all the facts in the case lest we may ere long have to deal with the same insect in the sugar-cane fields of Louisiana. Although the matter was first brought to the attention of naturalists little more than a year ago the literature is already rather extensive. Miss E. A. Ormerod, honorary consulting entomologist of the Royal Agricultural Society of England, has published a pamphlet, entitled "A Few Preliminary Observations on the Sugar-cane Shot-borer Beetle: its Habits and its Recent Spread in the West Indian Islands; with some suggested Measures of Prevention and Remedy." Mr. W. F. H. Blandford, in the Bulletin of the Royal Kew Gardens for July and August, 1892, has an extensive article on the "Sugar-cane Borers in the West Indies," which has been reprinted in the Official Journal of the Central Agricultural Board of Trinidad for October, 1892. Mr. J. H. Hart, in the August and September number of the latter journal, has an article entitled "Trinidad Cane Borers and Fungi." The committee of the Trinidad Field Naturalists' Club has published a report in the Journal of the Club for June, 1892, while numerous articles have appeared in the Barbados "Agricultural Reporter," the Port of Spain "Gazette," one of the Kingston, St. Vincent, papers, and in the "Museum Notes" of the Institute of Jamaica, as well as other West Indian journals.

HABITS OF THE SPECIES.

The known habits of allied species in this country justified the inference that the damage to sugar cane by this insect must follow some prior injury, and that if (as so positively stated to me by several well-informed correspondents) the insects fed upon sound and healthy canes this habit was to be looked upon as a modification of the more normal habit common to the family of feeding upon previously injured or unhealthy vegetation. As is well known, the common *Xyleborus dispar*, for instance, breeds preferably in wood in a moribund condition. Lacking a supply of such food, however, and particularly if the insect has developed in considerable numbers, the beetles will attack sound and healthy trees. The obvious remedy is to prepare a more normal food by girdling or otherwise damaging a worthless tree and then destroying such by fire at the proper time after the beetles have developed in healthy wood and have flown by preference to the diseased wood for purposes of oviposition.

The correspondence in reference to this sugar-cane pin-borer brought out the fact that while the sugar-planters on the island of Trinidad had in former years been in the habit of burning the bagasse or "megass" (cane refuse from the sugar mills), this practice has been discontinued of late. Here, in my opinion, lies one of the chief causes of the difficulty, and I have suggested, as a point well worth investigation, that this unburned bagasse, by encouraging undue increase of the species, was the superinducing cause of the attacks in the fields. It also occurred to me that, after cropping, the cut ends of the cane stumps would form desirable places for oviposition* and that, as before suggested, injury by the Xyleborus would be very apt to follow damage by any of the other insect or fungus enemies of the cane.

The investigations which have been made since my correspondence began have resulted in the partial discrediting of the idea that the insects ever attack perfectly healthy cane. Mr. Herbert H. Smith, who has studied the trouble on the spot in the island of St. Vincent, informs me that from his observations the Xyleborus invariably follows the attacks of the larger sugar-cane borer (*Diatræa saccharalis*). Mr. T. D. A. Cockerell, the curator of the Museum at Kingston, Jamaica, from his correspondence with observers in different islands, is also of the opinion that the Xyleborus damage is consequent upon prior damage by either the larger sugar-cane borer or the sugar-cane weevil of the genus Sphenophorus, which is common in certain localities. Mr. J. H. Hart, while admitting these points, places considerable weight upon the primary attack of a fungus known as *Trullula sacchari*, while Mr. H. Caracciolo is inclined to believe that this fungus only follows "sun-scald," the result, however, being the same, viz, the advent of the Xyleborus. Other suggestions have also been brought out. Mr. Hart considers that the method of propagating canes year after year from the same stock, the same field, and often from abandoned lands, is liable to induce constitutional weakness. Mr. G. W. Smith, of Grenada, believes that the beetle follows the attacks of other insects, but thinks that there is a probability that these depend upon the canes being constitutionally weak. One member of the committee of the Trinidad Field Naturalists' Club expresses himself as believing that owing to abnormal conditions of weather the canes this year are not perfectly healthy,

*It is interesting to note in this connection that Mr. Hart subsequently stated that seedling canes are not attacked. If this should prove to be generally true our suggestion is an important one.

and that thus the conditions brought about are favorable not only to this beetle but to the other cane enemies.

Mr. W. F. H. Blandford, who is himself a competent student of Scolytidæ, after carefully considering the facts which have been brought forward, and among them the opinions just mentioned, gives a summary of his conclusions, which I quote in full:

(1) The attacks of *Xyleborus perforans* are not independent of the health or condition of the canes.

(2) No one single cause will account for them in the different islands.

(3) A constitutional weakness of the canes is a favoring circumstance.

(4) Previous attacks of other borers are another, which may, however, depend on 3.

(5) In Trinidad excessive multiplication may possibly have had something to do with it, but this multiplication must follow antecedent favorable circumstances.

(6) The effects of fungoid disease and of drought upon the attacks require more consideration before they can be accepted as furthering them. There is, however, no reason why these causes, if present, should not operate.

(7) There is reason to suppose that the beetles are attracted to any cane which has soured.

SUGGESTED REMEDIES.

The best of the remedial measures which have been suggested are:

(1) The growing of varieties of cane which have been found to be more or less immune—viz, Transparent, Ribbon, and Caledonia Queen.

(2) The destruction of other sugar-cane pests. The investigation by Mr. Howard in 1882 showed that it is not difficult to keep the larger sugar-cane borer in check by the careful selection of seed cane, by the burning of trash cane and the keeping down of volunteer stocks, and by the laying down of seed cane in furrows instead of keeping it in flat or open mat. With the Sphenophorus we have had no experience.

(3) The remedies just mentioned for the larger sugar-cane borer will be direct remedies also against the Xyleborus, and consequently the burning of bagasse and of the canes which are so badly infested as to be unfit for the mill will result in the reduction of the numbers of the insects.

(4) Cutting the canes close, so as to avoid long stumps, is an excellent suggestion of Mr. Blandford's.

Having once succeeded in greatly reducing the possibility of the breeding of the insect in numbers in or about the fields, an investigation should at once be instituted as to the other food habits of the insect. It is probable that other vegetation, particularly when in a dying condition, will harbor the beetle, and will when present constitute a constant source of supply.

THE TECHNICAL NAME OF THE INSECT.

Considerable confusion has arisen on account of my identification of the insect as *Xyleborus pubescens* Zimmerman and the English determination of the same insect by Messrs. Blandford and Waterhouse as *X. perforans* Wollaston. The determination in this country was made on the authority of my assistant, Mr. E. A. Schwarz, who is of the opinion that except by actual comparison with Wollaston's types, and particularly of the male sex, a positive determination of the species as *X. perforans* is impossible. The species of this particular group of Scolytidæ are, as has been admitted by their closest student, Dr. Eichhoff, almost impossible to separate, and quite so without the males. The earlier descriptions are entirely insufficient, and it is not at all certain that it would not be advisable to adopt as the name of this species the Fabrician *X. ferrugineus*, since the types came from this same region (Cuba). The Fabrician description is certainly as good as that of Wollaston. I have only seen females from sugar cane, and from these the figure for this report has been drawn. These are indistinguishable from the species known as *X. pubescens* Zimm. in this country, but as just indicated, the characters of this sex alone do not permit positive conclusions. The form bred from pine, and from which the male is described by Mr. Schwarz in Entomologica Americana (Vol. II, p. 41), will be held as the true *pubescens* in this country. It remains to be seen whether the males from sugar cane will correspond with the males of this form. In the mean time, I have accepted temporarily the scientific name by which the insect has been designated in the English publications.

THE INSECTARY OF THE DIVISION.

[Plates IX, X, and XI.]

Ever since I have been connected with the Department it has been one of my hopes and desires to have a building properly constructed and fitted for the experiments and studies incident to the work of the division. The surroundings of the Department, while in some respects favorable to entomological studies, especially in the variety of the trees and shrubs represented on the Department grounds, are in other respects quite unfavorable. Experience has shown that nothing in the way of gauze coverings can be kept with security upon the grounds themselves, which are open to the public and to the curiosity and innate tendency to destruction of the small boy. For some years we used the old star house which was brought back from the Paris Exposition of 1878. It was, however, poorly fitted for the purpose and became insufferably hot during the summer months. My efforts to get an appropriation for an insectary in past years proved unavailing, and it was not until toward the close of the fiscal year 1891 that, owing to the failure of other projects, the appropriations of the division justified an expenditure sufficient to put up a special building. Even then there were a good many difficulties to be overcome before the money could be spent for this purpose; but the outcome, while by no means the ideal insectarium which I have wished to build, and necessarily kept within a limited price, yet answers a very good purpose and has greatly facilitated the work of the division. A brief description of this building, which was completed a year ago, may prove of interest to readers of this report, and especially to those at the different experiment stations who contemplate preparing some similar structure. The accompanying plans and views will convey a sufficiently correct idea of the building and will require but little further explanation.

The insectary consists of a neat story-and-a-half brick and stone structure 38 feet front by 21 feet deep, connected with a conservatory 21 by 45 feet, and is heated throughout by steam from the plant in the Department building.

The basement which underlies the whole of the brick structure is divided into three rooms, and a commodious hall, a portion of which can conveniently be inclosed as a dark room for use in apiarian experiments, should it be decided to do anything in this line at Washington, or for the storage of hibernating pupæ.

On one side of the hall is a large room 16 by 21 feet, which has been filled up with wall cases, and is used as a storeroom for the large number of appliances which have accumulated for use in the laboratory and in the conservatory, and also as a room in which most of the more modern styles of insecticide machinery are kept on exhibition. On the opposite side of the hall are two smaller rooms, one of which may be used as a cold room, while the other is used for experimental work with insecticides, and has been provided with work benches, wall cases, gas, water, balances, and most of the other conveniences for carrying on this most important branch of applied entomology.

The first floor is divided into two large well-lighted offices and a wide central hall. These rooms are used by the assistants in charge of the experimental work, and have been filled up with shelving for the bred material, bookcases, desks, microscopical apparatus, etc.

The second story contains a dark room for photographic purposes, and a bacteriological laboratory, which has been supplied with desks, tables, shelving, gas, water, etc., and with many of the best microscopical and bacteriological appliances, under the supervision of Mr. F. W. Mally.

The conservatory is an iron and glass superstructure with brick and stone foundation, and contains all the most modern improvements for shelving, heating, and ventilating. It is divided into two equal sections by a transverse glass partition, and each of the sections is heated independently, so that the one may be left at the normal outdoor temperature while the other may be heated to any degree desired. One section is used as a hibernating room and the other as a forcing room. The latter is provided with slate plant tables along the sides on which are kept the potted plants and many of the breeding cages. A brick wall about 1 foot high has been built just within the concrete walk, which extends alongside the plant tables, and the inclosed space filled with rich soil, in which from time to time will be planted such small trees and shrubs as support insects whose life histories are to be studied. The hibernating room is much the same as the forcing room, except that the central space is occupied by two slate plant tables with a narrow walk between. Both conservatory and offices have been supplied with the most improved arrangements for studying insects, as breeding cages, root cages, jars, etc., and several pieces of apparatus have been designed, and have proved so satisfactory as to deserve special mention.

For rearing aquatic insects two large glass aquaria have been so connected with each other and with the water pipes of the building, that a continuous supply of running water is supplied in such a manner as to give the effect of small cascades.

EXPLANATION OF PLATES TO REPORT OF ENTOMOLOGIST.

[Where figures are enlarged the natural sizes are indicated in hair lines at side, unless already indicated in some other way on plate.]

Explanation to Plate I.

THE POTATO-TUBER MOTH AND THE EGGS OF THE OX WARBLE.

Fig. 1. *Lita solanella:* *a*, eggs in natural position under skin of potato; *b*, outline of egg from above; *c*, same from side; *d*, section of burrow of larva; *e*, larva from above; *f*, larva from side; *g*, abdominal segment of same from side; *h*, same segment from above; *i*, pupa; *k*, burrow to surface exposed; *l*, moth—*a*, *d*, *k*, natural size; *e*, *f*, *i*, *l*, enlarged; *b*, *c*, *g*, *h*, still more enlarged (from Insect Life).

Fig. 2. *Hypoderma lineata:* *a*, eggs attached to hair; *b*, *c*, *d*, dorsal, ventral and lateral view of eggs; *e*, embryonic or first stage as seen in egg; *f*, *g*, mouth-parts of same; *h*, anal segments of same—*a*, *b*, *c*, *d*, *e*, enlarged; *f*, *g*, still more enlarged; *h*, still more enlarged (after Riley).

Explanation to Plate II.

THE OX WARBLE.

Fig. 1. *Hypoderma lineata:* *a*, second stage of larva from back: *b*, *c*, enlargement of extremities; *d*, ventral view of third

Explanation to Plate II—Continued.

THE OX WARBLE—Continued.

stage with details of extremities at *e* and *f*; *g*, dorsal view of mature larva with enlargement of anal spiracles at *h*; *i*, same, lateral view—enlarged (after Riley).

Fig. 2. *Hypoderma lineata:* Diagram of spiny armature (after Brauer).

Fig. 3. *Hypoderma bovis:* Diagram of spiny armature (after Brauer).

Fig. 4. *Hypoderma lineata:* Female enlarged (after Riley).

Fig. 5. *Hypoderma lineata:* *a*, ovipositor of female from side; *b*, tip of same from below—enlarged (after Riley).

Explanation to Plate III.

ROSE SAW-FLIES.

Fig. 1. *Cladius pectinicornis:* *a*, larva; *b*, female pupa; *c*, female adult; *d*, cocoon—enlarged; *e*, head of larva; *f*, antenna of male—still more enlarged (after Riley).

Fig. 2. *Cladius pectinicornis:* *a*, outline of egg; *b*, portion of leaf showing eggs *in situ* and work of young larvæ; *c*, newly hatched larva; *d*, *e*, lateral and dorsal aspect of middle segment of same; *f*, larval claw; *g*, rose leaf showing nature of defoliation—all enlarged except *g* (after Riley).

Fig. 3. *Emphytus cinctus:* *a*, adult female; *b*, full-grown larva; *c*, head of same; *d*, work on plant; *e*, *e*, young larvæ at work; *d*, *e*, natural size; *a*, *b*, enlarged; *c*, still more enlarged (original).

Explanation to Plate IV.

THE STRAWBERRY WEEVIL.

Fig. 1. *Anthonomus signatus:* *a*, *b*, strawberry spray showing work in bud and stem—natural size; *c*, outline of egg; *d*, larva; *e*, head of same; *f*, pupa; *g*, open bud showing location of egg on left and punctures made by snout of beetle on petals—*c*, *d*, *f*, *g*, enlarged; *e*, still more enlarged (after Chittenden).

Fig. 2. *Anthonomus signatus:* Spray of strawberry showing beetles at work—natural size (after Riley).

Fig. 3. *Anthonomus signatus:* Adult beetle—enlarged (after Chittenden).

Fig. 4. *Anthonomus signatus:* Adult beetle from side—enlarged (after Riley).

Fig. 5. *Catolaccus anthonomi:* Enlarged (after Chittenden).

Explanation to Plate V.

NATURAL ENEMIES OF IMPORTED ELM LEAF-BEETLE.

Fig. 1. *Camptobrochis grandis:* Adult from above enlarged showing still greater enlargements of head and hind tarsus (original).

Fig. 2. *Camptobrochis grandis:* Nymph—enlarged (original).

Fig. 3. *Eriphia* sp.: *a*, adult female from above—enlarged; *b*, head of male from the front; *c*, antennæ; *d*, mouth-parts—still more enlarged (original).

Fig. 4. *Cyrtoneura stabulans:* *a*, larva—enlarged; *b*, head of same from below; *c*. same from side—still more enlarged; *d*, thoracic spiracles of same still more greatly enlarged; *e*, anal stigmatal plate—enlarged; *f*, adult female from above; *g*, head of male from front—enlarged; *h*, mouth-parts of same; *i*, antennæ of same—still more enlarged (original).

Explanation to Plate VI.

Fig. 1. *Loxostege sticticalis:* Adult moth—enlarged (original).

Fig. 2. *Loxostege sticticalis:* *a*, eggs *in situ* on leaf of sugar beet—natural size; *b*, outline of same—enlarged; *c*, pupa in open cocoon; *d*, hibernating larva in its cocoon—natural size; *e*, anal segment of pupa—enlarged (original).

Fig. 3. *Loxostege sticticalis:* *a*, full-grown larva from above—enlarged; *b*, *c*, dorsal and side views of middle segment of same—still more enlarged (original).

Fig. 4. *Xyleborus perforans:* *a*, adult beetle from above—enlarged; *b*, antenna of same—still more enlarged (original).

Explanation to Plate VII.

Fig. 1. *Bruchus obtectus:* *a*, eggs in natural cluster within pod; *b*, portion of pod showing point of oviposition; *c*, full-grown larva; *d*, head of same; *e*, adult beetle from side; *f*, antenna of same; *g*, prothorax and scutellum of same; *b*, natural size; *a*, *c*, *e*, *g*, enlarged; *d*, *f*, still more enlarged (original).

Fig. 2. *Bruchus obsoletus:* *a*, adult from side; *b*, antenna of same; *c*, prothorax and scutellum of same; *a*, *c*, enlarged; *b*, still more enlarged (original).

Fig. 3. *Tephrosia virginiana:* food-plant of *Bruchus obsoletus:* *a*, flower; *b*, seed pods and foliage; *c*, open pod—natural size (original).

Explanation to Plate VIII.

BEAN AND PEA-WEEVILS.

Fig. 1. *Bruchus obtectus:* *a*, first larva from side—greatly enlarged; *b*, thoracic processes of same; *c*, head from front; *d*, same from side; *e*, antenna; *f*, thoracic leg; *g*, rear view of tarsus; *h*, same, front view—still more enlarged (from Insect Life).

Fig. 2. *Bruchus obtectus:* *a*, adult beetle; *b*, infested bean, enlarged (after Riley).

Fig. 3. *Bruchus pisi:* *b*, adult beetle; *c*, full-grown larva; *d*, pupa—enlarged; *g*, pea showing exit hole—natural size (after Curtis).

Fig. 4. *Bruchus pisi:* *a*, egg in natural position on pod showing outline of tunnel to *b* between walls; *c*, young larva entering interior of pea; *d*, points of oviposition upon pod with dotted line indicating course of mining larva; *e*, first larva; *f*, antenna of same; *g*, thoracic processes of same; *d*, natural size—*a*, *b*, *c*, enlarged; *e*, still more enlarged; *f*, *g*, still more greatly enlarged (from Insect Life).

Explanation to Plate IX.

INSECTARY OF THE DIVISION OF ENTOMOLOGY—View from southeast.

Explanation to Plate X.

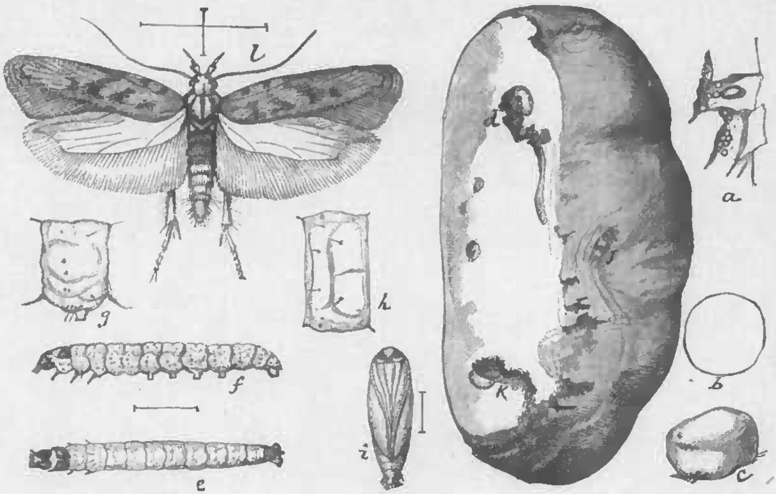
INSECTARY—Interior view of conservatory.

Explanation to Plate XI.

INSECTARY—View from northwest.

Explanation to Plate XII.

INSECTARY—Ground plan.



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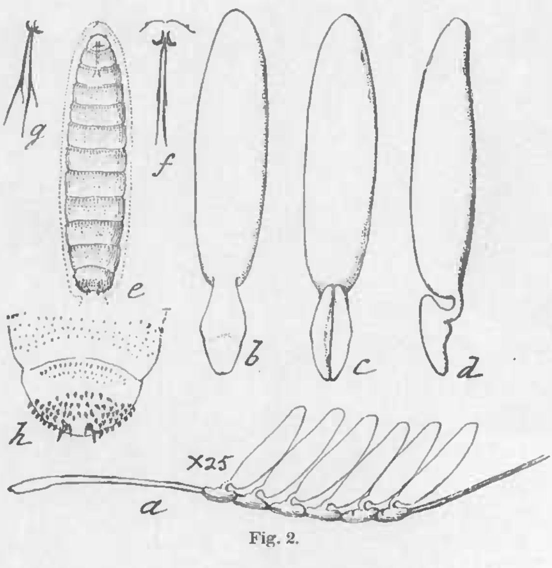
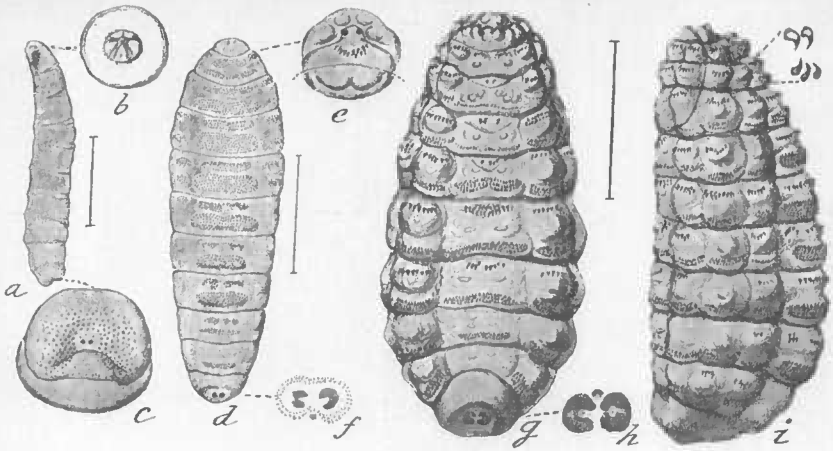


Fig. 2.

POTATO-TUBER MOTH AND OX WARBLE.



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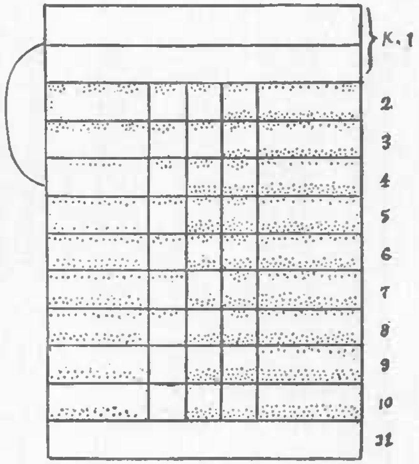

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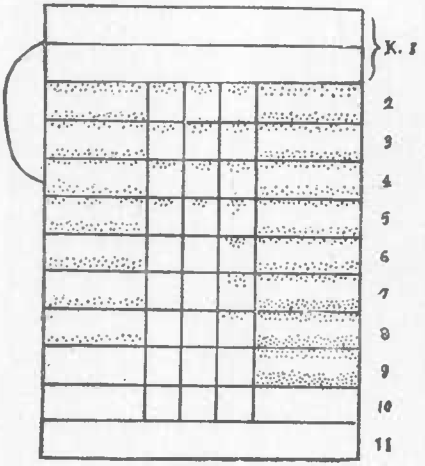

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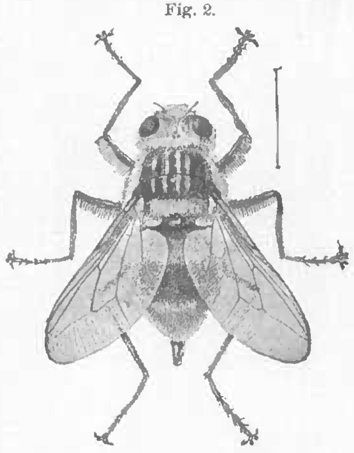
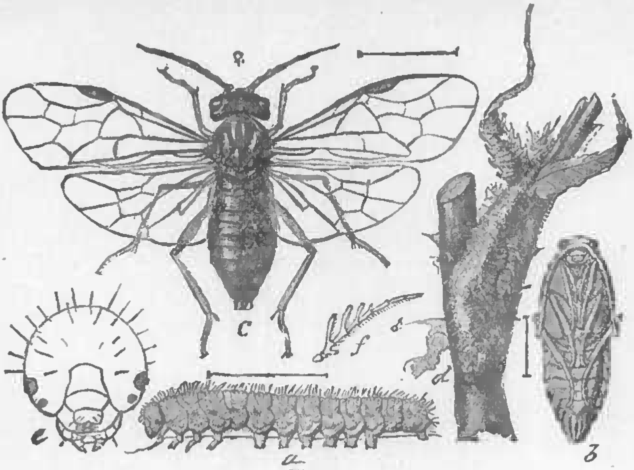


Fig. 4.

Fig. 5.

OX WARBLE.



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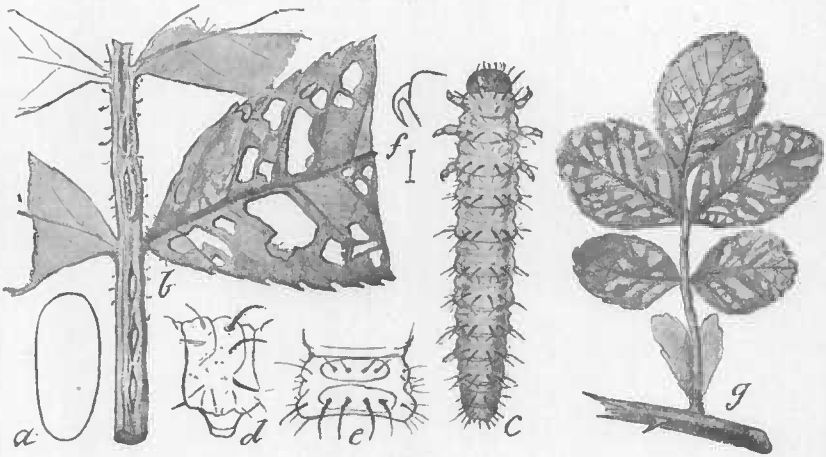


Fig. 2.

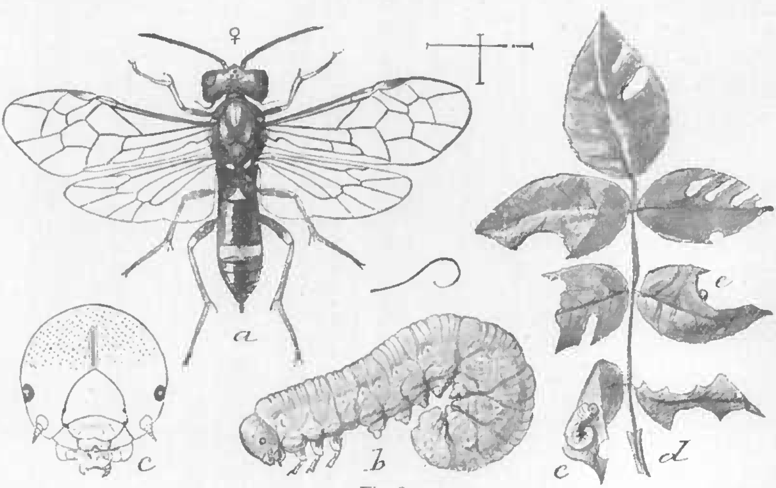
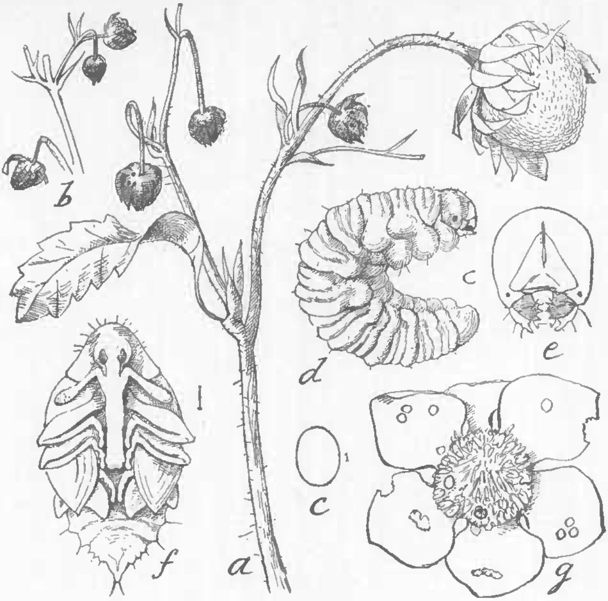


Fig. 3.

ROSE SAW-FLIES.



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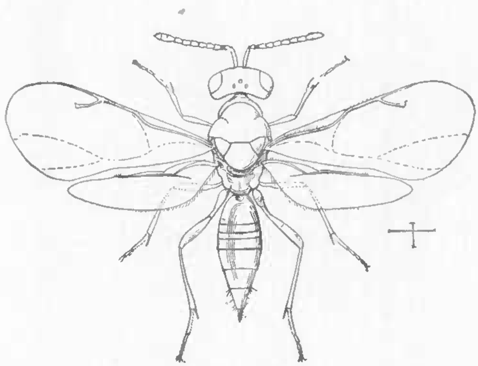

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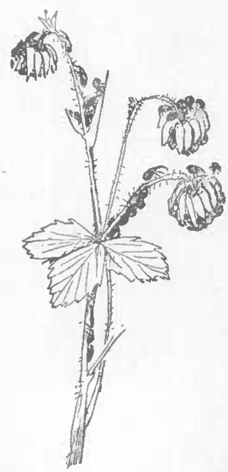

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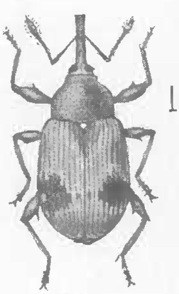

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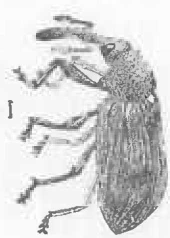
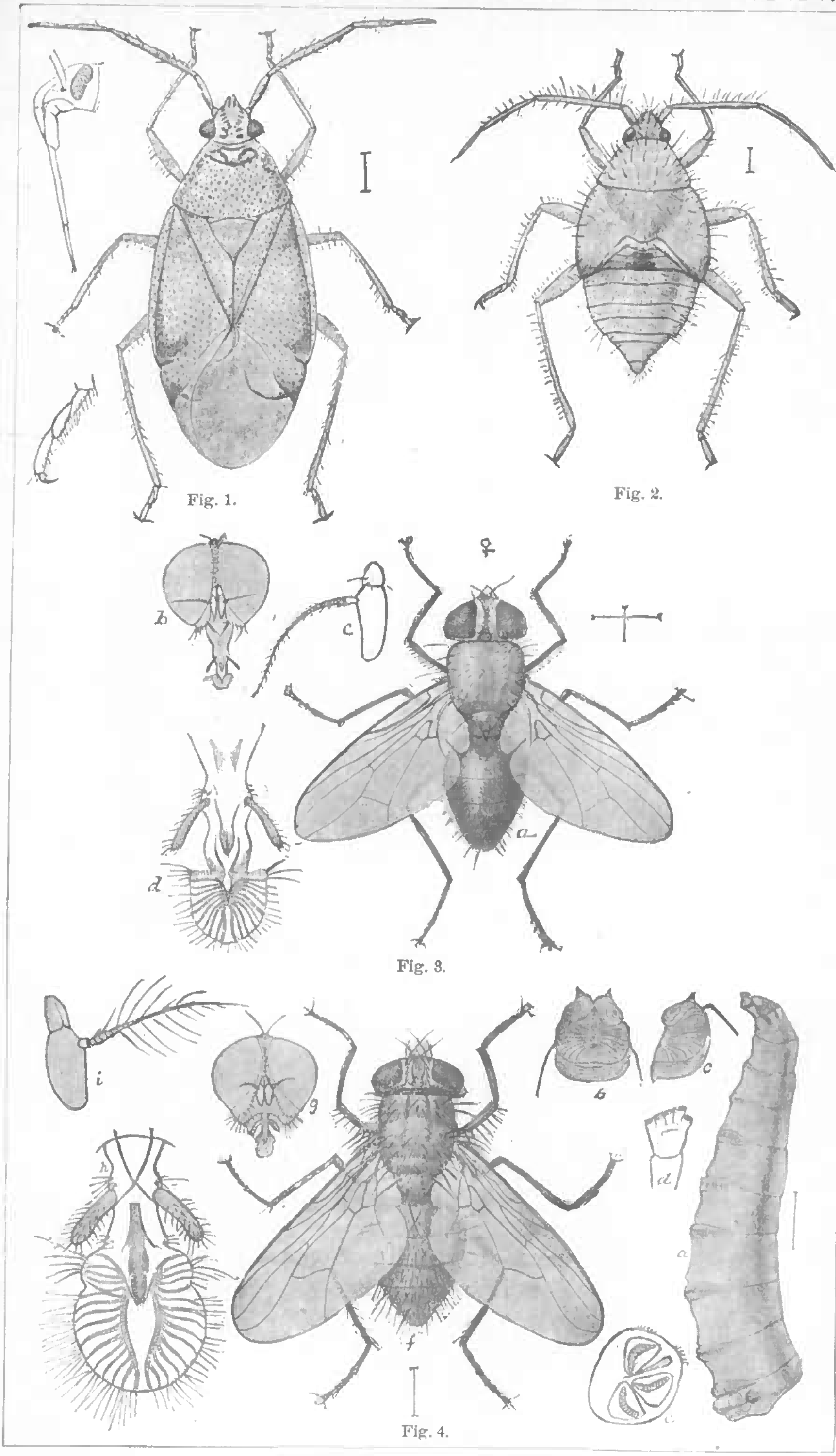
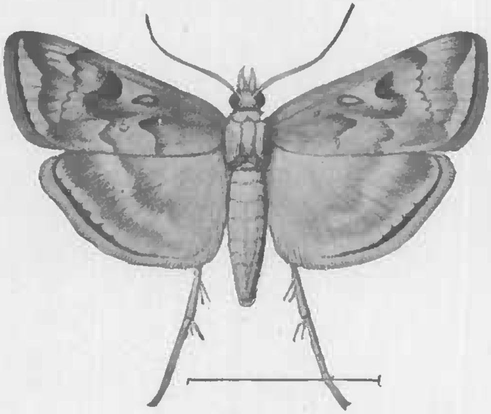


Fig. 4.

THE STRAWBERRY WEEVIL.



NATURAL ENEMIES OF IMPORTED ELM LEAF-BEETLE.



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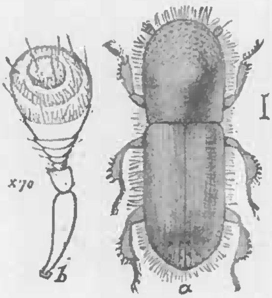

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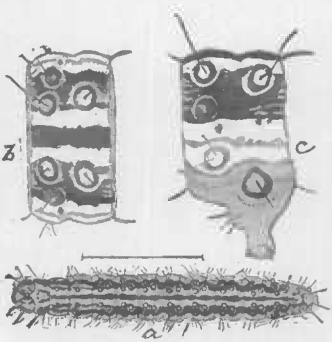

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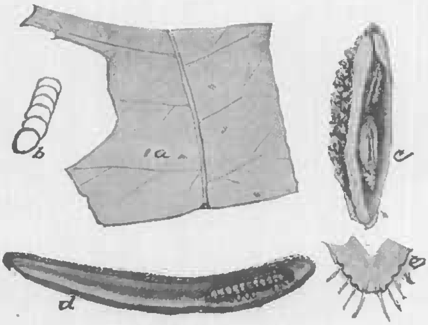
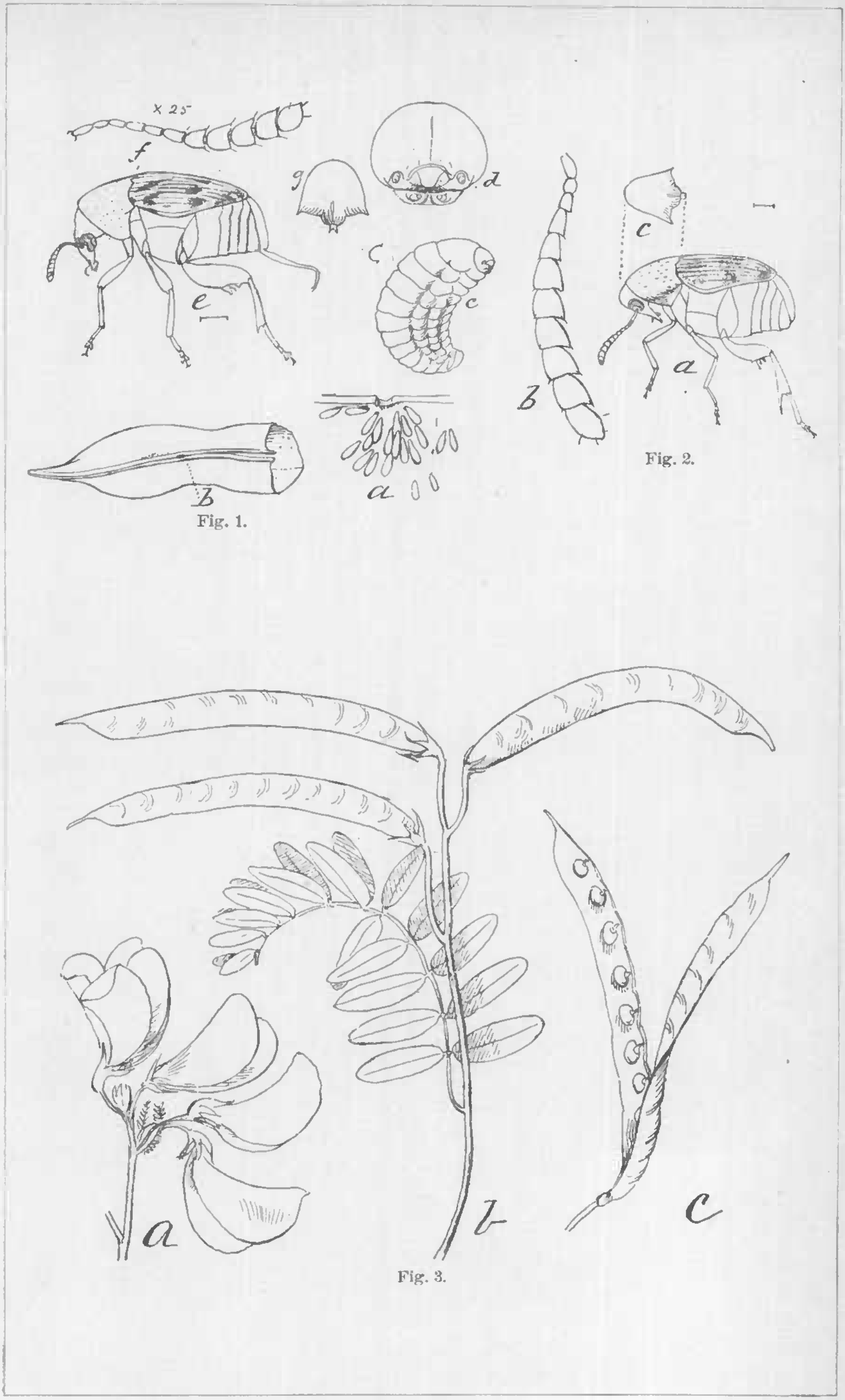
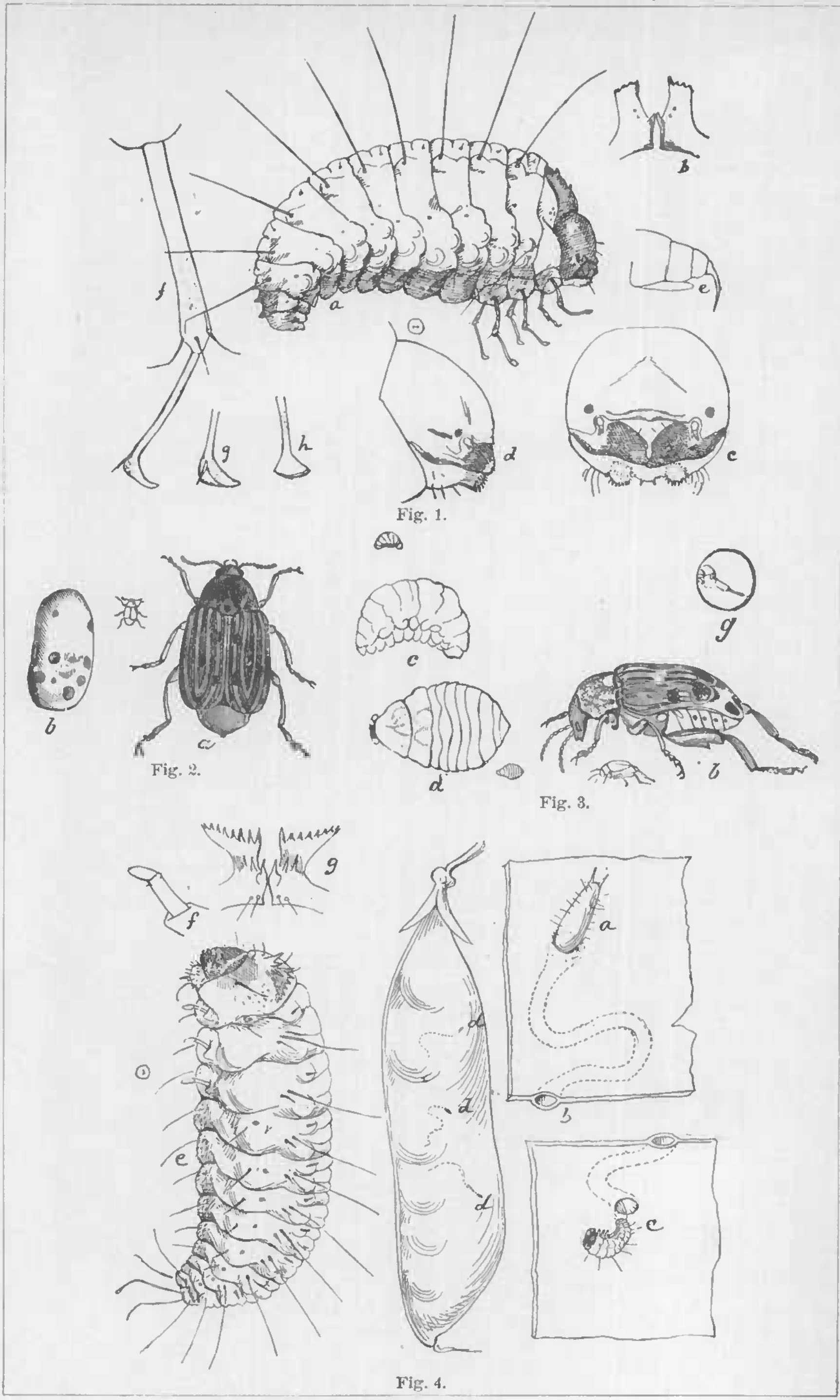


Fig. 2.

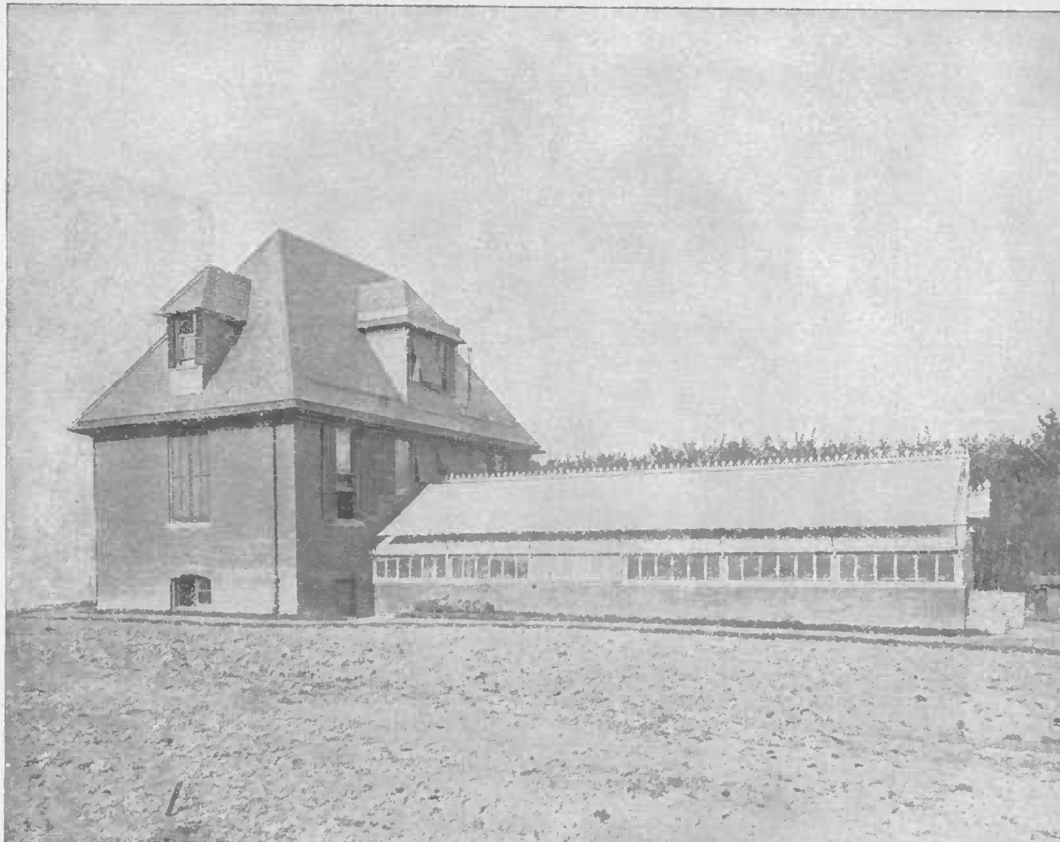
THE SUGAR-BEET CATERPILLAR AND THE SUGAR-CANE PIN-BORER.



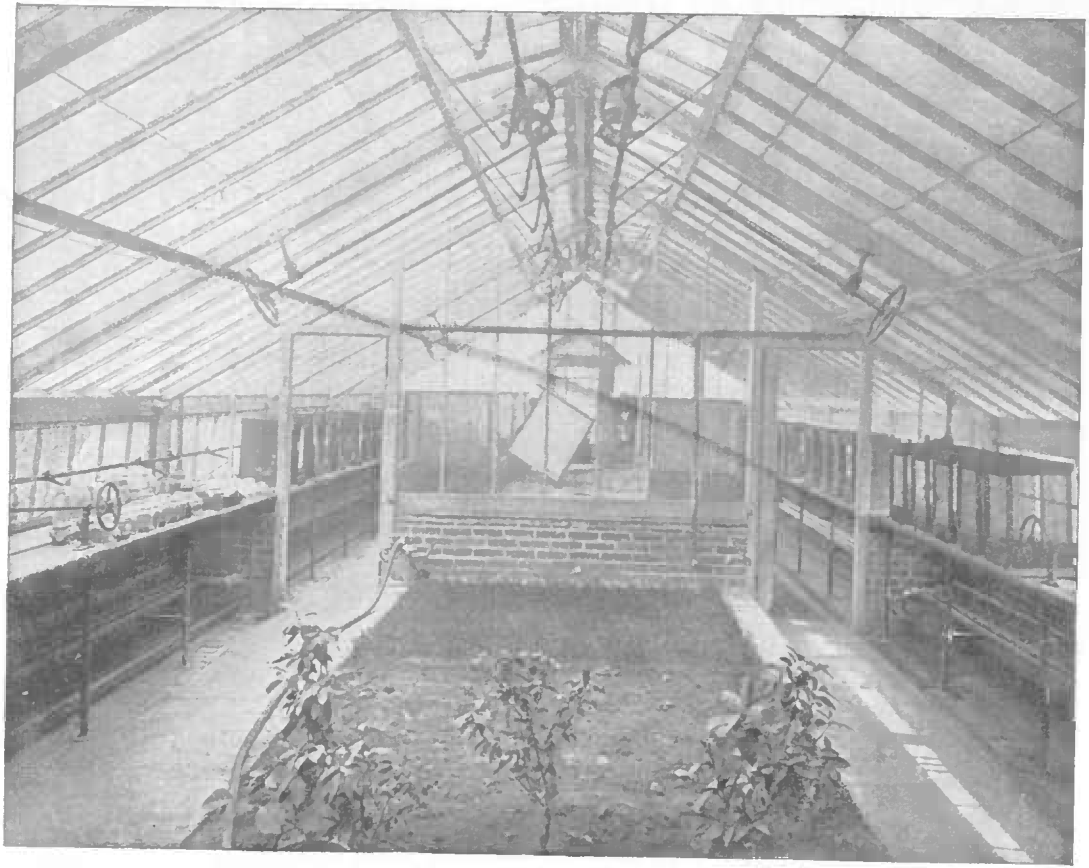
BRUCHUS OBTECTUS AND B. OBSOLETUS.



BEAN AND PEA WEEVILS.

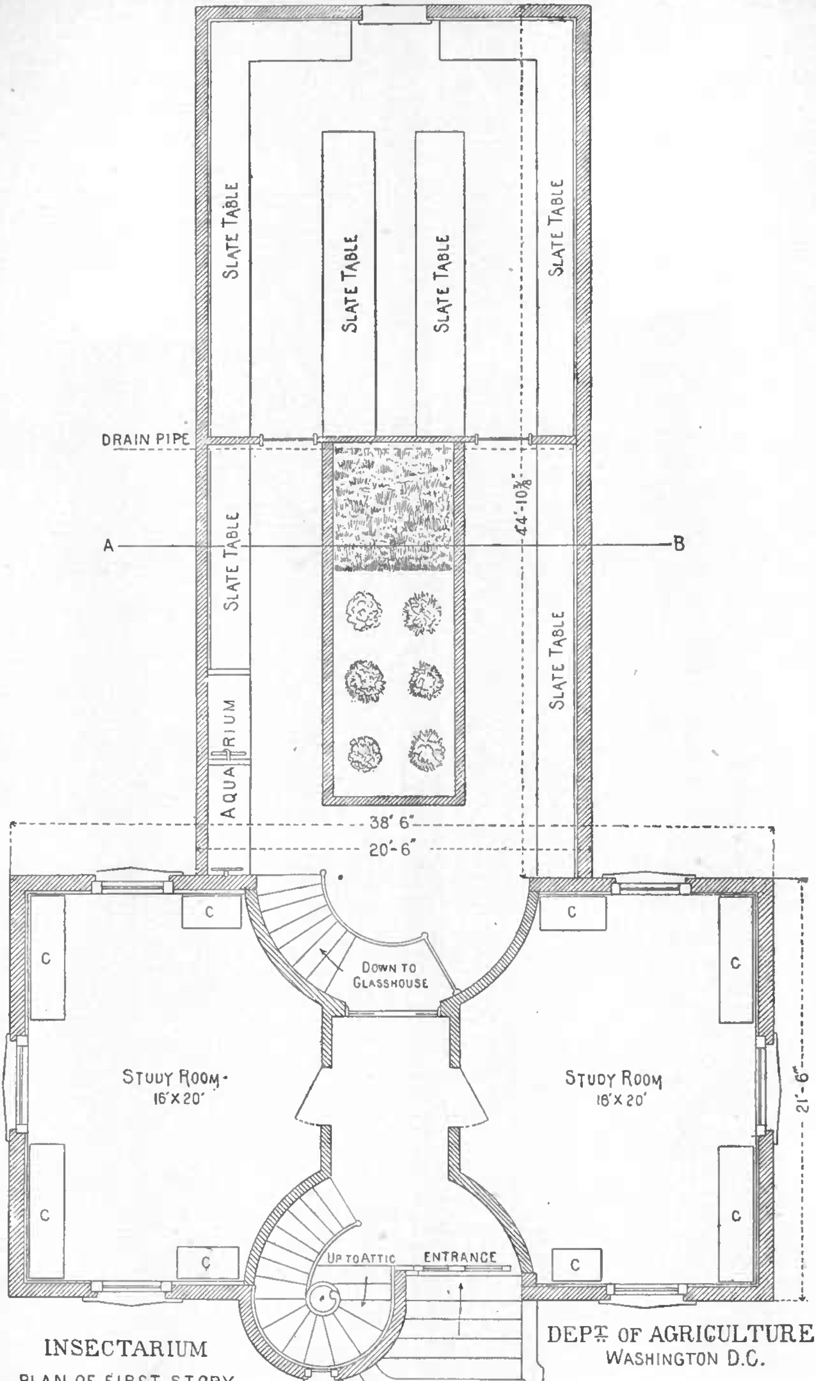


INSECTARY—VIEW FROM SOUTHEAST.



INSECTARY—INTERIOR VIEW OF CONSERVATORY.

Insectary—view from Northwest.



INSECTARY—GROUND PLAN.

REPORT OF THE ORNITHOLOGIST AND MAMMALOGIST.

SIR: I have the honor to submit herewith my seventh annual report on the work of the Division of Ornithology and Mammalogy, covering the year 1892.

The long delayed bulletin on hawks and owls is now passing through the press and will be distributed before the present report is issued. This bulletin was practically ready for the printer four years ago, as announced in previous reports, but was withheld for lack of funds to pay for the colored plates. Its publication being imperatively demanded, and no provision having been made by Congress to meet the cost of the illustrations, the division has undertaken to issue them at its own expense. In order to do this several field agents have been discharged and various other expenses have been curtailed, by which means enough money has been reserved to pay for engraving on stone and printing in ten or twelve colors an edition of 5,000 copies of twenty-six plates of the hawks and owls of the United States. The number of applications for the bulletin now on file indicates that the edition will be entirely inadequate to meet the demand and is likely to be exhausted soon after its appearance.

A bulletin on the prairie ground-squirrels or spermophiles of the Mississippi Valley region is nearly ready for the press, and will be followed shortly by a similar treatise on the pocket-gophers. Both are illustrated by maps showing the geographic distribution of each species. Colored drawings of the animals have been made, but the cost of reproduction unfortunately precludes their publication as intended.

The bulletin on crows will go to press as soon as the report on the insect contents of the crow stomachs is received from the Entomologist.

In the year 1892 more than 3,000 letters were received, many of them accompanied by schedules, reports, and miscellaneous notes, all of which were examined and filed for future reference. During the same time about 2,000 letters have been written, several hundred schedules distributed to observers and correspondents, and upwards of 500 packages sent out. Other routine work has consisted in the identification of specimens (about 300 separate lots or packages of which have been received), forwarding supplies to field agents, care of collections, correcting proof, compiling reference lists of publications useful in the work of the division, and miscellaneous work.

The division has been crippled during the year by the continued demands upon the time of its chief in connection with the business of the Bering Sea Commission,* and also by the reduction of funds consequent upon the reproduction of the colored plates for the hawk and owl bulletin already mentioned.

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* Dr. C. Hart Merriam and Prof. T. C. Mendenhall are the two Bering Sea Commissioners appointed by the President to serve without compensation pending the settlement of the questions submitted to the Tribunal of Arbitration to meet at Paris in February, 1893.

In closing, I have the honor to submit two recommendations, namely, (1) that provision be made for the employment of a competent artist so that the division will not be forced, as at present, to have its drawings made outside at the expense of the lump fund; and (2) that in the estimates for appropriations a sufficient increase be asked for to cover the cost of engraving and printing the plates necessary for the proper illustration of its reports and bulletins.

Respectfully,

C. HART MERRIAM,
Chief.

Hon. J. M. RUSK,
Secretary.

WORK OF THE YEAR.

OFFICE WORK.

Aside from the laboratory work, hereafter detailed under the head of "Economic Ornithology," the office force has been engaged in working up the results of investigations carried on in the field; in the preparation of reports thereon; in the identification of specimens received from field agents and correspondents, and in the care and arrangement of the collections.

PREPARATION OF REPORTS.

Report on the Death Valley Expedition.—This expedition was organized for the primary purpose of determining the actual boundaries of the natural life zones over the greater part of southern California and Nevada, and of studying the problems involved in the laws governing this distribution. The region was selected because of the exceptional advantages it offered for studying the distribution of animals and plants in relation to the effects of temperature and humidity at different altitudes from the bottom of Death Valley, which is below the level of the sea, to the summit of the High Sierra, culminating in the lofty, snow-capped peaks about Mount Whitney, at an elevation of nearly 15,000 feet. The close proximity of precipitous mountains and deep desert valleys often brings near together associations of species which in a more level country are characteristic of widely remote regions. In one place on the east side of the Sierra all the life zones of the North American continent from the plateau of Mexico to the Polar Sea may be crossed in traversing a distance of only 10 miles.

The area of which a biological survey was made comprises about 100,000 square miles in southern California and Nevada, situated between the parallels of 34° 30′ and 38° north latitude. It comprises also a small area in northwestern Arizona and southwestern Utah, thus including all of the torrid desert valleys and basin ranges between the High Sierra and the Colorado Plateau. The great Sierra Nevada was crossed along four distinct lines, and both slopes were worked with considerable detail. The Mohave Desert was traversed in various directions, and was worked to its extreme western end. Some work was done also in the Tejon Mountains—the westward continuation of the Sierra—in the Cañada de las Uvas, the San Joaquin Valley, and the coast region in Monterey and San Luis Obispo counties. Thus a broad zone, more than 200 miles in breadth and 500 in greatest length, stretching from the Pacific Ocean to the Colorado Plateau in Utah and Arizona, was covered by the operations of the division; and the present survey was practically connected with the biological survey of the San Francisco Mountain region in Arizona, made during the summer of 1889. (See North American Fauna, No. 3.)

One of the special objects of the expedition was the determination of the northern boundary of the Lower Sonoran life zone in the Great Basin—a matter of considerable importance, because this zone marks the northern limit of successful raisin production, and of the profitable cultivation of several subtropical fruits and other crops. The attempt to fix this boundary was undertaken with some misgiving by Mr. Bailey and myself, and was accomplished with great satisfaction after a horseback journey of about 1,700 miles. We succeeded in tracing the line in question completely across the deserts and barren ranges of the Great Basin all the way from the foot of the High Sierra in California to the foot of the Great Colorado Plateau in Utah; and, later in the season, other members of the expedition carried it northward along the west base of the Sierra.

The inexhaustible fertility of the soil in most parts of the arid region, and consequent high value of agricultural lands wherever water may be had in quantities sufficient for irrigation, taken in connection with the recent unparalleled development of the fruit-growing industry in southern California and Arizona, make it of the utmost importance to know beforehand just what crops are likely to prove most successful in each particular place, and point to the advantages that would result from mapping the boundaries of the areas fitted by nature for each of these products; for different parts of the Lower Sonoran zone are adapted not only to the successful cultivation of cotton and tobacco, but also to the needs of the orange, fig, and raisin grape.

In order to accomplish the objects of the expedition, it was necessary to make large collections representing the fauna and flora of numerous localities of different altitudes, to be studied in connection with the physical conditions and climatology of various parts of the several zones. The collections brought back and deposited in the U. S. National Museum comprise about 1,000 reptiles and batrachians, 1,000 birds, 6,000 mammals, 4,500 insects, and 25,000 plants, besides a number of fishes and mollusks from the hot springs of some of the interior deserts, and several hundred miscellaneous specimens. In working up these collections, the services of several naturalists of world-wide renown have been secured without expense to the Department, and their reports are now ready for publication.

The report of the expedition will be issued in two parts, the first comprising descriptions of the region traversed, discussion of the life zones and other general and theoretical matter, and the report on mammals; the second containing the special reports on birds (by Dr. A. K. Fisher), reptiles and batrachians (by Dr. Leonhard Stejneger), fishes (by President David S. Jordan and Prof. Charles H. Gilbert, of Leland Stanford, jr., University), mollusks (by Dr. R. E. C. Stearns), and the desert shrubs, yuccas, and cactuses (by Dr. C. Hart Merriam). Both parts are illustrated by plates and maps. The second part is now ready for the press; the first, for reasons already mentioned, is not finished but is being completed as rapidly as possible. A special report on botany has been prepared by Mr. F. V. Coville, botanist of the expedition, and will be published as a separate volume.

Reports on spermophiles and gophers.—From the agricultural standpoint the pocket-gophers and spermophiles or ground-squirrels are of very great importance. Throughout their extensive range, wherever the land is under cultivation, they are among the most destructive of mammals, feeding on growing grain, fruit, and garden vegetables to such an extent that the annual losses from their depredations must be counted by hundreds of thousands of dollars. Many States and Territories have paid large sums in bounties for their destruction without in the main materially reducing their numbers. Several years ago the division began a systematic study of these animals in the field, with a view to the early publication of one or more bulletins on the subject. This work has been pushed during the past year, and a bulletin on the spermophiles of the Mississippi Valley region is now ready for the printer. A similar bulletin on the pocket-gophers is nearly ready, and will be followed by others.

Report on the crow.—(See "Economic Ornithology.")

FIELD WORK.

As already stated, field work has suffered in consequence of the curtailment of funds incident to the publication of the colored plates of the Hawk and Owl bulletin; hence no attempt was made to continue the systematic biological survey carried on in the years 1889, 1890, and 1891. At the same time considerable good work has been accomplished, particularly in the region west of the Mississippi River. The most important field work of the year consisted in tracing the northern boundary of the Lower Sonoran zone from New Mexico to the Mississippi River. This area is one of the best marked and most important agricultural regions in the United States, embracing the cane-sugar, cotton, and subtropical fruit districts of the Gulf States and the Southwest. The work of the Death Valley Expedition determined the extent of the Lower Sonoran region in southern California and Nevada and carried its northern boundary from the Pacific coast eastward to southwestern Utah, while the biological survey of the San Francisco Mountain region, made in the summer of 1889, supplemented by subsequent field work, extended it across the Territory of Arizona.

The task of continuing the survey of this boundary easterly from New Mexico was assigned to the chief field agent of the division, Mr. Vernon Bailey, who had assisted me on previous expeditions in running the line in question from California to Arizona. Mr. Bailey and assistants visited many points in Mississippi, Louisiana, Texas, Oklahoma, Indian Territory, Arkansas, southern Missouri, and western Tennessee and Kentucky, securing data by means of which this important boundary has been located with much greater precision than has been heretofore possible.

The great Lower Sonoran region which spreads over considerable portions of California, Nevada, Arizona, New Mexico, and Texas, and thence, modified by moisture, stretches easterly over the Gulf and South Atlantic States to the mouth of Chesapeake Bay, comes into the southern United States from the table-land of Mexico. In order to ascertain more completely its affinities and agricultural capabilities a thoroughly competent field agent, Mr. E. W. Nelson, was sent to Mexico to study the native fauna and flora in connection with the agricultural resources of the country, and has gathered much information and material of great value.

Other field work has been done in California, Arizona, New Mexico, Texas, Colorado, North and South Dakota, Nebraska, Kansas, Iowa, Illinois, Kentucky, Tennessee, Mississippi, Alabama, Georgia, and the Carolinas, in the course of which the habits and geographic distribution of the various species of pocket-gophers and spermophiles or ground-squirrels have received special attention.

EXHIBIT AT THE WORLD'S COLUMBIAN EXPOSITION.

The division will be represented at the World's Fair by an exhibit illustrating both the work on the geographic distribution of species and that on the economic relations of birds and mammals. The main feature of the exhibit will be a model 20 feet in length and 10 feet in height, representing a mountain slope in the High Sierra of California, and showing the inhabitants of the different life zones from the subtropical deserts at the base to the arctic-alpine summit. On this slope the characteristic mammals, birds, and reptiles will be so assembled as to bring before the eye at a glance the successive faunas of the different elevations. In addition to this mountain slope, the results of the biological survey known as the Death Valley Expedition will be represented by a large model of the southwestern part of the United States south of latitude 38° and extending from southwestern Utah to the Pacific Ocean. This area is of peculiar interest, since the deepest depressions and the highest elevations in the United States are here found in close juxtaposition. The striking difference in altitude between the bottom of Death Valley and the summit of Mount Whitney (more than 15,000 feet), as well as the deep gorges of the Grand Cañon of the Colorado, the Yosemite Valley, and the Kings River Cañon are vividly brought out by the vertical scale, which is five times that of the horizontal. The fauna of the region will be represented by characteristic mammals, birds, and reptiles with appropriate surroundings. The exhibit will be accompanied by large photographs of typical desert scenery, and maps illustrating the geographic distribution of various species of mammals, birds, and plants.

The economic part of the exhibit comprises about thirty groups of mammals and birds, the subjects of which have been selected from species which are beneficial or harmful from an agricultural standpoint. Each group has been arranged to illustrate some feature in the life history of the species, and many are accompanied by an exhibition of their characteristic food.

NOTES ON SOME OF THE SPERMOPHILES AND POCKET-GOPHERS OF THE MISSISSIPPI VALLEY.

By VERNON BAILEY.

The destructive animals that form the subject of the present notes belong to two widely different groups—namely, the pocket-gophers, which have external cheek pouches and resemble the moles in living underground and throwing up little mounds along the courses of their subterranean tunnels, and the spermophiles or ground squirrels, that run about over the plains and prairies. Two species of pocket-gophers and five species of spermophiles inhabit the Mississippi Valley proper; both of the former and three of the latter are here considered. Their individual characteristics are so well shown in the accompanying colored drawings by Mr. Ernest E. Thompson that specific description is unnecessary.

SPERMOPHILES.

The name *Spermophilus*, meaning seed lover (from σπέρμα, seed, and φίλος, loving, fond), is particularly appropriate for these animals, since scarcely a seed or grain grows where they live that is not eaten by them. The following list includes only such species as they have been seen actually eating, or as have been found in their cheek-pouches or stomachs: Wheat, oats, barley, rye, corn, acorns, hazlenuts, seeds of mountain rice (*Oryzopsis micrantha*), feather-grass (*Stipa spartea*), pigeon-grass (*Setaria*), millet (*Setaria italica*), panic-grass (*Panicum*), wild sunflowers (*Helianthus*), pig-weed (*Chenopodium*), bind-weed and knotweed (*Polygonum*), puccoon (*Lithospermum*), ragweed (*Ambrosia artemisæfolia*), buffalo peas (*Astragalus caryocarpus*), *Hosackia purshiana*, black locust (*Robinia pseudacacia*), three species of prickly pear (*Opuntia missouriensis*, *O. fragilis*, *O. rafinesqui*), basswood seeds, seeds and berries of wild solanum, and strawberries. But their food is by no means restricted to seeds, for they are fond of various fruits, roots, and insects, and are known to eat lizards, mice, or any kind of fresh meat that may be accessible.

They eat various kinds of berries, the fruit of the prickly pear (*Opuntia rafinesqui*), green foliage of numerous plants, roots of sorrel (*Oxalis violacea*), and wild larkspur (*Delphinium azureum*); and also such insects as adult grasshoppers, crickets, and beetles, the larvæ of beetles and coleopterous insects; ants, eggs of insects, and chrysalids. Feathers of small birds were found in a few stomachs, though not in sufficient quantities to prove that birds had been eaten; the feathers may have been swallowed by accident while being carried to be used for the lining of their nests.

If one of their own species is found dead it is promptly eaten, thus proving that they are cannibals as well as generally omnivorous. An examination of the stomach contents of a large number of striped, Franklin's, and Richardson's spermophiles brings to light the interesting fact that these animals not only feed extensively on insects but that about 50 per cent of the stomach contents consist of this food alone. Moreover, most of the insects eaten are injurious to crops, as grasshoppers, crickets, and certain beetles. It is evident, therefore, that the spermophiles do much good, and not alone by preying on insects, for they destroy also large quantities of seeds of noxious weeds. At the same time it is not apparent that they do enough good to offset the harm. In many localities it is impossible to harvest a full crop unless the spermophiles are killed. They attack corn, digging up the seed as soon as it is planted; but the greatest mischief is done within a week or ten days of the time of sprouting, or until all the nutriment is drawn from the grain by the growing stalk. As a single spermophile digs up many hills of corn in a day, and as the animals often average four or five to an acre, it is not difficult to see that where they are numerous serious damage results. Large fields of corn are sometimes destroyed and have to be replanted several times. Wheat, oats, barley, and rye are taken in the same way. Nor is the damage confined to the time of planting, for as the small grains, begin to fill soon after blossoming the spermophiles cut down the stalks to reach the ovules, and in order to find the best heads cut a great deal more than they eat. And as the grain hardens they continue to cut it not only to eat on the spot but to carry off to their storehouses.

Troutmann, Bailey & Blampey N.Y.

STRIPED SPERMOPHILE, SPERMOPHILUS TRIDECEMLINEATUS Mitchell.

Trautmann, Bailey & Blampey NY

FRANKLIN'S SPERMOPHILE, SPERMOPHILUS FRANKLINII (Sabine.)

THE STRIPED PRAIRIE SPERMOPHILE (*Spermophilus tridecemlineatus*).

This well-known little animal is widely distributed throughout the central part of North America, ranging continuously from eastern Michigan to Wyoming and Colorado, and from central Texas north to the plains of the Saskatchewan in Canada, where it reaches latitude 55° N. In short, it occupies all of the prairie region east of the Rocky Mountains and is a true prairie-dweller, never entering a timbered region any more than the tree squirrels wander from their forest homes. But as the timber is cleared off and the country brought under cultivation it frequently follows the fields, and spreads to considerable distances from its original haunts. In Michigan forty years ago it was restricted to the few small prairies of the southern part of the State; to-day the southern half of the State is nearly as open as the original prairie country and the spermophiles have spread over it, reaching points as far north as Big Rapids in Mecosta County.

In Minnesota I have observed a similar extension of range, though on a smaller scale. When the timber was removed the spermophiles came in from adjoining prairies and were found about fields previously unoccupied by them.

The westward range of the species is limited by the Rocky Mountains, over which they do not pass, although they have penetrated well into the valleys on the east slope and climbed into some of the mountain parks.

FRANKLIN'S SPERMOPHILE (*Spermophilus franklini*).

Franklin's Spermophile is known locally under the names gray gopher, gray ground-squirrel, scrub-gopher, and several others, each distinctive enough in the limited region where it is used, but beyond the range of the species applying equally well to nearly half a dozen, more or less, similar animals which inhabit the Rocky Mountain and Pacific coast regions. Hence, the name Franklin's Spermophile, which can not be confounded with that of any other, is here adopted.

This spermophile inhabits the prairie region from the plains of the Saskatchewan south to southern Missouri, and in an east and west direction ranges from western Indiana to about the middle of Kansas and Nebraska. In other words, it occupies the moist and fertile eastern prairies, while its cousin the prairie-dog (*Cynomys ludovicianus*) is confined to the more arid plains that stretch westward from the prairies of the Mississippi to the Rocky Mountains. A widely isolated colony of these spermophiles exists in eastern New Jersey, in the region about Tuckerton, where a single pair, brought from Illinois, escaped from their cage in 1867. They are said to dig such shallow burrows that they are easily dug out by dogs, and in this way their numbers are held in check.

I am informed by Prof. C. B. Waldron, arboriculturist of the North Dakota Agricultural College and Experiment Station, that in eastern North Dakota, where Franklin's Sphermophile was formerly abundant, it is now being driven out by Richardson's Spermophile, which is on the increase in this region.

Prof. L. L. Dyche, of Lawrence, Kans., writes that on his father's farm at Auburn, Kans., these spermophiles were very common several years ago. He states further:

> They would dig up the corn almost as fast as it was planted for a distance of a few rods in from the stone walls wherever the latter inclosed the fields. On an average,

I think there could not have been less than one squirrel for each rod of fence; apparently there was one for each few feet. We killed many of them with guns, and tried to poison them with apparently very little success. By scattering shelled corn along the fences for the squirrels to feed upon while the planted corn was coming up, most of the difficulty was obviated. A wary old female cat, which had taken up her quarters in a barn in one of the fields, caught many of the squirrels, and was accustomed to carry them to her kittens when the latter were large enough to feed upon such things. The offspring of this cat, when they were full grown, also preyed upon the squirrels. In the course of a few years these cats, over a dozen in number, almost exterminated the squirrels. They would sit on the stone walls and pounce upon the squirrels when the latter came out from their hiding places.

RICHARDSON'S SPERMOPHILE (*Spermophilus richardsoni*).

Richardson's Spermophile, which resembles a small prairie-dog in general build and coloration, is not found in the United States, except in North Dakota and Montana, where it is abundant, troublesome, and apparently on the increase. Prof. C. B. Waldron writes that it is harder to contend with than any other species, and that the damage done by it is greater and greater each year. He says:

Its chief depredations are committed during the months of June and July, when growing grain, especially corn, peas, and garden crops, are apt to be entirely destroyed by it. It is found in greatest abundance in the agricultural regions lying just west of the Red River Valley, and seems to thrive best in the presence of civilization. For several years it has been encroaching upon the farms in the Red River Valley proper, but the wet season of last year [1891] very nearly or quite exterminated it on the level lands.

At Turtle Mountain, on the boundary between North Dakota and Canada, one of these spermophiles was shot by the writer as it ran from a shock of oats. Its cheek pouches contained 269 grains of oats.

POCKET-GOPHERS.

Pocket-gophers are stout, thickset animals, about the size of a rat, with small eyes and powerful forefeet armed with strong curved claws for digging. They are in every way fitted for underground life, and no other American rodent is so exclusively subterranean. They owe their name to the possession of large fur-lined cheek pouches, in which they carry the roots and other parts of plants collected for food. These pockets are used exclusively for this purpose, and not, as some suppose, for transporting earth in excavating the burrows. Roots and stems are cut in sections, about an inch in length, by means of the powerful front teeth, and are packed lengthwise in the pouches. Food not needed for immediate use is carried to chambers in the burrow and there stored for future use.

Pocket-gophers are best known from the little mounds of earth thrown up along the lines of their subterranean tunnels, and universally called "gopher hills." These mounds ordinarily contain 5 or 6 quarts of earth, and since the gophers work all summer and to some extent in winter also the total quantity of earth brought to the surface is considerable. From observations made in Minnesota I have estimated that about 500 square feet of ground is covered with subsoil by a gopher in the course of a season of seven months, supposing that he worked steadily all the time—which of course he does not. In case the soil is shallow and the subsoil poor the idea may be true that gophers do much injury by bringing clay or sand to the surface, but in general they undoubtedly do great good in plowing and draining land beneath the reach of the plow, while on the fire-swept prairies the only vegetation

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RICHARDSON'S SPERMOPHILE, SPERMOPHILUS RICHARDSONII (Sabine.)

which remains to decay and fertilize the soil is that which the gopher hills cover and protect from the flames.

The pocket gophers are even greater enemies to agriculture than the spermophiles. This is partly due to the circumstance that most of their work is done under ground and consequently out of sight, and partly to the fact that practically the whole of their food is of such a nature that the taking of it is an injury to mankind. In addition to the cereals which they devour in common with the spermophiles, they feed eagerly upon potatoes, carrots, turnips, and the like, and also on the roots of vines and fruit trees. Perhaps the most serious losses due to their ravages are in orchards, vineyards, and gardens.

When allowed in the fields they injure almost every farm crop that can be raised, but are especially destructive in alfalfa patches, meadows, and fields of small grain, where every hill thrown up covers and kills the plants on the spot where it lies. The damage done by a single gopher in a season is often considerable, and where the animals are numerous the injury becomes serious. A slight loss is sometimes suffered from the grain cut down and eaten, or carried into their holes. Sometimes a few bundles are destroyed in the shock, but this damage is slight compared with the loss of the grain covered up while growing. I have never known them to destroy any appreciable quantity of corn. They are very fond of potatoes, and occasionally one will follow a row for some distance and not leave a potato in any of the hills; farmers have told me of losing all the potatoes in a small patch, and, at the same time, have acknowledged their inability to catch the culprit. Turnips, beets, parsnips, and most garden vegetables are eaten whenever found, and a single gopher will destroy a surprising quantity of such crops. Perhaps none of their depredations cause the farmer more annoyance or provoke his impatience to a greater degree than the hills which they throw up in his meadows. The loss of the grass covered and eaten is not often of serious consequence, but in mowing with a machine the knife keeps running through the gopher hills, dulling and nicking and sometimes breaking the teeth. At such times it becomes necessary to sharpen the blades several times when ordinarily one grinding would suffice.

Two very distinct kinds of pocket-gophers inhabit the Mississippi Valley, one having deeply-grooved upper incisors and very large forefeet and claws (genus *Geomys*); the other with the upper incisors plane and the forefeet and claws smaller (genus *Thomomys*). These differences are shown in the accompanying cut. There are several species in each genus, but only one of each occurs in the Mississippi Valley proper north of Texas and Louisiana.

GRAY POCKET-GOPHER (*Thomomys talpoides*).

The gray pocket-gopher has the most northerly range of any species of the family, inhabiting the plains of the Saskatchewan, Montana, and the Dakotas; near our northern boundary it pushes easterly a few miles into the northwest corner of Minnesota. In eastern North and South Dakota it overlaps the range of the red pocket-gopher (*Geomys bursarius*), both occurring over a narrow strip east of James River. Other species of *Thomomys* inhabit all the States and Territories west of the Great Plains and range south into Mexico, but singularly enough none occur in Nebraska, Kansas, Indian Territory, Oklahoma, or eastern Texas, where *Geomys* alone holds the ground.

In the construction of burrows and nests and the mounds thrown up there is little difference between this species and *Geomys bursarius*, except that being a smaller animal the burrows are correspondingly smaller and the mounds are smaller and closer together. Usually after some familiarity with both it is not difficult to distinguish by the mounds which species is living beneath.

Thomomys talpoides is as solitary in habits as the other members of the family. Except during the mating season in spring it is rare to find more than one in a burrow, and, as the burrows of different individuals do not commonly connect, the animals must live in absolute solitude throughout the greater part of the year.

RED POCKET-GOPHER (*Geomys bursarius.*)

This species may be distinguished from the preceding not only by its reddish color and larger size, but also, as already stated, by its deeply-grooved upper front teeth and larger forefeet and claws. It occupies by far the greater part of the Mississippi Valley to the exclusion of all other species of true gophers, ranging from a point a little north of Grand Forks in the Red River Valley, on the boundary between North Dakota and Minnesota, southward to Indian Territory and Texas, where, however, it shades off toward another species. In an east and west direction it ranges from western Indiana to the foot of the Rocky Mountains in Colorado. In the Dakotas its range is restricted to a narrow strip east of James River, where it slightly overlaps the range of the smaller species (*Thomomys talpoides*).

METHODS OF DESTROYING PRAIRIE-DOGS, SPERMOPHILES, AND POCKET-GOPHERS.

The injury to crops caused by prairie-dogs, ground-squirrels, and pocket-gophers is an evil of such magnitude over more than two-thirds of the total area of the United States that there is a general demand for some economic means of destroying them. So many letters are received from correspondents requesting information under this head that it seems desirable to refer briefly to the methods which practical experience has shown to be most effective.

Pocket-gophers, spermophiles, and prairie-dogs may be caught in traps or poisoned.

TRAPPING.

Trapping is slower than poisoning, but has the advantage of being simple and safe. Few animals are more readily taken in this way. In the case of prairie-dogs and spermophiles a "No. 0" steel trap (made with the spring under the pan) should be set at the mouth of the hole, lightly covered with fine earth, and baited with almost any kind of grain. Bait is not always necessary, and in the case of a few of the spermophiles it is unnecessary to cover the trap.

Pocket-gophers may be caught even more easily. It is best to select a fresh hole, and after removing the loose earth at the mouth of the burrow, set the trap in the main runway flush with the bottom. It may be noticed that the earth removed in excavating the burrow is brought to the surface at intervals by means of side passages, through which it is pushed up from below, forming the characteristic "gopher hills." After the load is deposited the mouth of the hole is closed, and

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GRAY POCKET GOPHER, THOMOMYS TALPOIDES (Richardson.)

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RED POCKET GOPHER, GEOMYS BURSARIUS (Shaw.)

unless the animal happens to be working in the vicinity the side passage is likely to be abandoned and a new one made near the point from which the earth is being removed. The main passage, however, is usually kept open, as the occupant frequently passes back and forth. If the burrow is near the surface, the trap may be placed advantageously between two hills by digging down until the main burrow is reached, and setting the trap as before flush with the floor of the runway, so that the gopher will pass over it. A few bits of potato, turnip, or even grass may be scattered in the runway to attract the animal, but often no bait is necessary. Several special kinds of gopher traps are in use, but for ordinary purposes the No. 0 steel trap with the spring under the pan will be found as good as any.

POISONING.

Strychnine and bisulphide of carbon are the most speedy and effective poisons for the destruction of prairie-dogs, ground-squirrels, and pocket-gophers.

Strychnine.—In general, the scattering of strychnine about promiscuously is to be avoided on account of the danger to animals other than those for whom it was intended. In certain cases, however, it may be used to advantage, as is shown by the practical experience of Mr. Rollin C. Cooper, of Cooperstown, N. Dak. He writes, under date of November 28, 1888:

> I am farming 7,000 acres, and the gopher question has been one of great interest to me. I now think that I have the best of them and can rid my farm of them at little expense. I send men over my fields about twice in the spring, the first time as soon as the animals commence coming out of their holes, with wheat soaked in strychnine water. I use one ounce of floured strychnine to each bushel of wheat. Every farmer can flour his own strychnine with a case knife on any piece of iron or glass; it should then be put into quite warm water, dissolving the strychnine fully. Pour on to the wheat to be soaked until the wheat is nicely covered, letting it stand the necessary time. Soak the wheat twenty-four to thirty-six hours, or until somewhat soft. When sufficiently soaked, each man takes a teaspoon and a small can and walks over the fields, putting one teaspoonful into each hole. This being carefully done a couple of times each year will soon clean the animals out, and will greatly repay the farmer, even if repeated every year, as one man can go over 50 to 100 acres per day.

Bisulphide of carbon.—One of the simplest and probably on the whole the most effective and cheapest method yet devised for destroying these animals is by the use of bisulphide of carbon. This compound when pure forms a colorless, mobile liquid having a peculiar odor, and when taken internally is a violent poison. As usually obtained it contains impurities in the form of other compounds of sulphur which give it a strong and extremely offensive odor, and when inhaled soon causes death. For the purpose of destroying gophers or ground-squirrels the crude bisulphide is better and much cheaper than the pure article. Care should be taken in using it, as it is both inflammable and explosive. Its efficacy depends on the fact that its vapor is heavier than air and when introduced into burrows flows like water into all the recesses. This fact should be borne in mind in using it on sloping ground or in cases where there is reason to suppose that the holes contain water, as unless the poison is introduced at the highest opening of the burrow a certain part of the hole will remain free from it and here the animals may take refuge. If the holes contain water, this may act as a water trap preventing the diffusion of the vapor.

The method of using it for burrowing mammals is as follows: A small quantity (about 45 cubic centimeters or 3 tablespoonfuls for prairie-dogs, and 30 cubic centimeters or 2 tablespoonfuls for spermophiles and pocket-gophers) should be poured upon a bunch of rags or waste, which should be immediately placed within the mouth of the burrow, and the burrow closed.

During the past summer experiments were made by the writer in poisoning several species of mammals. The animals were secured by a long cord, and were then allowed to retreat into their burrows, when a measured quantity of bisulphide of carbon was introduced and the time necessary for it to cause death noted. The results of the experiments are shown in the accompanying table:

Tabular statement showing results of experiments in poisoning small mammals with bisulphide of carbon.

Species.	Distance from mouth of burrow.	Diameter of burrow.	Amount of bisulphide.	Time.
	Inches.	*Inches.*	*Cubic cm.*	*Min.*
Prairie-dog (*Cynomys ludovicianus*)	154	4	49	8
Do	99	$5\frac{3}{4}$	49	5
Do	120	....	49	5
Do	51	....	49	6
Do	14	....	29	*
Striped gopher (*Spermophilus 13-lineatus*)	14	....	....	6
Common skunk (*Mephitis mephitica*)	14	....	83	(†)
Pocket-gopher (*Geomys bursarius*)	60	....	....	‡5
Do	96	....	36	6
Do	48	....	29	9
Do	6	....	29	*6

* Vapor passed by and did not completely fill burrow. At end of time the animal was anæsthetized, but revived.
† Anæsthetized in five minutes; revived three hours later.
‡ Not quite dead.

Prof. E. W. Hilgard, of the University of California, deserves the credit of originating the bisulphide method of destroying burrowing mammals. In a bulletin "On the destruction of Ground Squirrels by the use of Bisulphide of Carbon," published in 1878, he states:

It is hardly necessary to enlarge upon the importance to California agriculture of devising some ready, safe, and effectual means of putting an end to the constantly increasing inroads of the ground-squirrel upon the grain fields and pastures of the State. Unlike most of other wild animals, whose range diminishes as culture advances, the ground-squirrel finds an improvement of the conditions of its existence as the area of cultivation increases. Each year we hear of its taking possession of "fresh fields and pastures new," while rarely loosening its grip upon any district once invaded; and the tax it levies upon the grain-growers of some counties exceeds all the other taxes combined. The damage done during the past season in Contra Costa County alone was estimated by the board of supervisors of that county at not less than $150,000, while in many individual cases from 30 to 50 per cent of the crop was harvested by the squirrels before the reaper could take the field.

After describing the properties of bisulphide of carbon and some of its uses, he goes on to say:

It is curious that in no case have I known a squirrel to run out of the holes before the gas; when it meets it face to face in a run, death seems to be almost instantaneous. But in most cases the animals seem to retire to their nests to die there in a stupor. The mode of proceeding is simply this: Select one or two of the freshest holes in a burrow, introduce into it, as deep down as you can reach, a wide-mouthed ounce vial full of the liquid, upset the vial and withdraw it. * * * The holes may all be closed at once, with earth, which need not be rammed; the only object being to keep the gas in, and to see if any of the inmates dig out afterwards. * * * The dead animal is thus buried and out of sight in its own burrow, creates no stench, and poisons nothing; its flesh would not be injurious even if dug up. No other wild or domestic animal runs any risk, unless it be the gopher. The holes retain an offensive odor for some time, and remain closed and untenanted. * * * As for the expense of this method, I have freed the most thickly-peopled portions of the University campus (level ground) from every vestige of squirrels with about a pound of the liquid per acre; about half an hour being spent by two men in closing the holes with shovels.

During the past five or six years this remedy has been recommended by the division, and has been used with success by numerous correspondents. Mr. Joseph Conaster, of Sunset, Wash., who was much troubled by the depredations of Townsend's spermophile, after using the poison, wrote, under date of July 20, 1892:

I think your bisulphide will exterminate the squirrels. Have annihilated two towns of them that I have been shooting and poisoning for three years. Did it all in two hours and am satisfied that the bisulphide will be the grand remedy of all.

ECONOMIC ORNITHOLOGY.

By WALTER B. BARROWS.

Studies have been made during the year of the food and economic status of many species of birds of prey, crows, jays, blackbirds, woodpeckers, cuckoos, kingbirds, robins, and horned larks. The work on crows has received constant attention, one or more assistants being occupied most of the time in examining stomachs of this species and in tabulating the results. The stomachs of more than 250 nestling crows were collected during May and June, and these, together with a larger number of stomachs of adults—more than 600 in all—have been examined, and, with the exception of the insect material, the results are ready for publication. As soon as the Entomologist's report is received the bulletin will go to press. About 700 blackbird stomachs have been examined, and most of the material for a report on the crow blackbird is now in hand and is being prepared for publication. Small numbers of the stomachs of woodpeckers, horned larks, and a few other species have been examined for the settlement of special questions referred to the section.

More than 2,400 bird stomachs have been received during the year, and about 2,000 have been examined during the same time. The collection now numbers 16,202 stomachs. The reference collection of seeds and other things likely to be found in bird stomachs has been very largely increased, and many slides have been prepared for the microscope.

Preliminary investigations of the food of cuckoos, kingbirds, cedar birds, robins, and some other species have been undertaken in connection with the exhibit for the World's Columbian Exposition, and in the case of the horned larks and cedar birds several facts of general interest have been brought out, which are embodied in the two following papers.

FOOD OF THE HORNED LARKS OR SHORE LARKS (*Otocoris*).

The horned larks or shore larks are well known in most sections of the United States either as residents or as winter visitors. During the larger part of the year they are found in flocks of varying size, sometimes of only half a dozen individuals, and again of hundreds; during the nesting season, however, they keep mostly in pairs. They frequent open fields, gravelly plains, or sandy wastes, and even in midwinter few places are too bleak for them. They are strictly terrestrial, rarely alighting except on the ground, although at the approach of the nesting season the male occasionally perches on a rail or stone while singing. Much of the time, however, the song is uttered while high in the air, somewhat after the manner of the European skylark.

Owing to their gregarious habits, their fondness for open grounds, and their seed-eating propensities, it has been supposed that they were capable of doing considerable damage to grain crops; and at various times during the past two or three years complaints have reached the Department that they did great damage by pulling up newly-sprouted grain, particularly wheat and oats. The charge was not a surprising one, since the common crow and several American blackbirds are strongly addicted to this habit, and our horned lark is rather closely related to the European skylark, which is almost as notorious for his grain-pulling as for his song. Efforts were made to secure specimens of the bird while actually feeding in newly-sown grain fields, but, as usual in such cases, the specimens so much desired were the most difficult to obtain, and as yet the charge has been neither disproved nor sustained.

Many horned larks were collected, however, under such circumstances that their stomach contents should give a fair idea of the usual food of the species, and enough examinations have been made to warrant publication of the results.

Forty-seven birds taken in Wayne County, Mich., about June 1 (May 31, June 1 and 2) were shot in or near fields where corn was already up, and where Hungarian grass had been recently planted. Thirty-five of these were young birds, not nestlings, however, but young of the year, able to fly, and probably not fed at all by the old birds. As the food of these immature birds proves to be markedly different in some respects from the food either of nestlings or adults, it may be briefly considered here. Thirty-four of the young birds had eaten seeds of Hungarian in amounts varying from three or four kernels to at least one hundred, and several of the stomachs contained no other food. In two stomachs were found seeds of pigeon grass or foxtail grass, wild species belonging to the same genus (*Setaria*) as the Hungarian, and a favorite food of many species of birds. Other species of grass seed had been eaten by five of the birds. Seeds of various species of *Polygonum* (bindweed, knotweed, and smartweed) were found in fifteen of the stomachs; in addition, two birds had eaten seeds of the ragweed or bitterweed (*Ambrosia artemisiæfolia*), one had taken seeds of goosefoot or pigweed (*Chenopodium*), and two had eaten seeds as yet not identified. Two birds had eaten small amounts of oats, but the condition of the fragments renders it almost certain that these were "road pickings," obtained in the manner of the English sparrow from the droppings of horses. Of the entire contents of these stomachs 76 per cent was vegetal (mainly seeds), 6 per cent was animal (insects and spiders), and 18 per cent was coarse sand. Throwing out the sand the food consisted of 92.7 per cent vegetal matter and 7.3 per cent of insects.

The large amount of sand is worthy of notice, and its presence, together with the thickened muscular walls of the stomach, would be sufficient evidence to many naturalists of the granivorous habits of the bird. What is here spoken of as a stomach might be called a gizzard with more propriety, since in its shape and relative size it is strictly comparable with the same organ in doves, partridges, and domesticated fowls.

The fact that no green vegetable matter of any kind was found in these stomachs, and not a single sprouted seed, is rather remarkable, but it must be remembered that these were young and inexperienced birds, doubtless with good appetitics and not much judgment, and having found an abundance of food of one kind (Hungarian grass seed) they were content for the most part with this. The small proportion of insects taken can be accounted for in a similar way. The birds were unskilled in catching insects, and naturally took only such as chance threw in their way. Most of the insects which would be likely to occur in abundance in almost bare and cultivated fields during the heat of a June day are quick-moving insects and not to be caught without some exercise of skill. Eleven of the stomachs contained no traces of insects; twelve others only such minute fragments as sufficed to determine them as bits of insect shell. Among the remaining birds one had eaten two small caterpillars and another a tiny grub, probably the larva of a small beetle. One contained two or three minute claws from the feet of a bug (Hemipteron), another a part of an ant, and still another the larger part of a tiger beetle (*Cicindela*). The bulk of the insect food seemed to consist of beetles, but in most cases the fragments were so small as to make their specific determination extremely difficult if not impossible.

Turning now to the twelve adult horned larks taken in the same fields and at the same time, a decided change in the proportion of animal and vegetable food is noticed. These twelve stomachs contained nearly 16 per cent of insects, 61 per cent of vegetable matter, and 23 per cent of sand; or, throwing out the sand, 20 per cent of the food consisted of insects and spiders, and 80 per cent of vegetable matter. The vegetable matter is essentially the same in kind as was found in the immature birds, but Hungarian grass seed occurred in only seven stomachs (and in those in reduced quantity); "road pickings" were rather more numerous, and one stomach contained several bits of corn, while two contained a few kernels of wheat. Possibly the grain in these last cases was seed corn and seed wheat, but as it showed no signs of sprouting it is equally possible that it was waste grain or derived from road pickings. The same species of grass and weed seed appear, with the addition of cabbage or turnip seed in a single stomach.

Except in amount, the insect food is not very different from that already recorded. Four stomachs were devoid of any traces of insects, and in four more the fragments were so small as to be unidentifiable, or only recognizable as parts of the shell of beetles. Among the better-preserved material was found a large spider, a small ant, several small beetles, two or three lepidopterous larvæ (2 caterpillars), and several small pupa cases. The fact that these adult birds had eaten, on the average, nearly three times as many insects as the immature birds, seems to argue a greater fondness for insects, but, as is shown later, it is altogether probable that nestlings are fed very largely on insects, and it is very likely that some of these birds when shot were engaged in collecting food for second broods of young still in the nest. At all events, the fact that at one time they were compelled to hunt insects diligently for their young must have modified their habits and increased their knowledge and skill in this direction. The fact that the amount of gravel (23 per cent) was nearly one-third greater than in the younger birds may seem a little odd, but it is hardly probable that the actual amount of gravel varies very much from hour to hour, or day to day, and its relative bulk therefore depends much upon the amount of food, whether the stomach be well filled or almost empty. Crows swallow large quantities of sand or gravel whenever their stomachs contain food which needs grinding, and they have the power (and the disposition) to disgorge most of this gravel so soon as the grinding is done. We do not know that horned larks have such a power or habit, but from what we know of domesticated fowls it seems more probable that they retain most of the gravel swallowed until its sharp edges are gradually worn away by attrition, when it is discharged through the intestines.

As a general rule the young of granivorous as well as of omnivorous birds require a considerable amount of animal food, but the young of some birds, for example, pigeons, are fed by regurgitation, largely on vegetable food, and it is believed that many seed-eaters feed their young in the same way, the seeds and grain being first softened in the crop or stomach of the parent bird, and subsequently choked up for the benefit of the young. Whether or not horned larks regurgitate any food is not known, but as they nest very early in the spring—often before the last snowstorm of the season—the ability to do so would be a decided advantage to the birds, and occasionally might save the lives of the nestlings during unseasonable weather, when insect food was unobtainable.

The food of very young horned larks is therefore of special interest, and it is much to be regretted that a sufficient number of stomachs is not at present available for study. Our collection contains many stomachs of so-called young birds, but only two which are positively known to be nestlings. These two were taken in Niagara County, N. Y., April 30 and May 2, 1888, and from the appearance of the stomachs the birds were then nearly ready to leave the nest. An examination of the stomachs of these nestlings shows an average of 43 per cent of insects, 43 per cent of seeds and grain, and 14 per cent of sand. Ignoring the sand, the food consists of 50 per cent animal matter and 50 per cent vegetable. The insect matter is so finely ground by the action of the gizzard that it is impossible to say what and how many insects are represented, but evidently a large part of the material belonged originally to beetles. The vegetable matter in one stomach consisted entirely of the remains of seeds of foxtail grass (*Setaria glauca*); in the other, of two seeds of this species and several kernels of wheat, all but one in fragments. This wheat showed no signs either of germination or of previous maceration or digestion, hence the conclusion seems inevitable that it was waste grain, or newly-sown grain not yet sprouted. As one stomach contained 8 per cent of sand and the other 20 per cent it seems clear that the young birds were in good condition to digest hard grain, and it is not likely that they were furnished with any soft vegetable food.

In order to compare the summer and winter food of horned larks, ten stomachs collected in Canada, Illinois, Kansas, and the District of Columbia, during February and March, have been examined and the results are given herewith. Of the entire contents 6.7 per cent consisted of insects, 79.3 per cent of vegetable matter, and 14 per cent of sand; or, throwing out the sand, insects formed 7.8 per cent of the food, and vegetable matter the remaining 92.2 per cent.

As might be expected the insects represented are few both in species and individuals. Beetles occur in four stomachs and their larvæ in three; two stomachs contain remains of large bugs, and a single grasshopper had been eaten by one bird. Most of these insects undoubtedly were in a torpid or semitorpid condition, and it is surprising that so many should have been discovered, especially when it is remembered that the birds keep entirely in the open ground, avoiding brush and woods of every description, and never searching for food along fences and stone walls, or in corners, where many winter birds are so likely to be found.

The vegetable food, on the other hand, is represented very fully, not less than a dozen species of seeds occurring in the stomachs, and sometimes in large numbers. Almost every stomach had some grass seed, and one or more species of *Sporobolus* occurred in eight of the ten stomachs. Seeds of pigeon-grass (*Setaria*) were common also, one stomach containing at least a hundred in addition to forty seeds of pigweed (*Chenopodium*). Other weed seeds which had been eaten freely were Roman wormwood (*Ambrosia artemisiæfolia*), sorrel (*Rumex acetosella*), amaranth (*Amarantus*), and buttonweed (*Diodia teres*). One stomach contained twenty of the large, hard seeds of the last-named species, a most troublesome weed, and one of the last seeds which any bird would be expected to eat.

SUMMARY.

The examination of these fifty-nine stomachs of the horned lark shows the following facts:

(1) The species is essentially granivorous, but, as in many other seed-eating species, insects are eaten more or less at all times, and, other things being equal, a larger proportion of insect food is taken when it is most abundant. Nestlings, however, appear to be fed very largely on insect food, even at a time when it must be collected with some difficulty. Before leaving the nest, however, young horned larks are able to digest grain and hard seeds, and are supplied with gravel for this purpose. After leaving the nest, young birds, at least for a time, do not eat as much insect food as the adults.

(2) The birds do not appear to discriminate, at any season, between injurious and beneficial insects, taking whatever is most abundant or most easily obtained. Probably the consumption of torpid insects in winter—even if the species were injurious—is of little account, since few of them would be likely to survive the winter. Considering the small average amount of insect food, $9\frac{1}{3}$ per cent for the whole year, it seems probable that this element of the food is of slight economic importance.

(3) The evidence at hand does not warrant the belief that horned larks do any appreciable damage to grain crops. They may pick up some newly-sown grain or grass seed which has been left uncovered, but the loss thus caused must be trifling.

(4) On the other hand, the consumption of weed seeds at all seasons of the year is a positive benefit, although the amount of good done must vary much with circumstances. Any bird, however, which eats freely the seeds of such pests as pigweed, bitterweed, amaranth, and sorrel should be given the most perfect protection, unless it is clearly shown to have bad habits which offset the benefit thus conferred.

FOOD HABITS OF THE CEDAR BIRD (*Ampelis cedrorum*).

By F. E. L. Beal.

In connection with the investigation of the food habits of birds, now being carried on by the division, a series of one hundred and twenty-five stomachs of the common cedar waxwing (*Ampelis cedrorum*) was examined recently, and the results have been tabulated and embodied in the present paper. While the number of stomachs is much less than could be desired, yet as but little based upon actual dissection has been published concerning the food habits of this bird, it may be interesting to give such facts as have been obtained, as they confirm many of the observations made by ornithologists, while they run somewhat counter to many of the popular ideas in regard to the species.

The cedar bird, or, as it is more commonly known among horticulturists, the "cherry bird," is popularly supposed to feed almost entirely upon small fruit, and it is a matter of common observation that during the season of cherries it visits the trees in great numbers, frequently completely stripping those which bear the earliest ripened fruit. Nevertheless, close observers have noticed that other elements enter into its diet, even at the time when fruit is most abundant, and have more than suspected that this bird does not quite deserve all the obloquy that fruit-raisers have heaped upon it.

The one hundred and twenty-five stomachs under consideration were obtained from twelve States, Canada, and the District of Columbia, as follows:

Pennsylvania	39	New Jersey	3
New York	34	Ohio	3
Connecticut	21	North Carolina	2
Massachusetts	6	Dakota	1
Iowa	5	Georgia	1
Virginia	4	Wisconsin	1
District of Columbia	4	Canada	1

No special relation was noticed between the food of the birds and their geographical distribution, all appearing to feed upon practically the same substances wherever obtained. The distribution in time, however, gives more interesting results.

Of the whole number of stomachs examined, 45, or 36 per cent, contained an appreciable amount of animal, *i. e.*, insect, remains. Besides these, 6 others contained traces of insects. In the stomachs in which insect remains were found, the amount varied from 1 to 100 per cent, but averaged 47 per cent. But if the 125 stomachs are taken into consideration, the insect remains amount to only 17 per cent of the whole quantity of food eaten.

Looking now at the distribution in time, we find that the 125 birds were killed during the year as follows: January, 3; February, 6; March, 5; April, 5; May, 18; June, 10; July, 19; August, 11; September, 26; October, 16; November, 4; and December, 2.

No remains of insects were found in the stomachs taken in the months of January, February, March, October, and December. Among the others they occurred to the following extent:

Month.	Number examined.	Number with insects.	Percentage containing insects.
April	5	1	20
May	18	17	94
June	10	4	40
July	19	8	42
August	11	2	18
September	26	12	46
November	4	1	25

Owing to the small number of birds taken in the months of April and November, not much reliance can be placed on the results obtained, but the data given by the food eaten in the other months may be safely taken as representing a close approximation to the truth. Of the eighteen birds taken in May, all but one had eaten insects in quantities varying from 1 to 100 per cent. If the animal food is compared with the whole amount taken in the month, it is found to be 51 per cent. If, however, the mineral constituent of the stomach contents is omitted as not being strictly food, the ratio of animal matter rises to 55 per cent. In the month of June ten birds were taken, four of which had eaten insects to an extent averaging 54 per cent of their food. If, as before, the animal food is compared with the whole amount taken by all the birds, the ratio is 22 per cent. In the same way it is found that the insects eaten by the eight birds in July formed 50 per cent of the food. Considering the whole quantity of food eaten by all the birds taken in this month, the animal matter amounts to 21 per cent. Of the eleven birds taken in August, only two had eaten insects, but these two had taken them to an average extent of 70 per cent; when compared with the whole amount taken by all, the ratio falls to 13 per cent.

In September twenty-six birds were examined, twelve of which had eaten insects in widely varying quantities, but giving an average of 32 per cent of all their food. Comparing as before the animal food with the whole amount of food taken in this month, the result is 15 per cent.

Among the birds examined were three nestlings which merit a passing notice. Their stomachs contained respectively 80, 84, and 100 per cent of insect food, or an average of 88 per cent. These insects consisted of Scarabæid beetles (*Aphodius fimetarius*) and the three birds had eaten thirty-two of them. The vegetable element of their food was composed of mulberries.

Of all the stomachs examined, only seven (all taken in the month of May) contained any mineral element, such as gravel, etc. In three of these this was composed, in part, at least, of the shell of some mollusk, which it might be supposed had been eaten for the sake of the lime for egg-shells, but one of the trio was a male.

The insects eaten have not been submitted for specific identification to an entomologist, but the orders were represented as follows: Dermaptera in one stomach; Orthoptera in four stomachs; Coleoptera in fourteen stomachs; Diptera in eight stomachs; Lepidoptera in thirteen stomachs; and Hymenoptera in ten stomachs; from which it appears that beetles and caterpillars were the favorites. Arachnids (spiders) also occurred in two stomachs.

The representatives of the first of these orders were three specimens of *Forficulæ*, or earwigs, rather rare insects of nocturnal habits, which are said to hide by day in flowers, where they were probably found by the birds. The Orthoptera were represented by the jaws and some other remains of grasshoppers. Several species of beetles represented the Coleoptera, two belonging to the family *Scarabæidæ* and two to the *Chrysomelidæ*, while some jaws were found that probably belonged to one of the *Cicindelidæ*. Among the *Chrysomelidæ* were found seven specimens of the well-known elm leaf beetle (*Galeruca xanthomelæna*).* The Diptera

[* The fact that the birds eat the elm leaf beetle (*Galeruca*) is abundantly attested by our own observations in the field. They have been seen in small flocks on elm trees on the grounds of the U. S. Department of Agriculture, greedily devouring these insects, and the same observation was made on elms at the Maryland Agricultural Experiment Station in 1891 and 1892. That a second species of the same family was eaten is of special interest, since it shows positively that the members of this family, though possessed of a disagreeable smell and taste, and mostly avoided by birds, are not distasteful to the cedar bird. The *Chrysomelidæ* include some of the most harmful leaf beetles known, among others the Colorado potato beetle, the striped squash and melon beetle, and the destructive leaf flea beetles.—W. B. B.]

are represented by the Tipulid flies, remains of which were found in several stomachs. The remains of the Lepidoptera consisted of many small caterpillars, of which not less than 100 individuals were found in one stomach, and many more in others. Several ants and a great number of very minute insects, perhaps ichneumon flies, represented the Hymenoptera. Five spiders were found in one stomach, and a trace of one in another.

The vegetable remains found in these stomachs consist entirely of the pulp, skin, and seeds of fruit, and some remains of flowers, with the possible exception of a single seed of some species of grass, which may have been taken accidentally. Of the eighteen birds taken in May, ten had eaten the stamens and petals of flowers. These were in some cases so mixed with the remains of very small insects as to suggest that one might have been eaten for the sake of the other, but which was the preferred element remains in doubt.

Of the birds that had eaten fruit, twenty-four, or 19 per cent of the whole number, had taken varieties that are or may be cultivated, viz, cultivated cherries by seven birds, mulberries by four, *Rubus* fruits by eleven, and apples by two. As these last were taken in the month of February, they can hardly be considered of any great importance from an economic point of view. With regard to the *Rubus* fruits and the mulberries, it is equally as probable that they were wild as cultivated, for the former, at least, are of universal distribution, and, during their season, usually can be obtained more easily from fields and roadsides than from gardens.

One bird was found to have eaten the berries of the common asparagus, which also may be noted as having no special economic interest.

Of the wild fruits eaten the following species were identified with certainty—

Juneberry (*Amelanchier canadensis*).
Hackberry (*Celtis occidentalis*).
Dogwood (*Cornus florida*).
Huckleberry (*Gaylussacia* sp. ?).
Red cedar (*Juniperus virginiana*).
Mistletoe (*Phoradendron flavescens*).
Pokeberry (*Phytolacca decandra*).
Black cherry (*Prunus serotina*).
Choke cherry (*Prunus virginiana*).
Choke berry (*Pyrus arbutifolia*).
Black elder (*Sambucus canadensis*).
Black haw (*Viburnum prunifolium*).
Frost grape (*Vitis cordifolia*).

In several stomachs remains of fruit were found without seeds or other characteristic parts, so that identification was impossible.

To sum up, it may be said that four facts seem to be reasonably well established, although it is possible, and perhaps probable, that a more extensive research may change or at least greatly modify them:

(1) That the cedar birds eat a certain amount of insect food at all times when it can be obtained, aggregating in the case of the stomachs examined 17 per cent of the food for the whole year; (2) that the greatest amount of insect food is eaten during the months when fruit is most abundant; (3) that the greatest number of insects is eaten during the month of May, with a decrease during the succeeding months until September, when the percentage again rises; (4) that the young while in the nest are fed to a very great extent upon insect food.

REPORT OF THE BOTANIST.

SIR: I have the honor of presenting herewith a report of the work of the Division of Botany for the year 1892. It contains a statement of the field investigations and expeditions, of the office work, of the botanical publications and bulletins, and an account of the experiments conducted in the cultivation of grasses and forage plants.

Respectfully,

GEORGE VASEY,
Botanist.

Hon. J. M. RUSK,
Secretary.

WORK OF THE YEAR.

The work of the Division of Botany has been conducted during the past year with great vigor. This work comes under the following heads:

(1) Botanical field investigations for a more complete knowledge of the vegetable products of little known localities.

(2) Office work in the determination of plants collected in the field, their preparation for the herbarium, and the distribution of duplicates among agricultural colleges and educational institutions.

(3) The publication of botanical bulletins both scientific and popular.

(4) The conducting of experiments on grasses and other forage plants in different parts of the country, particularly in the arid regions.

(5) Investigation of weeds.

FIELD WORK.

The field work during the past year has been much diminished on account of the reduced appropriations. An expedition was organized for the exploration of northwestern Idaho. The region of its operation was the headwaters of the Snake River from Lewiston eastward and northward, among the numerous mountain ranges of Bitterroot and Cœur de Alene, of the basaltic basins of the Clearwater and Pelouse rivers, and the country around the lakes Cœur de Alene and Pend d'Oreille.

This expedition was very successful, although attended with many difficulties and some dangers, and resulted in the collection of about 20,000 specimens, including trees, shrubs, herbs, grasses, and other herbaceous plants.

One agent was employed in Alaska. Our acquaintance with the flora of Alaska, except some points near the coast, has been meager, and a more thorough investigation was extremely desirable. Accordingly an agent was sent to the southeastern part of Alaska to examine the flora of that region. An arrangement was made with the Superintendent of the U. S. Coast and Geodetic Survey, by which the agent was carried on the steamer *Hassler* from San Francisco to Yakutat Bay, in the vicinity of which his explorations were conducted during the season. Investigation was directed especially to the timber trees and grasses, a complete collection of which was transmitted to the Department.

Other field work was performed in various parts of California, of Arizona, of Texas, and of Florida. About 30,000 specimens were thus obtained.

OFFICE WORK.

The determination of the plants collected by the several field agents was a work requiring critical examination and occupied much time and expert labor. About 12,000 specimens were mounted and added to the herbarium, and over 15,000 specimens were distributed to agricultural colleges and other institutions of research. The amount of office work accomplished has been greater than during any previous year.

PUBLICATIONS.

The following publications have been issued during the year, in addition to the Annual Report of the Botanist for 1891:

Contributions from the U. S. National Herbarium. Vol. III. No. 1. Monograph of the Grasses of the United States and British America. By Dr. George Vasey. Issued Feb. 25, 1892. 8°. pp. v+89. Index.

Contributions from the U. S. National Herbarium. Vol. II. No. 2. Manual of the Phanerogams and Pteridophytes of Western Texas. By John M. Coulter. Issued June 1, 1892. 8°. pp. v+153–345. Index.

Contributions from the U. S. National Herbarium. Vol. I. No. 5. List of plants collected by Dr. Edward Palmer, in 1890, on Carmen Island. By J. N. Rose. List of plants collected by the U. S. S. *Albatross* in 1887–'91, along the western coast of America. By J. N. Rose, D. C. Eaton, J. W. Eckfeldt, and A. W. Evans. Revision of the North American species of Hoffmanseggia. By E. M. Fisher. Systematic and alphabetic index of new species of North American Phanerogams and Pteridophytes, published in 1891. By Josephine A. Clark. Issued Sept. 20, 1892. 8°. pp. v+129–188. Index.

Bulletin No. 13. Grasses of the Pacific Slope, including Alaska and the adjacent islands. Plates and descriptions of the grasses of California, Oregon, Washington, and the northwestern coast, including Alaska. By Dr. George Vasey. Part 1. Issued Oct. 20, 1892. Roy. 8°. pp. 7+[50]. 50 plates.

Contributions from the U. S. National Herbarium. Vol. I. No. 6. List of plants collected by C. S. Sheldon and M. A. Carleton, in the Indian Territory, in 1891. By J. M. Holzinger. Observations of the native plants of Oklahoma Territory and adjacent districts. By M. A. Carleton. Issued Dec. 6, 1892. 8°. pp. v+189–232. Index.

EXPERIMENTS ON GRASSES AND OTHER FORAGE PLANTS.

The experiment station at Garden City, Kansas, has been conducted during the past year with great energy and with pronounced success, as will be seen from the report following. On account of the reduction in the appropriation, the Department was under the necessity of discontinuing the assistance afforded to State experiment stations in the prosecution of grass experiments, except in the case of the three States of Georgia, Mississippi, and Louisiana. These were placed under the superintendence of Prof. S. M. Tracy, whose report is given below.

INVESTIGATION OF WEEDS.

During the summer so many complaints were received about the damage done in the Northwest by the Russian thistle (*Salsola kali* var. *tragus*), that the Secretary of Agriculture detailed Mr. L. H. Dewey, Assistant Botanist, to investigate the subject. His report, to be published as Farmers' Bulletin No. 10, describes the extent of this pest in North and South Dakota, Minnesota, and Iowa, estimates the damage done by it during 1892 at $2,000,000, and recommends as the principal remedies early fall plowing, the burning of stubble, and the raking and burning of the thistle in neglected fields.

THE GRASS EXPERIMENT STATION OF THE DEPARTMENT AT GARDEN CITY, KANSAS.

The present is the fourth year of this station, which was established for the purpose of conducting experiments to ascertain what grains and forage plants were adapted to cultivation in the arid and semiarid districts west of the one-hundredth meridian.

When the station was opened, only 8 or 10 acres of land was already plowed, and this had been neglected for several years until it had become overrun with weeds, the extermination of which cost much time and labor. The first year's work (1889) was principally devoted to breaking the native sod, sowing the seeds of the grasses which were selected for experiment, and inclosing the premises with a wire fence. A few acres was planted with various kinds of sorghum, imphee, and Kaffir corn, which, without irrigation, made a remarkable growth, some of the varieties reaching a height of 10 feet.

The Kaffir corn, although growing only 6 feet high, produced the largest proportion of foliage, and was estimated to yield at the rate of more than 20 tons of green feed to the acre.

A large part of the grass seeds failed to germinate, or died out soon after germination, but some ten or twelve kinds gave promise of persistence. In the fall of this year 40 acres of the newly plowed land was seeded to winter rye.

The second year (1890) about 50 acres was sowed with grass seed of fifteen kinds, about 12 acres devoted to other forage plants, such as sanfoin, spurry, serradilla, goats-rue, hairy vetch, Bokhara clover, and alfalfa, and about 8 acres to Polish wheat. Many other forage plants were cultivated in small plats.

The season was one of uncommon drought, there being only 13 inches of rainfall during the period from January 1 to October 25. In consequence, the result was disappointing as to a large part of the crops, especially as to the grasses. Five or six kinds, however, endured the drought remarkably well, and it was resolved to increase the cultivation of these in the future. The forage plants above mentioned suffered much, yet maintained life, and it was believed that they would do better during the following season. The Bokhara clover made a good crop, as it will undoubtedly do in the driest season. Notwithstanding the discouraging effects of the drought, there was some compensation in the fact that the winter rye did surprisingly well under the circumstances, and yielded a crop of 17 bushels per acre; but the 8 acres of Polish wheat, which up to June 1 was promising a heavy yield, was not able to fill the heads, and harvested at the rate of only 8 or 10 bushels per acre. Of the numerous varieties of sorghum which were planted, most were failures on account of the drought and the desiccating winds; although one variety, called "Jerusalem corn," maintained much vigor and matured a fair crop of seed. This Jerusalem corn had been tried in other places with favorable results, and it is known to be quite as valuable as corn for fattening stock, and also to be very good as human food. Such quantities of the rye and wheat as could be spared from the wants of the station, were distributed among the farmers of the surrounding country for further experiments.

The third year (1891) 240 acres was in cultivation. Of this there was 20 acres of winter rye, 10 acres of Polish wheat, 50 acres of Jerusalem corn, and nearly 50 acres of other varieties of sorghum.

The early part of this season was remarkably dry, the rainfall from January 1 to May 21 amounting to only $1\frac{41}{100}$ inches; but the remainder of the season, up to October 3, gave a rainfall of over 23 inches, nearly 3 inches above the average.

All the crops suffered from the early drought, but nevertheless the winter rye yielded at the rate of 12 bushels per acre, the Polish wheat at the rate of 24 bushels, and the Jerusalem corn at the rate of 40 bushels. The 10 acres of alfalfa, which came near perishing the preceding year, recovered itself, yielded two cuttings of hay, and was growing vigorously at the close of the season. Several of the other forage plants gave evidence of hardiness and persistence.

Most of the grasses proved thrifty, the Hungarian brome, of which 6 acres was sowed, being particularly promising, and remaining green and vigorous until winter.

About 2,500 packages of Jerusalem corn were distributed to applicants. All the surplus of the other grains was also distributed in quantities varying from 2 ounces to 2 bushels. In all there was sent out 64 tons of seed.

The results of this year's experiments, which covered the important factors of depth of plowing and seeding, time of planting, and methods of cultivation, were considered very favorable.

Confirmatory reports have been received as to the seeds sent out to farmers for trial. The superintendent states that one man reports a yield of 86 bushels of rye from 2 bushels of seed sent to him; another, 84 bushels of Jerusalem corn from 5 pounds of seed; another, 10 bushels of Polish wheat from 15 pounds of seed. The superintendent further says: "People in this part of the country bless the experiment station, and declare that the Department of Agriculture has never before done anything that has so directly benefited the people."

We now come to the present year's work (1892). Dr. J. A. Sewall, the superintendent, reports as follows:

REPORT OF DR. J. A. SEWALL.

I beg leave to submit the following report relative to the work done and the results attained at this station during the year 1892:

The season has been remarkably dry and warm. The temperature for several days in August reached 104° F.

The rainfall up to November 7 has been below the average of seventeen years' observation, as will be seen from the following table:

	Inches.		Inches.
January	0.00	August	1.09
February	0.21	September	0.34
March	1.12	October	0.28
April	0.77	November 1 to 7	0.30
May	3.96		
June	2.27	Total rainfall during above period	13.97
July	3.63	Average yearly rainfall	20.21

The following is a list of the grasses, forage plants, and grains under cultivation this season, with the results:

GRASSES.

(1) Switchgrass, *Panicum virgatum*, 20 acres. This grass made a good growth, standing very evenly. Fifteen acres was cut early in the season, just as it was beginning to bloom, and yielded about 1½ tons to the acre of excellent hay. Five acres was left to mature as a seed crop, but, owing to the lack of rain, very few seeds matured—not enough to pay for threshing. (Plate I.)

(2) Hungarian brome, *Bromus inermis*, 5 acres. This most promising and valuable grass made a good growth notwithstanding the drought. It was cut as a seed crop and yielded 1,000 pounds of clean, first-class seed. This field was sowed in the spring of 1891. Another field of 20 acres sowed in the spring of the present year, 1892, made a very satisfactory growth and was as green in October as at any time during the season. It produced no seed, but next season, with the average rainfall, will probably yield 250 to 300 pounds of seed per acre. (Plate II.)

(3) Colorado blue-stem, *Agropyrum glaucum*, 10 acres. This grass was sowed in the spring of 1890. It made a good growth, standing much thicker than for the two previous seasons, and yielded about 1¼ tons per acre of excellent hay, particularly relished by horses, and apparently equal to that produced by the common grasses. (Plate III.)

(4) *Agropyrum tenerum*, 2 acres. In yield it was about equal to the *A. glaucum*, but does not stand the drought as well, and is not so good for hay; yet I think it a valuable and reliable crop for the plains.

(5) Indian grass, *Chrysopogon nutans*, 1 acre. The yield was excellent, about 2 tons to the acre. Cut early it makes an excellent hay, which is eaten with relish by horses, mules, and neat cattle. If left until seed matures, it is too coarse and hard for feeding. (Plate IV.)

(6) Tall oat grass, *Arrhenatherum elatius*, 2 acres. This grass grows in bunches, leaving fully one-fourth of the ground bare; otherwise it is very satisfactory, standing 3 to 4 feet high. The entire crop was saved for seed.

(7) Three species of beard-grass, *Andropogon provincialis*, *A. Hallii*, and *A. scoparius*, sowed in 1890, have improved in quality and quantity each year, but are not as promising as those above named. (Plate V.)

Of twenty species of grasses, each occupying a small area, nearly all give indication of profitable culture. It is evident that when the land has been more completely subdued by longer cultivation they will do much better.

OTHER FORAGE PLANTS.

(8) Alfalfa, *Medicago sativa*, 11 acres. This forage plant recovered fully from the drought of last year and yielded 1 ton per acre for the first crop. The second crop, quite as good as the first, was destroyed by the grasshoppers.

(9) Sanfoin, *Onobrychis sativa*, 1 acre. This forage plant bears the drought well, but here makes a better pasture than a hay crop. It was badly injured by the grasshoppers.

(10) Goats-rue, *Galega officinalis*, and kidney vetch, or lady's fingers, *Anthyllis vulneraria*, leguminous plants from France, are most excellent forage plants, resisting the drought, but this season they were destroyed by the grasshoppers. (Plates VI and VII.)

GRAINS.

(11) Arctic rye, 43 acres, yielded 26 bushels per acre.

(12) Red Texas oats, 5⅞ acres, yielded 420 bushels, or 71½ bushels per acre, weighing 37 pounds per bushel. This extraordinary result I attribute to the manner of cultivation. The ground was plowed 1 foot deep, and thoroughly harrowed and pulverized. For the purpose of testing the value of this treatment, I had put in 1 acre of the same kind of oats, with the ground treated in the ordinary manner, namely, plowed about 4 inches deep and harrowed. This acre was immediately adjoining the other field, and was sowed with the same kind of seed. On this acre we harvested 18 bushels of oats that weighed 32 pounds to the bushel.

(13) Algerian wheat, 6 acres. This yielded 147 bushels, or 24½ bushels per acre, and weighed 64 pounds per bushel.

(14) Polish wheat, 10 acres. It gave us 205 bushels, or 20½ bushels per acre, weighing 60 pounds per bushel.

(15) Black hulless barley, 3 acres. It yielded 70 bushels, or 23⅓ bushels per acre, weighing 66 pounds per bushel.

(16) White Algerian barley, 4 acres. This yielded 144 bushels, or 36 bushels per acre, weighing 48 pounds per bushel.

The amount of rainfall on the above-named cultivated crops, from the time of sowing to the time of harvesting, was $8\frac{12}{100}$ inches, which is $\frac{4}{10}$ of an inch less than the average amount for the same time, counting the past 16 years.

(17) Jerusalem corn, 30 acres. The yield of seeds was 900 bushels, or 30 bushels per acre, weighing 58 pounds per bushel. The first planting was the last week in May, and it failed to come up. The second planting was during the last days of June and the 1st of July, and it was harvested the first week in November. The amount of rainfall on this crop was only $5\frac{34}{100}$ inches.

I am doing what I can to introduce this corn, or sorghum, as an article of food, and I think that in another year there will be a good demand for the meal for bread-making.

Sweet clover, or Bokhara clover (*Melilotus alba*). We find that this is a sure crop here, and will yield at least two cuttings. At first we regarded it as worthless for fodder, but further experiment was made by cutting it early, about May 20, for the first cutting, and we found that our horses and mules ate it with a relish. In fact they ate no other hay for two weeks, and they certainly thrived on it.

I have put up a baled-straw barn on the 160-acre lot, so as to keep the teams there during the working season, and thus to economize time. The barn is 20 by 40 feet, 10 feet high. It has a thatched roof, and the total cost, exclusive of labor, does not exceed $15. (Plate VIII.)

EXPERIMENTS ON EVAPORATION.

Some carefully conducted experiments were made to determine the rate of evaporation under different conditions. A number of sheet-iron vessels were made, 1 foot square at the top and 1 foot deep. These were all filled with soil prepared for the purpose, and then sunk in the earth so as to be level with the surface, each one being accurately weighed. They were set on the 1st of August. A certain number of these vessels were covered, each with a mulching of one-third of a pound of oat straw, and an equal number were left exposed, or without any mulching. The 15th of September these vessels were taken up and weighed. The difference in the evaporation between the mulched soil and that without mulching was 9 pounds, equal to more than 190 tons per acre.

TREE-PLANTING.

Of the 2,200 trees planted around the 160-acre lot, as a wind-break (in four rows), all are living and made a marvellous growth, except about 50 trees which were completely destroyed by grasshoppers. They were entirely stripped of bark and foliage. The trees have been thoroughly cultivated during the season and were mulched this fall with a layer of rye straw about 1 foot thick.

MODE OF CULTIVATION.

The land for the cultivated crops was plowed not less than 1 foot deep. This furnishes a reservoir for the rain. Then the surface was made as fine as possible with a harrow having 1,600 small, short teeth. This pulverized soil prevents evaporation and conserves the moisture. On the whole the results of the experiments made and the work done are gratifying and satisfactory.

The above report of the work of the Garden City experiment station could hardly make a better showing if it were for a well-cultivated farm in the eastern part of the State. The evidently flourishing condition of the crops and the excellent average yield has attracted the attention of the surrounding country, and the station has had many visitors to witness the progress of the work. It is situated in the semiarid region, which was a few years ago rapidly settled, and as rapidly abandoned by many of the settlers on the bursting of the boom, leaving that country again almost in the condition of a desert. Yet a few thoughtful men, experienced in the physical and climatic conditions of the country, retained hope in its resources, since here and there throughout the dry region there were farmers who had succeeded nearly every year in securing remunerative crops.

Early in September, 1892, a reporter connected with the Denver News visited the station, and in that paper was published an account of what he saw and what he thought. His account occupies over a column of the paper, and is so impartial and thorough as to be worthy of attention. The following extracts are made from his report:

Garden City is a very pleasant and inviting Kansas town located on the line of the Atchison, Topeka and Santa Fe road, in the Arkansas valley, some 60 miles east of the Colorado State line, in longitude 101° west. It now contains some 1,200 inhabitants. It is surrounded by a typical plains country, the river being dry a portion of the year. The soil of the valley and adjacent plains is fertile, but, being in the arid region, irrigation is necessary to successful agriculture. One or two ditches have been taken out of the Arkansas, and afforded a supply of water during the earlier part of the season. When the river runs low, I was informed that "You Colorado fellows get all the water." In any event, Garden City is the most eastern point in the Arkansas valley where irrigation is at all practiced. With an assured water supply, however, a most productive agricultural section would soon exist here.

The town is still suffering from a "boom," which, early in the eighties, was the biggest thing of its kind on earth. Judged by its harvest of blighted hopes, ruined prospects, and bankrupt fortunes, the men who started it were criminals and the victims who fell within its fatal spell were lunatics. Real estate went to fabulous prices, while all imaginable schemes and enterprises on paper were projected. The result was that many fine business blocks and two great hotels that would do credit to Denver were constructed. A sewer system was put in and waterworks erected and many improvements completed, which were far beyond the capacity of the town to maintain even with the 6,000 or 8,000 people that it had at that time. I saw one elegant brick residence that would adorn Capitol Hill, and which cost $35,000, which now rents for $8 per month. It would take a column, however, to tell the story of the boom. It finally burst, as they all do, and Garden City has not yet recovered from the fitful fever of those days. It is evidently destined to be a pleasant western village that will reflect in its growth and trade and activity the development of the country by which it is surrounded.

The principal object of interest in the vicinity of Garden City is the Government experimental forage farm, which is located some 2 miles from the business portion of the town. It comprises 240 acres, one tract of 80 acres and one of 160 acres.

The improvements on the 80-acre tract consist of a neat and substantial one-story frame house of six rooms, a frame barn, a granary, a tool house, and a straw barn. On the 160-acre tract a straw barn is being constructed. Both tracts are fenced. On one side of the 80-acre tract are rows of cottonwoods, while about the other are two or three rows of black locust, all of which are growing finely. The straw barns mentioned are curiosities in their way. The first one was built on the 80-acre tract. Baled straw was used, each bale being securely fastened by wooden pins. These bales form the sides and ends of the barn, it being covered with a good shingle roof. It makes a safe, economical, durable, warm structure, and is especially adapted to a country where cold piercing winds sweep the plains in the winter and hot suns beat down in summer. The second one, which is on the 160-acre tract, is now being constructed. The roof and gables on this one are being thatched, and it presents a most unique appearance. There is actually no wood about it save the window frames and doors. Farmers who have more straw than money are advised to take a hint from these facts.

After a review of the grain crops, grasses, and other forage plants, he proceeds as follows:

The most successful variety of corn is known as Jerusalem corn. I saw 30 acres of it, and never looked at a finer field of corn west of the Missouri. It looks green and rank, produces an abundance of excellent fodder, and yields well of the grain, which is equal in all respects for feeding and fattening to Indian corn. It maintains a rapid growth and matures early, and I see no reason why it should not be adopted as one of the favorite and profitable crops of the plains country.

Of seventy-five or more varieties of grasses which have been experimented with, three are thought to be undoubtedly adapted to culture on the plains. The first of these—and by all odds the best—is the bromus grass. The first experiment with it was on a patch of ground 4 or 5 rods square. It did so well that there are now 20 acres of it under cultivation. It makes a most excellent hay and yields largely to the acre. It also makes a fine pasture grass. As I saw the field since it has been cut and the hay stacked, it looks green and will furnish a large amount of pasturage. I am certain that no grass yet tried on the plains is better adapted to successful growth.

The next in favor is known as the Colorado redtop, which makes even a better hay than the bromus, but is not so well adapted for pasture. The third is the blue stem, which is most popular with Colorado stockmen, and which makes both a good hay and a good pasture. All of these grasses, it is believed, can be grown with profit and success in the arid region. In the experiments it is found that the grasses do better when sown upon land that has been previously cultivated, and from which a crop or two of grain has been taken. The forage grasses do not thrive well on fresh broken prairie sod.

The value of these experiments, and the fact that they can be duplicated by all practical farmers, lies in the fact that the results gained have been wholly without irrigation, and from land which fairly represents the arid region. What has been done about Garden City can be done all along the line of western Kansas, and western Nebraska, and in eastern Colorado. The culture is neither expensive nor impracticable—it is simply intelligent and thorough—and these two characteristics must be prominent in any system of agriculture that may prevail within the lines of the arid region. If, for instance, certain varieties of oats, wheat, barley, and corn can be produced on this dry Government farm, as the result of deep plowing, they can also be as successfully grown by any intelligent and industrious farmer who will do the same thing—plow deep. The results given above can be also achieved by anyone who is willing to comply with the necessary conditions; if he is not, he is certain to fail, and the sooner he quits farming and gets out of the arid region, the better it will be for all parties concerned.

The future of this great plains country lying between the line of sufficient rain on the east and the line where irrigation is possible on the west has for many years been the matter of serious consideration. I can never believe that it was always intended to be a sparsely populated waste. It must be made to subserve some good industrial purpose. There are those who believe that "the rains follow the plow," and to a certain extent this is true. But that the arable line will advance westward until it meets the irrigated fields of Colorado I do not believe. There will, for many generations to come at least, be a deficiency of rainfall in this region, and to meet this fact certain varieties of grain, grasses, and forage plants must be adapted to existing conditions, and to aid in ascertaining what these are the experimental farm at Garden City exists.

Were a varied agriculture, such as is found in the East or under the benign influences of irrigation, possible on these plains, there would be no special necessity for this expenditure of money on the part of the Federal Government; but it is not possible, and the question is, What profitable purpose can they best subserve? I observe that the arid region, beyond the line where irrigation can be practiced, can be utilized as a semipastoral region, where the farmer must look to his cattle, fed upon these forage plants and grains which shall be found adapted to growth upon the plains, for returns for his labor rather than to grain or any of the other products of a varied agriculture. This industry is the legitimate successor of the range cattle business. With the products of 80 acres devoted to bromus grass and redtop, to red Texas oats, and Jerusalem corn, a farmer can raise, feed, and fatten many head of horses, cattle, sheep, and hogs, and find for them a profitable market. And this I believe is the future industry of these arid plains.

With reference to the straw barns mentioned it may be useful to give some details regarding their construction. These, in the words of Mr. Sewall, are as follows:

The first thing to do is to bale the straw; then level the ground for a foundation, and lay down two 2x4's; then lay the first tier of bales on these.

Make hardwood pins or dowels 8 inches long and about an inch square, pointed at both ends. Drive four of these (one in each corner) into the bale half the length of the pin. Lay the second tier, breaking joints as in brick work, pressing the bales on to the pins, and so on until you have made the walls as high as you wish, say, 8, 10, or 12 feet.

Put in window and door frames wherever you want them. These should be made of 2-inch plank, 10 inches wide. On the top of the last tier of bales lay planks 8 inches wide and bolt with wooden pins 2 feet long.

On these planks or plates nail the rafters. The roof and gable ends may be boarded and shingled; or boarded with 6-inch boards, placed 10 inches apart, and thatched with straw.

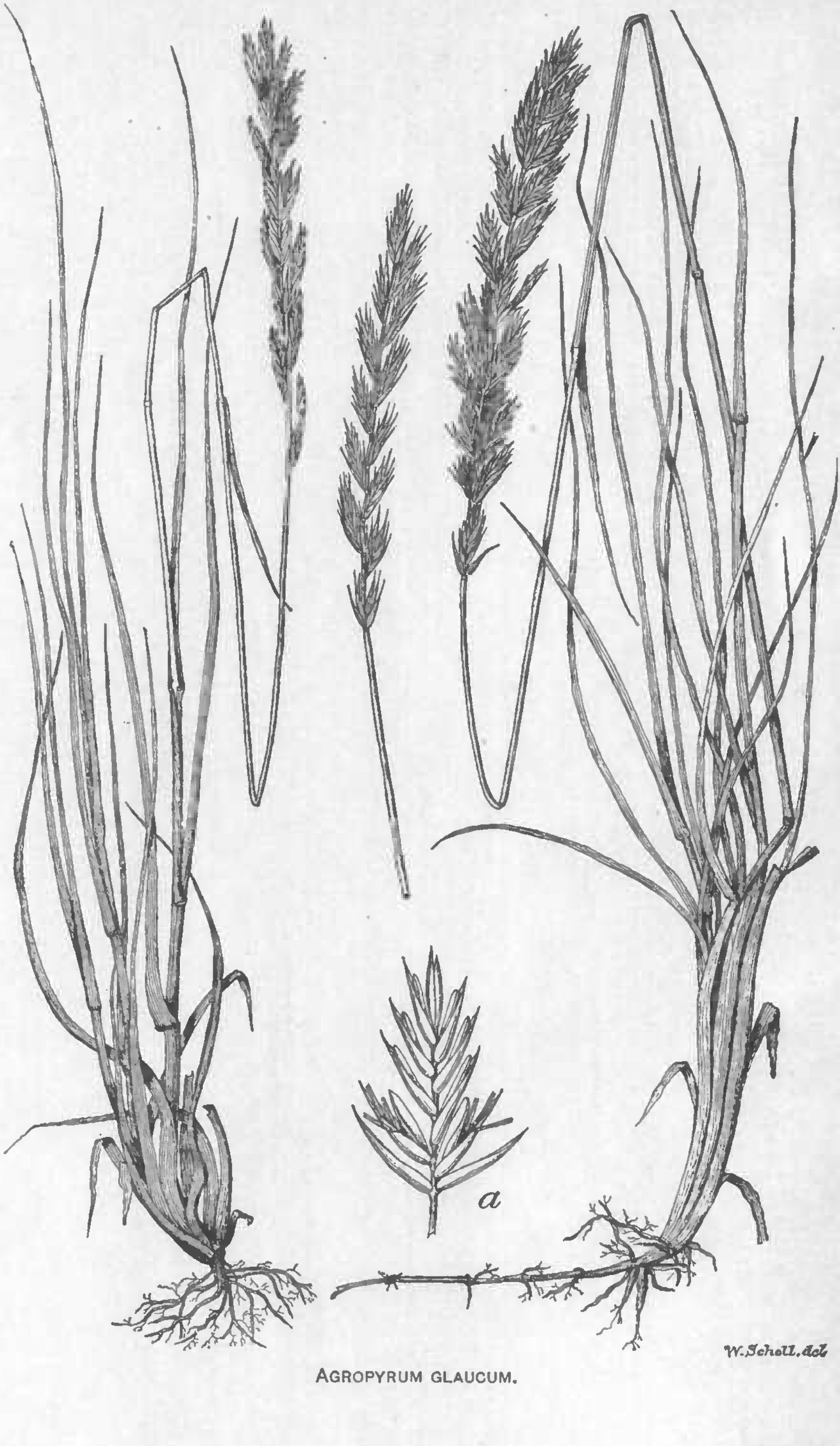
A barn may be built of any size in this way. Those at the United States experimental grass and forage station at Garden City are 20 by 40. One is 12 feet high, with a loft for hay; the other is 10 feet high, with roof and tall gables. The cost is about one-third that of a barn constructed of lumber.

These barns are cheap, durable, and adapted to the plains country. There should be hundreds of them in the arid region, as any intelligent or practical farmer can build one at his leisure and not only utilize his straw, which would otherwise go to waste, but provide the best shelter for his stock and farm machinery.

PLATE I.

PANICUM VIRGATUM.

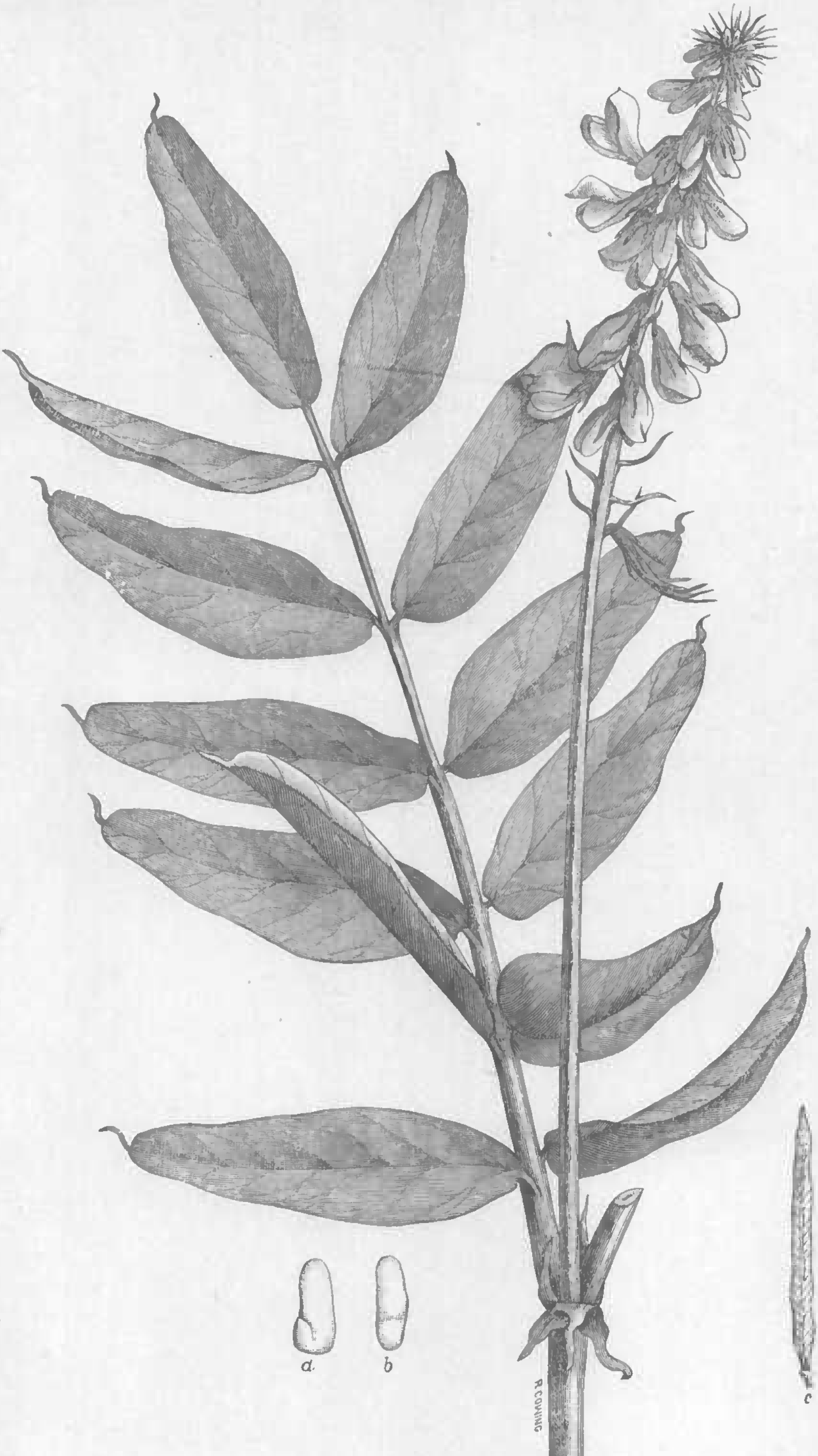
BROMUS INERMIS.



AGROPYRUM GLAUCUM.

CHRYSOPOGON NUTANS.

ANDROPOGON HALLII.



GALEGA OFFICINALIS.

ANTHYLLIS VULNERARIA.

Report of Botanist, U. S. Dept. of Agriculture, 1892.

BARN OF BALED STRAW.

COÖPERATIVE BRANCH STATIONS IN THE SOUTH.

By S. M. TRACY, *Superintendent.*

In the Report of the Secretary of Agriculture for 1891, an account is given of the establishment in 1888 of a station for special work with grasses and forage plants in Mississippi, and of the establishment, in 1891, of other stations in North Carolina, Georgia, Florida, and Louisiana for similar work. The appropriation for the present year having been greatly reduced from the amount provided in previous years, the work in North Carolina and Florida was dropped, but that in Georgia, Louisiana, and Mississippi is still continued.

In the South there is no scarcity of hay-producing plants, and good forage is abundant during the summer and autumn months, but in the winter and early spring the fields are nearly bare and the pastures of native grasses are almost worthless. Lespedeza and Bermuda grass, the two great forage plants of the South, begin their annual growth only after the advent of summer, and are killed to the ground by the first severe frost. While they grow, they thrive with such luxuriance as to crowd out most other plants, and so, when they are killed by frosts, the fields are left with very little forage until the warm weather of the next season.

From the fact that comparatively few cattle are kept in the South, and that the few which are kept are seldom stabled, the Southern farmer has very little stable manure for use on his cultivated fields, and must therefore look to other sources for his fertilizers. The work of the various experiment stations has clearly shown, that for the lime lands and the piney-woods region of the South it is much more economical to grow the fertilizers in some crop suitable for plowing under than to purchase them, either in the form of chemicals or as cotton-seed meal. With these two important conditions in view, it has been the effort of these Southern grass stations to find—

(1) Such plants as would yield a fair amount of pasturage during the winter and early spring months; and

(2) To find such plants as would be of the greatest value for fertilizing purposes, and would also give fair returns, either as hay or as pasture plants.

With these ends in view, the stations have planted seeds of 495 species of grasses and forage plants, procured from nearly all parts of the world. Most of these have been planted at each station, and many at two or more stations for several seasons, on soils of very different characters. As was to be expected, most of those tested have proved of little or no value when grown under the peculiar climatic conditions which obtain throughout the South. A few, however, are growing finely and promise to become valuable additions to our list of hay and pasture plants, while others are being recognized as important factors for restoring fertility to soils which have become exhausted by continued cultivation in cotton and corn. Among the more promising of these are the following:

HUNGARIAN BROME (*Bromus inermis*).—This is nearly related to the well-known "rescue-grass," but is decidedly superior in its more permanent character and its ability to thrive on drier and less fertile soil. It starts into growth with the autumn rains, and is fresh and green during the winter months, being uninjured by our heaviest frosts. It forms a compact sod so firm as to prevent the growth of other grasses and weeds, and the yield of forage is larger than from any other winter grass we have tested. It is eaten well by all kinds of stock, and continues in good condition well into the summer. It produces a dense mass of leaves a foot or more in length, which make the finest of hay, though the stems are short and the yield of hay is small. It is preëminently a winter grass, and as such we regard it as being the most valuable grass which we have imported.

TEOSINTE (*Euchlæna luxurians*).—This plant needs a long season of hot weather, a rich soil, and abundant moisture to succeed well, and it is useless to plant it except where all these conditions can be had. It has done fairly well at the Mississippi and Georgia stations, very little in North Carolina, and has made a heavier crop than any other plant which has been grown at the Louisiana station. In Mississippi, the heaviest yield secured has been 22 tons per acre, while the Louisiana station reports the enormous yield of 55 tons of green forage per acre. The plant makes from forty to sixty shoots from a single seed; and, as these grow from 10 to 12 feet high, they are so crowded that the stalks are small and a very large proportion of the bulk consists of leaves which, pound for pound, have a fodder value fully equal to that of sorghum. Its value for feeding purposes is seen in the fact that the entire crop grown at the Louisiana station was sold to a local dairyman at the rate of $2 per ton while standing in the field. There is probably no better plant than this for soiling purposes, as it starts very quickly after cutting, and in the extreme South will give three or four heavy cuttings each season. The seed matures well at the Louisiana station, but has never done so in Mississippi.

CRAB GRASS (*Panicum sanguinale*).—In the Northern States this is regarded as a troublesome weed and wholly worthless as forage, but in the South its character is very different, and it has great value for hay. It makes a heavy growth on lands from which wheat, oats, or other early crops have been harvested, and on good soils will yield 2 tons per acre of hay which, if cut before it is too ripe, is fully equal to the best timothy. On land which was plowed in February we have cut four crops of about 1 ton each in a season. As its best growth is made in cultivated fields, and at a season when other crops are not abundant, it is of considerable value for grazing; and as the hay made from it is of excellent quality and costs nothing but the cutting, it is highly prized by many planters, especially near the Gulf coast, where it is usually mixed with Mexican clover (*Richardsonia scabra*), which is equally valuable.

COW PEA (*Dolichos sinensis*).—It is often desirable to plow under some green crop when it is impossible to give up the land for the one or two years necessary to grow a crop of red clover or melilotus. In such cases we have no other plant which is so desirable as the cow pea. It may be sowed at almost any time during the summer, will grow on any soil, and makes excellent hay or pasture; while the long deep roots bring a large amount of plant food from the subsoil and leave it near the surface, where it is available for succeeding crops. One of its great merits is that it can be grown successfully under varying circumstances, and that when the seed is put into the ground with even ordinary care a crop is the sure result. Many planters use the bunch varieties for planting between the rows of corn or cotton at the last plowing. When sowed in this way they do not interfere with the growing crop, will give a fair yield of seed, and the decaying vines make a most excellent covering for the soil during the winter. By spring the roots and vines will be thoroughly decayed, and by reversing the beds so as to bring the rows of cotton this year on the rows where the peas grew last year, the crop is largely increased and no time is lost. When sowed in this way they are difficult to gather for seed, but make the best of fall pasture, and the droppings from the cattle fully repay the loss of the vines.

When sowed broadcast after oats, wheat, or some other early crop, the running sorts make a heavy yield of hay, which, although somewhat difficult to cure, is of the very best quality. By growing such a crop, hay is made at a very small expense, while the soil is shaded during the driest and hottest months, and left loose, mellow, and in the best possible condition for any future crop. The roots penetrate the soil as deeply as do those of red clover; and this fact makes the crop an especially valuable one for heavy and seepy soils which need draining. When land is not in use otherwise for even two months during the summer or fall, it will always pay well to seed it to peas, as the seed which can be gathered will fully pay the cost of cultivation and give the fertilizing value of the crop as a clear profit.

MELILOTUS (*Melilotus alba*, Bokhara clover, sweet clover).—This plant bears a close resemblance to alfalfa, but is larger and coarser in every way and is especially adapted for use on calcareous soils. It will make an excellent growth on any lime lands, even on "rotten limestone" hills which are so barren that they will sustain no other plants, but is of almost no value on the red clays, which contain but little lime. It is not generally liked by animals unaccustomed to its use, but it starts into growth very early in the spring, when green forage is scarce; and if stock are turned on it at that time they very soon acquire a taste for it and eat it readily through the remainder of the season. When grown for hay, one and sometimes two crops can be cut in the fall after sowing in the spring, and during the next season two or three crops may be cut, after which it should be allowed to mature seed. Unless cut early the stems become hard and woody, and in all cases care is necessary in handling in order to prevent the loss of leaves, which drop from the stems very easily. Excellent hay can be made by sowing melilotus on lands which have been set in Johnson grass, the mixture seeming to improve the palatability of both. From land cultivated in this manner we have seen three cuttings, of about 2 tons each per acre, made in one season.

As a restorative crop for yellow loam and white lime lands, this plant has no superior, and for black prairie soils it has no equal. Most of the black prairie soils are still rich in plant food, and during the early part of the season cotton makes a rank growth on them and promises a heavy crop; but with the August and September droughts the bolls drop from the stalks, and the crop is far less than is expected from the rank growth of the plant. The use of ordinary fertilizers seems to have little effect on such soils, and the trouble with them appears to be in their mechanical condition rather than in their want of plant food. Draining with tile has worked well where we have tried it, but this is too expensive to be generally adopted, and we have found the growing of an occasional crop of melilotus to accomplish fully as good results.

The expense of seeding land to melilotus is less than for seeding to oats, the crop is a profitable one either for hay or for pasture, and at the end of the second year the land is left in the best possible condition for any succeeding crop. The roots of the melilotus are long, penetrating the soil to a depth of 3 or 4 feet, are quite large, and by their decay at the end of the second year leave the soil with innumerable minute holes, which act as drains to carry off the surplus water, and loosen the soil so that the roots of other plants can go deeper and find more abundant supplies of food. Melilotus is one of the few plants which are able to draw their supply of nitrogen from the air, and so, by its decay, it furnishes the most valuable and expensive ingredient of commercial fertilizers free of cost, and in the best possible form.

The hay from this crop will not sell as well as that from lespedeza, but the crop is heavier, will furnish more pasture, and is by far the most valuable crop we have for a natural fertilizer.

ALFALFA (*Medicago sativa*).—This plant has failed to produce satisfactory yields at any of the stations except the one in Louisiana, where it is planted on the alluvial lands near the river and where its growth has been unusual. At that station, the first sowing was made in October, 1890, and in June, 1892, twenty months after planting, fourteen cuttings, averaging nearly $1\frac{1}{4}$ tons per acre, had been taken from the land. Another field, sowed in March, 1892, had given three cuttings by the end of June. At the Mississippi station a field was sowed in 1889 which gave three cuttings of about $1\frac{1}{2}$ tons each per acre in 1890, while in 1892 the yield had decreased to three cuttings of only about 1 ton each. A thoroughly drained soil, with an abundance of moisture, seems necessary to its successful growth.

HAIRY VETCH (*Vicia villosa*).—The seed of this plant was first sowed in October, 1888, and since then has given heavy annual crops on the same ground, although it has received no attention and the ground has not been plowed since the first sowing. In 1889, another field was sowed and has given equally good results. It is an annual which bears a close resemblance to a very slender pea vine, and which makes its entire growth during the cooler months. The seeds germinate with the first autumn rains and, in a favorable season, the ground will be well covered by January 1. At this date, December 12, the plants at the Mississippi station average about 6 inches in height, and will afford good grazing in January. If not pastured, the vines will reach a length of from 10 to 12 feet in May, when the seed will ripen, and by July the plants will have disappeared. Stock eat the vines greedily, but should be taken off the field by the first of April, to give the plants an opportunity to mature a crop of seed. If the stock is taken off in time so that even a moderate crop of seed is procured, the land will not need plowing or reseeding for the next season. For winter grazing we regard this as the most valuable plant we have ever seen, while for fertilizing purposes it is fully equal to the cow pea.

From our experience during the past five years, we do not expect to find any one plant which can be regarded, under all circumstances, as being "the best" for either hay, pasture, or fertilizing purposes. To secure the best results for either purpose, we must use a mixture of two or more sorts which make their maximum growth at different seasons; and one of the species used should be a leguminous plant, in order that the land may become better prepared for succeeding crops. The selection of the sorts must vary with the character of the soil on which they are to be planted, the length of the growing season, and the amount of moisture in the soil. Most of the true grasses are affected more by moisture than by other differences in the soil, while most leguminous plants are affected more by the amount of lime present. For general cultivation in the South for hay, we regard Bermuda grass, lespedeza, Johnson grass, red clover, and crab grass as the five best species, and value them in about the order given. For winter grazing, we have found nothing better than hairy vetch, Hungarian brome, orchard grass, rescue-grass, and burr clover. For the region near the Gulf coast, alfalfa should be added to the list of hay plants, and carpet grass (*Paspalum platycaule*) to the list for pastures; while at the Carolina and Georgia stations wonderful results have been secured by the growth of crimson clover. If the crop is to be grown partly for hay or pasture and partly for its fertilizing effect on the soil, there is nothing equal to the cow pea and winter vetch for immediate effect. If the land is not to be plowed for a year or more, the winter vetch and melilotus, red clover, or lespedeza are our best plants. If the land contains an excess of lime, melilotus will be the better crop, but if deficient and somewhat barren, lespedeza will succeed better. On lime soils which are already in fair condition, red clover will give excellent results as a fertilizer, and will also give two or three crops of hay which will be of more value than that from either melilotus or lespedeza.

The work of the Southern grass stations is demonstrating clearly—

(1) That hay, equal to the best in quality, can be produced here at less expense than in any other part of the country;

(2) That by using a proper selection of varieties, good pasturage can be secured during at least ten months of the year; and

(3) That by growing leguminous crops for hay and pasture, a large proportion of the money now expended in the purchase of commercial fertilizers can be saved.

THE RUSSIAN THISTLE.*

The Russian thistle or Russian cactus (*Salsola kali* var. *tragus*) is really neither a thistle nor a cactus. Saltwort is its true English name, but to the farmers of the Northwest, who are best acquainted with the plant, it is known as the Russian thistle.

The weed is an annual, growing to a height of 6 inches to 3 feet, branching profusely, and when not crowded forming a dense, bush-like plant 2 to 6 feet in diameter and one-half to two-thirds as high. When young, it is tender and juicy throughout, with small, narrow, downy, green leaves; but in late summer it sends out hard, stiff branches which bear, in place of leaves, sharp spines, one-fourth to one-half inch long. At the base of each cluster of spines is a papery flower about one-eighth inch in diameter.

The Russian thistle takes possession of a field to the exclusion of everything else, drawing from the land a large amount of nourishment. It is armed with spines quite as sharp as those of the Canada thistle and much stronger, so that in some sections the farmers find it necessary to bind leather about the horses' legs while at work. It is the worst tumbleweed of the plains, and in time of prairie fires is easily blown across a fire-break of any width, carrying fire to stacks and buildings.

The plant originated in eastern Europe or western Asia, and in Russian wheat fields has quite as bad a reputation as in those of the Dakotas. It was introduced into Bon Homme County, S. Dak. about fifteen years ago, probably in flaxseed imported from Europe. By the year 1892 it has become more or less common over all the region between the Missouri and Jim rivers in South Dakota, extending into North Dakota as far as the second tier of counties. A district of about 30,000 square miles is infested with the weed, which has become a pest

*Abstract of Farmers' Bulletin No. 10.

throughout two-thirds of this area. More than 640,000 acres of the badly infested region is devoted to wheat-raising, and the total loss caused by the plant in 1892 is estimated at more than $2,000,000.

The Russian thistle grows best on high, dry land. The plants are less numerous and robust in wet than in dry seasons, not because they cannot stand wet weather, but because they are more crowded by other plants. The thistle appears to grow equally well in alkaline and nonalkaline soils. The absence of trees and fences, the strong winds, and the methods of farming followed in the Northwest are particularly favorable to its distribution and growth. The policy of growing only a few very profitable crops has induced the farmers to break up a larger area than they can work well. Wheat is sowed over acre after acre, sometimes merely drilled in on the furrow, or even on unplowed stubble land. Where whole sections and even townships form one continuous wheat field, an acre here and there so grown up to weeds as not to be worth harvesting, does not seem to be of much importance; but it is in such places that the principal development of thistle seeds for the succeeding year takes place. Plowing in the spring or early summer is especially favorable to the growth of the Russian thistle, since it then obtains a thorough foothold in July, and, being able to stand dry weather better than other plants, takes complete possession of the soil.

The following remedies are recommended: Plow in August or early September, before the weeds have grown large and stiff and before they have gone to seed. If the season be long and the plants come up through the furrow, it may be necessary to harrow the land before winter. Burn over stubble fields as soon as possible after harvest, and cut the stubble with a mowing machine if the fire does not burn everything clean. If the weeds have been neglected and have grown large and rigid, as they do by the middle of September, especially on neglected barren fallow, they may be raked into windrows and burned. This method is to be recommended only as a final resort, for by the last of September some of the seeds will be ripe enough to shell out and will escape being burned with the plants. Barren fallowing does very well if the land is kept barren by thorough cultivation. It gives but little benefit to the land, however. A much better method is to sow clover, millet, or rye, pasture it and plow it under while green. Corn, potatoes, beets, or any cultivated crop, well taken care of, will in two years rid the land not only of the Russian thistle but of nearly all other weeds. Sheep are very fond of the plant until it becomes too coarse and woody. By pasturing sheep on the young thistle it may be kept down, and the only valuable quality the plant has may be utilized. If the Russian thistle is to be kept out of cultivated fields, it must be exterminated also along roadsides, railroad grades, fire-breaks, waste land, wherever the sod has been broken, and in all places where it may obtain an accidental foothold.

Plate IX represents a branch of the plant as it appears in autumn; *a*, a branch of a young plant; *b*, a mature seed, enlarged. A branch of a Russian thistle before flowering is represented in the Report of the Botanist of the U. S. Department of Agriculture for 1891, Plate X.

SALSOLA KALI VAR. TRAGUS.

REPORT OF THE CHIEF OF THE DIVISION OF VEGETABLE PATHOLOGY.

SIR: I have the honor to submit herewith my annual report for the year 1892, consisting, as heretofore, of a summary of the work of the division.

Respectfully,

B. T. GALLOWAY,
Chief.

HON. J. M. RUSK,
Secretary.

INTRODUCTION.

During the year but few changes have been made in the divisional force. Early in August Miss E. A. Southworth resigned to accept a position in Columbia College, New York. The matter being brought to your attention, Mr. D. G. Fairchild was made first assistant. The establishment of a laboratory at Eustis, Fla., made it necessary to send two assistants there, Mr. W. T. Swingle and Mr. H. J. Webber being selected for the purpose. Mr. Swingle was already a member of the force, but Mr. Webber was appointed especially for the work in view. The scientific staff of the division now consists of Erwin F. Smith, M. B. Waite, D. G. Fairchild, Newton B. Pierce, W. T. Swingle, H. J. Webber, Joseph F. James, P. H. Dorsett, and Miss May Varney. But two field agents were employed during the year, viz, Mr. J. F. Swingle and Mr. Elam Bartholomew, the former located at Manhattan and the latter at Rockport, Kans. The clerical force, consisting of one stenographer and typewriter and two clerks engaged in general work, remains the same as last year.

During the year the division has published one number of the Journal of Mycology; a special bulletin on the California vine disease, and another on the experiments made in 1891 in treating plant diseases; also Farmer's Bulletin No. 5, on the treatment of smuts of oats and wheat, and part of Farmer's Bulletin No. 7, on spraying fruits for insect pests and fungous diseases. A circular of inquiry on wheat rust was issued early in March, and another on potato leaf-blight was sent out in August.

The preparation of an index to all literature on plant pathology and allied subjects, which was begun early in the year, has been continued. As announced in the Journal of Mycology (Vol. VII, No. 2), where the first part of this work was published, the index is designed especially to aid experiment station workers and others who do not have access to the more important literature on plant diseases. The preparation of the index consumes a considerable part of the time of myself and assistants, but such time I consider well spent, as it keeps the force thoroughly posted upon nearly all subjects having a bearing upon the investigations of the division.

The correspondence of the division is steadily growing, but by means of farmers' bulletins, special circulars, etc., many of the questions asked can be answered quickly and in sufficient detail to serve every purpose. As a part of the more or less general work of the division the delivery of addresses before horticultural, agricultural, and other societies may be mentioned. Addresses of this kind were made by myself and assistants during the year before societies and associations in Connecticut, New York, New Jersey, Delaware, Virginia, Florida, and California. The preparation of an exhibit for the Columbian Exposition is a matter which has also consumed a considerable part of the time of the office force. From these somewhat general remarks I will now pass to a review of the more extended investigations of the division made during the year.

FIELD WORK OF THE YEAR IN TREATING PLANT DISEASES.

EXPERIMENTS IN THE TREATMENT OF RUSTS AFFECTING WHEAT AND OTHER CEREALS.

The rusts affecting the cereal crops of this country have unquestionably played an important part in keeping the average yield down to a ridiculously low figure. It is difficult to ascertain how much damage is really caused by rusts, for the reason that it is almost impossible to get accurate figures for comparison. Usually, the comparison of one year's yield with another, or one field with another, is made by farmers when the question as to the loss arises. Of course data obtained in this way is not reliable, as other things besides rust fungi may have played an important part in diminishing or increasing the yield. Taking wheat, however, as an example, I think that, one year with another, a very low estimate of the loss in the United States resulting from rust would be 2 bushels per acre. The average yield of wheat in this country in 1891 was only 15.3 bushels per acre*, so that if by any possible means rust could have been entirely prevented, the average would have been raised to 17.3 bushels. This would mean a total increase in round numbers of 80,000,000 bushels, which, if sold for the average value of the crop per bushel in 1891, would bring $67,000,000. It is not to be supposed that rust could have been entirely prevented, but even if half the damage had been arrested, our farmers, on their wheat crop alone, would have saved in the neighborhood of $34,000,000.

With the exception of some experiments now in progress in Australia, no systematic endeavor has, so far as known, been made to prevent rust. The problem, for a number of reasons, is a difficult one. In the first place, spraying, which has proved so successful in the prevention of other plant diseases, is, with this crop, exceedingly laborious and expensive. Besides spraying, there remain, as the most promising means of preventing rust, the treatment of the soil with chemicals before the seed is planted, the treatment of the seed with fungicides, the adoption of certain methods of fertilizing, planting, and cultivation, and finally the discovery of varieties able to resist the attacks of the parasite, and

* Report of the Secretary of Agriculture 1891, p. 290.

at the same time possessing all other qualities of a first-class grain. The foregoing problems, especially the production of rust-resisting varieties, will require long and painstaking labors to settle. Before any intelligent efforts at breeding can be undertaken, a thorough study of the more important rust-resisting and nonrust-resisting varieties must be made in order to determine if they possess anatomical or physiological characteristics, separate or combined, which enable them to resist the disease.

The experiments the past season were confined to soil treatment, seed treatment, and spraying, as it was thought best to obtain some definite information on these points before undertaking the more difficult lines of work. Spraying experiments alone were carried on at Manhattan, Kans., while work covering all three lines was conducted at Garrett Park, Md., and Rockport, Kans. By this arrangement it was believed that the results would be more valuable, as the experiments would be conducted under widely different conditions of soil and climate. Briefly stated, the principal objects of the experiment were as follows:

(1) To determine the effect on winter wheat of treating the soil with various chemicals before planting.

(2) To determine the effect of treating the seed before planting with chemicals known to have fungicidal value and with hot water.

(3) To determine the effect of spraying and dusting the plants every ten days from the time they appeared above ground until harvest, using various preparations of known fungicidal value and others that had never been tested in this respect.

(4) To determine the effect of spraying and dusting every twenty days, beginning and ending as in the preceding case and using the same preparations.

(5) To determine the effect of spraying and dusting the plants every ten days, combined with certain soil treatments alone, and with both soil and seed treatments.

(6) To determine the effect of spraying and dusting every twenty days, combined with other treatments the same as the last.

(7) To determine the effect on spring-planted oats, wheat, and rye, of spraying and dusting with preparations of different strengths from those used in the preceding work, the treatments to be made at intervals of two, ten, and twenty days, respectively.

The word "effect" is here used in a broad sense, including the influence of the various treatments on rust as well as on the soil, seed, and plants.

EXPERIMENTS AT GARRETT PARK, MD.

A block of ground 400 feet long and 110 feet wide was selected for the work at this place. It was comparatively level and fairly even in fertility throughout. The ground was plowed, thoroughly harrowed, and then laid off in plats 3 feet wide and 33 feet long, with walks 2 feet wide at the sides and 3 feet wide at the ends. The platting was finished on October 14. Planting began the same day and ended on October 25. The planting was done by hand, the grain being sown in drills 9 inches apart and at the rate of 2 bushels per acre. The drills were opened and the grain covered by means of a hoe. One hundred and seventy-five plats were planted, eighty-five of which served for the experiment proper, eighty-five for duplicates, and five for miscellaneous treatments.

Following is a list of the various treatments, arranged in tabular form:

Plats.	Kind of treatment.	Plats.	Kind of treatment.
1 and 91....	Untreated.	37 and 127....	Untreated.
2 and 92....	Soil treatment with flowers of sulphur, 4 ounces to each 20 feet of row.	38 and 128....	Seed treatment, 24 hours' immersion in a $\frac{1}{10}$ per cent solution of corrosive sublimate.
3 and 93....	Untreated.	39 and 129....	Untreated.
4 and 94....	Soil treatment with flowers of sulphur, 2 ounces to each 20 feet of row.	40 and 130....	Plants sprayed every 10 days with standard strength Bordeaux mixture, beginning as soon as above ground.
5 and 95....	Untreated.	41 and 131....	Untreated.
6 and 96....	Soil treatment with flowers of sulphur, 1 ounce to each 20 feet of row.	42 and 132....	Plants sprayed every 10 days with ammoniacal solution of copper carbonate, standard strength, beginning as soon as above ground.
7 and 97....	Untreated.	43 and 133....	Untreated.
8 and 98....	Soil treatment, flowers of sulphur and air-slaked lime, equal parts mixed, 4 ounces to each 20 feet of row.	44 and 134....	Plants sprayed every 10 days from the time they appeared above ground with a solution of potassium sulphide 2 ounces to 3 gallons of water.
9 and 99....	Untreated.	45 and 135....	Untreated.
10 and 100....	Soil treatment, flowers of sulphur and air-slaked lime, equal parts mixed, 2 ounces to each 20 feet of row.	46 and 136....	Plants sprayed with Bordeaux mixture, standard strength, every 20 days.
11 and 101....	Untreated.	47 and 137....	Untreated.
12 and 102....	Soil treatment with powdered iron sulphate (dried), 4 ounces to each 20 feet of row.	48 and 138....	Plants sprayed every 20 days with ammoniacal solution of copper carbonate, standard strength.
13 and 103....	Untreated.	49 and 139....	Untreated.
14 and 104....	Soil treatment with solution of iron sulphate (dried), 8 ounces to a gallon of water, sprayed on the ground at the rate of one-half gallon to each 20 feet of row.	50 and 140....	Plants sprayed every 10 days with cupric ferrocyanide mixture.
15 and 105....	Untreated.	51 and 141....	Untreated.
16 and 106....	Soil treatment, one-half gallon of standard Bordeaux mixture to each 20 feet of row.	52 and 142....	Plants sprayed every 10 days with ferrous ferrocyanide mixture.
17 and 107....	Untreated.	53 and 143....	Untreated.
18 and 108....	Soil treatment with one-half gallon of water containing one-half ounce of potassium sulphide to each 20 feet of row.	54 and 144....	Plants sprayed every 10 days with copper borate mixture.
19 and 109....	Untreated.	55 and 145....	Untreated.
20 and 110....	Soil treatment with one-half gallon standard ammoniacal solution of copper carbonate to each 20 feet of row.	56 and 146....	Plants sprayed every 10 days with ferric chloride solution.
21 and 111....	Untreated.	57 and 147....	Untreated.
22 and 112....	Soil treatment with one-half gallon standard Bordeaux mixture to 20 feet of row.	58 and 148....	Plants dusted every 10 days with flowers of sulphur.
23 and 113....	Untreated.	59 and 149....	Untreated.
24 and 114....	Soil treatment with a solution of potassium bichromate, $1\frac{1}{2}$ ounces of the crystalized bichromate in $13\frac{1}{2}$ quarts of water, sprayed on the entire plat.	60 and 150....	Plants dusted every 10 days with sulphosteatite.
25 and 115....	Untreated.	61 and 151....	Untreated.
26 and 116....	Seed treatment, 15 minutes immersion in water at a temperature of $132\frac{1}{2}°$ F.	62 and 152....	Complete treatment with standard strength Bordeaux mixture; seed soaked 24 hours, ground sprayed before planting with $13\frac{1}{2}$ quarts, and plants sprayed every 10 days.
27 and 117....	Untreated.	63 and 153....	Untreated.
28 and 118....	Seed treatment, 24 hours' immersion in 1:800 solution of copper sulphate, then limed.	64 and 154....	Complete treatment with potassium sulphide solution (same as for Bordeaux), 2 ounces of potassium sulphide to 2 gallons of water.
29 and 119....	Untreated.	65 and 155....	Untreated.
30 and 120....	Seed treatment, 24 hours' immersion in Bordeaux mixture, standard strength.	66 and 156....	Seed immersed 15 minutes in water at $132\frac{1}{2}°$ F., ground sprayed with ammoniacal solution, standard strength, and plants sprayed every 10 days with the same preparation.
31 and 121....	Untreated.	67 and 157....	Untreated.
32 and 122....	Seed treatment, 24 hours' immersion in potassium bichromate, 5 per cent solution.	68 and 158....	Seed immersed 15 minutes in water at $132\frac{1}{2}°$ F.; soil treated with Bordeaux mixture, standard strength, and plants sprayed every 10 days with same preparation.
33 and 123....	Untreated	69 and 159....	Untreated.
34 and 124....	Seed treatment, 24 hours' immersion in a solution of potassium sulphide, 1 ounce to a gallon of water.	70 and 160....	Seed immersed for 15 minutes in water at $132\frac{1}{2}°$ F.; soil treated with lime and sulphur, equal parts, mixed, at the rate of 4 ounces to 20 feet of row.
35 and 125....	Untreated.	71 and 161....	Untreated.
36 and 126....	Seed treatment, 24 hours' immersion in a solution of potassium sulphide, one-half ounce to 1 gallon of water.		

Plats.	Kind of treatment.	Plats.	Kind of treatment.
72 and 162....	Seed immersed for 15 minutes in water at 132½° F., and soil treated with iron sulphate at the rate of 2 ounces to 20 feet of row.	77 and 167....	Untreated.
73 and 163....	Untreated.	78 and 168....	Soil treated with common salt at the rate of $\frac{1}{15}$ ounce to 20 feet of row.
74 and 164....	Seed, soil, and plants treated with iron (ferrous) sulphate; seed immersed for 24 hours in a 10:100 solution; soil sprayed before sowing and plants sprayed every 10 days with solution, 4 ounces to 1 gallon of water.	79 and 169....	Untreated.
		80 and 170....	Soil treated with common salt at the rate of $\frac{1}{20}$ ounce to 20 feet of row.
		81 and 171....	Untreated.
		82 and 172....	Soil treated with copper sulphate solution, 13½ ounces to 13½ quarts of water per plat.
75 and 165....	Untreated.	83 and 173....	Untreated.
76 and 166....	Seed immersed in ammoniacal solution, standard strength, 24 hours; plants sprayed every 10 days with the same preparation.	84 and 174....	Plants sprayed with cupric hydroxide mixture every 10 days.
		85 and 175....	Untreated.

As will be seen from the foregoing list, nine solutions and two powders were used in the spraying and dusting experiments. For the sake of convenience, the solutions were prepared at the time of each treatment in 2-gallon quantities. At first this was much more than was necessary to cover each plat, but towards the last, when the wheat was full grown, the entire amount was needed. Following is a list of the eleven preparations showing the composition of each:

1. BORDEAUX MIXTURE.

Cupric sulphate	5.22 grams..........	.184 ounces.
Lime (quick)	1.26 grams..........	.044 ounces.
Water	7,572 grams..........	2 gallons.

2. AMMONIACAL SOLUTION OF COPPER CARBONATE.

Cupric basic carbonate	2.34 grams..........	.082 ounces.
Aqua ammonia (26°)..........	50 cubic cm	1.68 ounces.
Water	7,572 grams..........	2 gallons.

3. FERROUS FERROCYANIDE MIXTURE.

Ferrous sulphate (exsiccatus)	3.44 grams..........	
Potassium ferrocyanide (yellow prussiate of potash).	9 grams..........	.518 ounces.
Water	7,572 grams..........	2 gallons.

4. COPPER BORATE MIXTURE.

Cupric sulphate	5.22 grams..........	.184 ounces.
Sodium borate (borax)..........	13 grams..........	.458 ounces.
Water	7,572. grams..........	2 gallons.

5. FERRIC CHLORIDE SOLUTION.

Ferric sesquichloride..........	.24 grams..........	.254 ounces.
Water	7,572 grams..........	2 gallons.

6. FERROUS SULPHATE SOLUTION.

Ferrous sulphate (exsiccatus)	30.42 grams	1.072 ounces.
Water	7,572 grams	2 gallons.

7. CUPRIC FERROCYANIDE MIXTURE.

Cupric sulphate	5.22 grams	.194 ounces.
Potassium ferrocyanide (yellow prussiate of potash).	11.90 grams	.404 ounces.
Water	7,572 grams	2 gallons.

8. CUPRIC HYDROXIDE MIXTURE.

Cupric sulphate	5.22 grams	.194 ounces.
Potassium hydrate (caustic potash)	2.34 grams	.082 ounces.
Water	7,572 grams	2 gallons.

9. POTASSIUM SULPHIDE SOLUTION.

Potassium sulphide (liver of sulphur)	28.34 grams	.998 ounces.
Water	7,572 grams	2 gallons.

10. FLOWERS OF SULPHUR.

Commercial article in dry form.

11. SULPHOSTEATITE.

Furnished by C. H. Joosten, New York. A powder consisting approximately of 9 parts of steatite or talc and 1 part of finely-powdered copper sulphate.

The details as to the methods of preparation, application, etc., are omitted here, but will be found in full in the Journal of Mycology (Vol. VII, No. 3). It may be said, however, in passing, that the ammoniacal solution of copper carbonate, containing 2 ounces of copper carbonate, dissolved in 1 quart of ammonia and diluted with water to 22 gallons, was used as a basis in preparing all of the mixtures containing copper. The mixtures containing iron were double the strength of the copper preparations.

The leaves of wheat were found extremely difficult to wet, and to overcome this a 5-cent bar of common ivory soap was added to each preparation, excepting the iron chloride and ferrous sulphate. With these soap would not mix. The soap greatly increased the wetting power of the preparations, but in no case was it found possible to make the liquids cover all parts of the foliage.

The work of spraying and dusting began on November 14, and was carried on, with but one or two interruptions, in accordance with the original plan until May 16, seventeen treatments in all being made upon the ten-day plats, and nine upon those in the twenty-day series. Without going into further details in regard to the work, the general results may be summarized as follows:

(1) No rust whatever appeared on any of the plats or in any of the adjoining fields until the first week in May. At this time the fungus appeared in isolated spots among the original plats and soon spread to others.

(2) For the first ten days after the rust appeared the duplicate plats and those sprayed with Bordeaux mixture, ammoniacal solution of copper carbonate, and ferrous ferrocyanide mixture were less affected than any of the others. By May 20, however, all plats were affected alike, the rust being exceedingly abundant on almost every leaf. The absence of rust from the duplicate plats for the first ten or twelve days can only be explained upon the theory that the plants being at least two weeks behind the others in point of growth, they were not in the proper condition for infection.

(3) The soil and seed treatments were absolutely worthless so far as the prevention of rust was concerned. Moreover, a number of them killed every grain and others so weakened the vitality of the latter that growth was very poor.

SUPPLEMENTARY EXPERIMENTS IN THE TREATMENT OF RUST OF WHEAT AND OTHER CEREALS AT GARRETT PARK, MD.

As a supplementary experiment it was decided early in March, 1892, to spray spring-planted wheat, oats, and rye with a number of the standard fungicides, using full and half strength preparations. It was thought best to plant the grain as late as possible in order to invite the attacks of rust fungi. No harvest, of course, was expected. On May 17, therefore, fifty-seven plats, each 3 by 33 feet, were staked off. Thirty-six plats were planted with wheat, twelve with oats, and nine with rye. In the case of each crop, half of the plats were treated and half were left for control. The fungicides used were Bordeaux mixture, full and half strength; ammoniacal solution, full and half strength, sulphur, and sulphosteatite. The Bordeaux mixture, full strength, contained 6 pounds of copper sulphate and 4 pounds of lime to 22 gallons of water. The ammoniacal solution was made by dissolving 2½ ounces of copper carbonate in 1½ pints of ammonia, then diluting to 25 gallons. For the half-strength preparation the quantity of water in each case was doubled. The sulphur and sulphosteatite were used as described in the experiment with winter wheat. The plants were treated at intervals of two, ten, and twenty days, respectively, from the time they appeared above ground until they were 8 inches high. The results of the work may be briefly summarized as follows:

(1) Rust appeared more or less on all the plats when the plants were from 2 to 5 inches high.

(2) The fungus was more abundant at first on the untreated plats and those dusted with flowers of sulphur and sulphosteatite. Despite the treatment, however, rust increased on every plat, and by the time the plants were 8 inches high there was no difference between the plats as regards the amount of the fungus.

In all cases where the liquids were used soap was added to make them wet the leaves more thoroughly. It was found, however, exceedingly difficult to cover the foliage even when the sprayings were made every two days. In case of these oft-repeated treatments fully four-fifths of the leaf surface was frequently found wholly unprotected.

WHEAT RUST EXPERIMENTS AT MANHATTAN, KANS.

The experiments at Manhattan, Kans., were conducted by Mr. J. F. Swingle on his farm about 1½ miles west of the State Agricultural College. In September, 1891, a plat of ground containing between 8,000 and 10,000 square feet was selected, and in October it was divided into nineteen plats, each about 20 feet square. The accompanying diagram shows the arrangement adopted, what would have been the twentieth plat being cut off to give the required number. A portion of the ground, marked by the diagonal lines, had been plowed in July. This part almost exactly coincided with lines running north and south across the ground, and included plats numbered 3, 4, 7, 8, 13, 14, 17, and 18. As this early plowing seemed to have an effect upon the yield of grain and

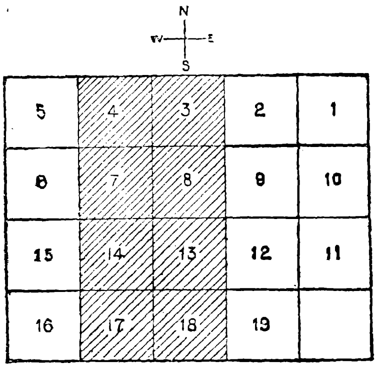


FIG. 1.—Plat of ground for wheat experiment at Manhattan, Kans. Nos. 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19 untreated. Nos. 2, 8, and 14 treated with Bordeaux mixture. Nos. 4, 10, and 16 treated with ammoniacal solution of copper carbonate. Nos. 6, 12, and 18 treated with potassium sulphide. The portion marked by diagonal lines was plowed early in the season.

straw, it should be taken into account when comparisons are made. All the land was rich bottom and had borne but one crop, and that in the preceding year.

The fungicides used in the work were Bordeaux mixture, ammoniacal copper carbonate solution, and potassium sulphide solution. The sprayings were made with a knapsack pump and a Vermorel nozzle every ten days from October 17, 1891, until June 13, 1892. On June 21 an estimate was made as to the amount of rust on the various plats. This varied from 20 per cent to 100 per cent, the former being on a plat treated with Bordeaux mixture and the latter on an untreated plat. Without going into details here, it seems that the plats sprayed with Bordeaux mixture showed the lowest percentages of rust, potassium sulphide and ammoniacal solution following in the order named.

On June 27 and 28 the grain was harvested, the plats being cut down to a uniform size of 16½ feet square. On August 8 the straw and grain were weighed and the grain thrashed out and weighed separately. Tabulating the results showed that there was no striking difference in favor of any of the treatments as far as rust was concerned. It was found, however, that the yield was greater where the ammoniacal solution was used than in the case of Bordeaux mixture. It is barely possible that this increase was due to the fertilizing effect of the fungicide on the soil, and it was also noted that plats treated with potassium sulphide gave about the same yield as ammoniacal solution. Here, too, the increase may have been due to the fertilizing effects of the fungicide. To sum up, briefly, the results, it would appear that Bordeaux mixture did, to a considerable extent, prevent rust, but the other preparations had no such effect. Further, the influence on the yield by the prevention of rust was not appreciable.

EXPERIMENTS AT ROCKPORT, KANS.

Three lines of work were carried on at this place. The first may be designated as experiment A, the second as experiment B, and the third as experiment C. Experiment A was to a certain extent the same as that with winter wheat at Garrett Park, Md. There were ten kinds of soil treatments, seven of seed treatments, six treatments involving spraying, and six combining soil, seed, and spraying treatments. In the spraying treatments only three preparations were used, viz, Bordeaux mixture, ammoniacal solution of copper carbonate, and potassium sulphide solution. These were applied at intervals of ten and twenty days, respectively, beginning on October 28 and ending June 24. The Bordeaux mixture contained 6 pounds of copper sulphate and 4 pounds of lime to 22 gallons of water; the ammoniacal solution of copper carbonate contained 3 ounces of copper carbonate, dissolved in one quart of ammonia, to 22 gallons of water; the potassium sulphide solution was made by dissolving 2 ounces of the chemical mentioned in 3 gallons of water. One hundred and thirty-one plats were used in the experiment, each plat being 25 feet long and 4½ feet wide. The wheat was planted by hand in rows, the same as at Garrett Park, the work beginning on October 9 and ending on October 15. Each plat was duplicated, the duplicates in every case being removed as far as possible from the originals in order to get an average condition of soil. Every alternate plat was left untreated to serve as a check or control. The common red rust, *Puccinia rubigo-vera*, appeared to a greater or less extent upon all of the plats the last week in May. *Puccinia graminis* and *Septoria gramineum* also occurred in limited amount in various parts of the block. The two last mentioned fungi, however, did little damage; in fact, they may be left out of consideration entirely in accounting for the injury done. *Puccinia graminis* ran its usual course, increasing in amount until the crop was harvested. The general conclusions in regard to this work may be given in Mr. Bartholomew's own words, as follows:

> Regarding the efficacy of the various treatments, I have little hesitancy in saying that the several soil treatments, so far as the prevention of rust is concerned, are practically valueless. The sulphur treatments were productive of good results in an increase of yield, but with this the matter drops. The success, whatever there has been of it, was attained through spraying. While it is true that no plat was entirely free from rust, it is nevertheless a fact that the ravages of this pest were reduced to a minimum on the plats treated every ten days with Bordeaux mixture and ammoniacal solution of copper carbonate. In my opinion the potassium sulphide solution should be discarded, as it had a deleterious effect wherever applied.

It may be added that the data furnished by the detailed notes made at the time of each treatment and by the final weighing of the straw and grain bear out fully the foregoing statements.

Experiment B consisted in spraying spring wheat and oats with eleven different preparations, and treating the seed and soil in one case only, with Bordeaux mixture. The solutions used are all fully described in another part of this report.* For the sake of clearness, however, the names are given in the following list, the numbers being the same as those used throughout the experiment.

26. Basic cupric acetate mixture.
27. Copper borate mixture.
28. Cupric ferrocyanide mixture.
29. Cupric hydroxide mixture.
30. Tricupric orthophosphate mixture.
31. Cupric polysulphide mixture.
32. Ferrous ferrocyanide mixture.
33. Iron borate mixture.
34. Iron sulphide mixture.
35. Zinc borate mixture.
38. Bordeaux mixture.

* "Experiments in treating the diseases of nursery stock," pp. 227–229.

Ivory soap was used with each of the foregoing, the same as at Garrett Park. Fifty plats, each 15 by 3 feet, were used for wheat, and the same number for oats. As regards the duplicates and control plats, the experiment was the same as A. The planting was all done on April 8. The oats were harvested on July 16, and the wheat two days later. In accordance with the original plan, the first spraying was made when the rust appeared, this being on June 4. Four other sprayings were made, viz, on June 6, 16, 25, and July 25, respectively. Summarizing the results, it may be said that Nos. 26, 27, 29, 30, 31, 35, and 38 gave excellent results as preventives of rust. The two plats treated with No. 26 were almost entirely free from rust, while the adjoining untreated plats were affected with the fungus from bottom to top. The yield, too, in this case was correspondingly above the average. Nos. 28 and 33 gave fairly good results, while 32 and 34 were complete failures.* In the plats where the seed and soil were treated with Bordeaux mixture the full amount of rust appeared. The yield in this case of both straw and grain was below the average.

The experiment in spraying oats was fully carried out, but as no rust whatever appeared the results, so far as the prevention of this disease was concerned, were negative.

Experiment C consisted of spraying one plat each of late-planted spring wheat and oats with Bordeaux mixture, full strength, combined with soap. It was thought that possibly rust would not appear in experiments A and B; consequently the late spring grains, which are almost invariably attacked by the disease, were put in. Each plat was 33 feet long and 3 feet wide, there being two in each case—one for treatment and the other for control. The sowing was not done until May 20, but the weather was so warm that the plants were well up by the 30th of the same month. Six treatments in all were made, namely, on May 30, June 3, 6, 16, and 25, and July 5, respectively. Contrary to all expectations, no rust of consequence appeared on any of the plats; consequently the work was valueless.

EXPERIMENTS IN TREATING THE DISEASES OF NURSERY STOCK.

This work, as heretofore, was carried on at Geneva, N. Y., and Mullikin, Md.

WORK AT GENEVA, N. Y.

The experiments at this place upon the leaf diseases of nursery stock, to which reference was made in my last report, were continued the present year. They were planned to throw light upon the following problems:

(1) Can leaf-blight of pear, cherry, plum, and quince stocks, and powdery mildew of the apple, be prevented by the use of Bordeaux mixture or ammoniacal solution?

(2) Can French or American pear seedlings be grown successfully in the neighborhood of blocks of diseased nursery stock under the protection afforded by the use of fungicides?

(3) What is the effect produced upon the growth of nursery stock by repeated treatments with Bordeaux mixture and ammoniacal solution?

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*For a full discussion of the details of this experiment, see the Journal of Mycology, Vol. VII, No. 3.

(4) What effect, if any, has the stock upon the scion, as regards the resistance of the latter to leaf blight?

As announced in my last report, these experiments were carried on under the supervision of my assistant, Mr. D. G. Fairchild. The results of the treatments made in 1891, as set forth in Bulletin No. 3 of the division (pp. 57–60, 62–68), were not as striking as had been expected, owing to the dry season and small amount of the various diseases which appeared. The first season's work, however, in a large measure settled the first and principal problem involved.

The knowledge gained from the work in 1891 made it possible to enlarge and modify the original plans for the better settlement of the questions proposed, but it was found that problems 3 and 4 were altogether too complex to be settled by any but an elaborate and extensive series of trials, requiring at least three years for its completion. It was also found that in order to continue the experiments upon quinces, pears, and plums it would be necessary to deal with stocks which had been left unbudded in 1891. Accordingly, instead of treating in the second year (1892) buds only, which was the original plan, a large number of stocks were left unbudded. As the leaf diseases are acknowledged by nurserymen to attack most severely just such unbudded stocks "carried over" from the previous year, the results obtained this season are in a high degree encouraging. Several diseases during the year were present in sufficient abundance to thoroughly test the efficacy of the preparations. Bordeaux mixture, about one-third its original strength,* proved in all respects adequate for the prevention of plum and cherry leaf-blight, and for pear and quince leaf-blight, and ammoniacal solution prevented the disease to a somewhat less degree. Only two fungicides were used, of strengths as given in the footnote. Apple powdery mildew did not appear upon any of the experimental stocks, and was found upon inquiry and observation to be of very little importance when compared with the damage done by the apple thrips or diseases of other varieties of stocks. The season's treatments may be summarized briefly as follows:

Cherry leaf-blight.—Treatments with Bordeaux mixture and ammoniacal solution were made to rapidly-growing Windsor, Montmorency, and Yellow Spanish buds, grown both upon Mahaleb and Mazzard stocks and budded in 1891. While no difference between the stocks as regards resistance of the inserted buds to the disease was observed, the treated buds were rendered immune, while the untreated lost many of their leaves and failed to make as good growth in diameter as the treated ones. The Windsor buds proved most susceptible to the disease, but were prevented from losing their leaves by the treatments. Six treatments, viz, May 26–27, June 15–16, 23, July 6–7, 21, August 5, proved slightly superior to five on the first five dates just mentioned, and the one-third strength Bordeaux was visibly superior to the ammoniacal solution. Unbudded Mahaleb stocks did not lose their leaves, while unbudded Mazzard lost 80 per cent before the 1st of October. No treatments of unbudded stocks were made in 1892.

Plum leaf-blight.—Treatments in all respects similar to those made

*Two pounds copper sulphate dissolved in 15 gallons of water, and 2 pounds of lime slaked and added in 5 gallons of water. The lime was added until no red reaction was given with yellow prussiate of potash. The formula of ammoniacal solution used was 5 ounces cupric carbonate dissolved in ammonia and diluted with 40 gallons of water. Four to 5 pints of ammonia (26°) were necessary for solution.

with the cherry stocks were made to plum budded stocks of the Hudson River Purple Egg, Fellenburg or Italian Prune, and Early Prolific or Early Rivers varieties. These were budded upon the two standard stocks, Myrobolan and Marianna. Numerous stocks were also left unbudded for treatment. Bordeaux mixture and ammoniacal solution, while both proving entirely efficacious in the prevention of the disease on the *budded* stocks seemingly caused an early fall of leaves on the *unbudded* trees. The efficacy of these fungicides as preventives of leaf-blight of budded plum stocks is not to be questioned when they are applied properly. The application of the spray to the under side of the foliage has proved essential. No marked difference between Myrobolan and Marianna stocks was noticed as regards their effect upon the resistance of the buds to the disease. The buds on Marianna, however, grew more vigorously and averaged higher. Bordeaux mixture proved superior even in its weak strength (one third standard) to the ammoniacal solution, and six treatments on dates as above given were more efficacious than five.

Pear leaf-blight.—As it was found early in the season of 1891 that budded pear stocks seldom lost their leaves from leaf-blight, the experiments of 1892 were designed to ascertain what effect treatments with fungicides would have upon unbudded stocks carried over from the previous fall. Such stocks suffer severely from the disease, and it was thought they would furnish a severe test for the preparations. Bordeaux mixture, weak strength,* and ammoniacal solution* were used with striking results upon French, American, and Japan stocks. The treated stocks held their foliage intact, while the untreated lost nearly every leaf. A marked increase in the caliper of treated over untreated was noticed. The Bordeaux mixture proved markedly superior to the ammoniacal solution and is the only tested mixture worthy of extended trial upon pear stocks. Six treatments were notably superior to five. Only budded stocks of the variety Flemish Beauty were affected by leaf-blight, and the protection afforded by the Bordeaux mixture to these stocks was complete.

Leaf-blight of pear seedlings.—An extended experiment with pear seedlings in the seed-bed was carried on in cöoperation with Prof. S. A. Beach, the botanist of the New York State Agricultural Experiment Station. This experiment was designed to test twenty-five preparations, most of which were new, with a view of ascertaining their value as preventives of leaf-blight. These preparations were carefully compounded at the Department, the best theoretical proportions being worked out by laboratory experiments.

Compounds of copper, iron, and zinc were employed, each 1,000 parts of water used being calculated to have in it one part of copper, two parts of zinc, or two parts of iron, according to the metal forming the base of the preparation. The metals were present in the mixtures only as compounds. It should be understood that the term "mixture" is here used to designate the whole preparation as thrown upon the plant, and consisted in each case of the insoluble compound of copper, iron, or zinc suspended in the water holding in solution the soluble salt of the alkali used. The following is a list of the various mixtures with their formulæ. In all cases, when not otherwise stated, the two ingredients were simply dissolved, each in 1 quart of water, and poured together, the quantity being then made up to 1 gallon.

* See footnote on page 225.

1. BASIC CUPRIC ACETATE MIXTURE.

Basic cupric acetate (refined powder)	grams..	11.90

(Wet up as a thick paste and allowed to stand 24 hours or more before dilution in 1 gallon (3,783 grams), of water).

2. COPPER BORATE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Sodium borate (borax)	do....	16.39
Water	gallon..	1

3. COPPER BASIC CARBONATE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Sodium carbonate (sal soda)	do....	14.90
Water	gallon..	1

4. AMMONIACAL COPPER CARBONATE SOLUTION.

Cupric basic carbonate (copper carbonate)	grams..	7.03
Water (added to make the carbonate into a thin paste)	cc...	50
Aqua ammonia 26 per cent (stronger water of ammonia)	cc...	150
Water	gallon..	1

The carbonate, wet up with water, is allowed to stand a few minutes to become thoroughly wet before the ammonia is added.

5. CUPRIC FERROCYANIDE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Potassium ferrocyanide (yellow prussiate of potash)	do....	22.35
Water	gallon..	1

6. CUPRIC HYDRATE, BLACK, MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Potassium hydrate (caustic potash)	do....	14.90
Water	gallon..	1

(The cupric sulphate and potassium hydrate are dissolved each in 1 quart of water, and after mixing are allowed to stand until black before diluting.)

7. CUPRIC HYDROXIDE MIXTURE.*

Cupric sulphate (bluestone)	grams..	14.90
Potassium hydrate (caustic potash)	do....	29.80
Water	gallon..	1

Prepared as No. 6, but put on before turning black.

8. CUPRIC HYDROXIDE MIXTURE.*

Cupric sulphate (bluestone)	grams..	14.90
Potassium hydrate (caustic potash)	do....	26.82
Water	gallon..	1

Prepared precisely as No. 7.

9. TRICUPRIC ORTHOPHOSPHATE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Sodium phosphate	do....	26.07
Water	gallon..	1

10. CUPRIC POLYSULPHIDE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Potassium sulphide (liver of sulphur)	do....	14.90
Water	gallon..	1

*These two mixtures do not differ essentially, because of a miscalculation in the amounts of KHO added. Intended to have been 14.90: 7.45, not 14.90:29.80; and 14.90:8.27, not 14.90:26.82.

11. COPPER SUCRATE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Cane sugar	do....	14.90
Potassium hydrate (caustic potash)	do....	14.90
Water	gallon..	1

(The cupric sulphate and sugar are added together in 1 quart of water and brought to boiling; then the potassium hydrate dissolved in 1 pint of water is added and the whole made up to 1 gallon.)

12. COPPER SILICATE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Sodium silicate (water glass)	do....	44.70
Water	gallon..	1

13. CUPRIC SULPHATE, AMMONIA AND SOAP MIXTURE. (SOAP EAU CELESTE.)

Cupric sulphate (bluestone)	grams..	14.90
Aqua ammonia (ammonia water 26 per cent)	cc..	.75
Palm soap	grams..	44.70
Water	gallon..	1

The cupric sulphate is first dissolved in water and the ammonia added; then the soap dissolved in warm water is added and the solution well mixed.

14. CUPRIC OXYCHLORIDE MIXTURE. (FORM A.)

Cupric sulphate (bluestone)	grams..	14.90
Chloride of lime	do....	29.80
Water	gallon..	1

15. CUPRIC OXYCHLORIDE MIXTURE. (FORM B.—TRIBASIC.)

Cupric sulphate (bluestone)	grams..	14.90
Chloride of lime	do....	21.28
Water	gallon..	1

16. COPPER SULPHITE MIXTURE.

Cupric sulphate (bluestone)	grams..	14.90
Sodium hyposulphite	do....	37.25
Water	gallon..	1

17. FERRIC CHLORIDE AND PHENOL MIXTURE.

Ferric sesquichloride (iron chloride)	grams..	36.46
Phenol (carbolic acid)	do....	36.46
Water	gallon..	1

18. FERROUS FERROCYANIDE MIXTURE.

Ferrous sulphate exsiccatus (iron sulphate, dried)	grams..	22.94
Potassium ferrocyanide (yellow prussiate of potash)	do....	45.88
Water	gallon..	1

19. IRON BORATE MIXTURE.

Ferrous sulphate exsiccatus (iron sulphate, dried)	grams..	22.94
Sodium borate (borax)	do....	91.76
Water	gallon..	1

20. FERRIC HYDRATE MIXTURE.

Ferrous sulphate exsiccatus (iron sulphate, dried)	grams..	22.94
Potassium hydrate (caustic potash)	do....	11.47
Water	gallon..	1

21. IRON SULPHIDE MIXTURE.

Ferrous sulphate exsiccatus (iron sulphate, dried)	grams	22.94
Potassium sulphide (liver of sulphur)	do	91.76
Water	gallon	1

22. ZINC BORATE MIXTURE.

Zinc sulphate	grams	33.36
Sodium borate (borax)	do	33.36
Water	gallon	1

23. ZINC FERROCYANIDE MIXTURE.

Zinc sulphate	grams	33.36
Potassium ferrocyanide (yellow prussiate of potash)	do	66.72
Water	gallon	1

24. ZINC SILICATE MIXTURE.

Zinc sulphate	grams	33.36
Sodium silicate (water glass)	do	58.38
Water	gallon	1

25. ZINC SULPHIDE MIXTURE.

Zinc sulphate	grams	33.36
Potassium sulphide (liver of sulphur)	do	66.60
Water	gallon	1

Six treatments were made with each of the above preparations and the effects on the seedlings carefully noted. The leaf-blight was present in sufficient quantity to test them thoroughly, and, without going into details, it may be said that only a comparatively small number gave results which would encourage further trials. None were successful in entirely preventing leaf-blight. The test points more strongly than ever to the remarkable nature of the cupric compound as found present in Bordeaux mixture as a preventive of the disease. The details of this test will be published in a forthcoming number of the Journal of Mycology, together with full account of the preparation and composition of the various mixtures.

WORK AT MULLIKIN, MD.

The experiments at this place were a continuation of those inaugurated last year and described in my last report, also more fully in a special bulletin* to which reference has already been made. The treatments the past season were made in accordance with the original plan. At this writing the final measurements of the various stocks have not been made; consequently an accurate summary of the results can not be given. It may be stated, however, that even the most cursory examination of the various blocks shows a striking difference in favor of some of the treatments. The most remarkable results were obtained in the treatment of plum, cherry, and pear stocks. It is hoped ere long to publish a full report on the subject in a special paper.

WORK ON BLACK ROT OF THE GRAPE.

Experiments in the treatment of black rot of the grape were carried on in the vineyard of Mr. John A. Svedberg, near Sterling, Va. This vineyard was used in 1891 for similar purposes and was described in

* Bulletin No. 3, Division of Vegetable Pathology.

my last report. The block of vines, known as Vineyard 6, in which the work was carried on the past season, consists of 660 Concords, seven years old, planted 6 feet apart each way and trained to stakes 8 feet high. The experiment was designed to test the effect of twenty-five preparations: (1) as preventives of black rot, and (2) as regards their effect on the foliage, flowers, fruit, and wood. The preparations used were the same as those described above, under the treatment of nursery stock. As a supplementary experiment, however, a part of the vineyard, known as No. 1 in the last year's work, was dusted with three powders and a part was sprayed with Bordeaux mixture containing 3 pounds of copper sulphate and 2 pounds of lime to 22 gallons of water. The object of this work was to ascertain, if possible, the comparative merits of the powders and Bordeaux mixture as preventives of black rot. One of the powders—viz, flowers of sulphur—is already well known as a fungicide. The others—precipitated sulphur and sulphosteatite—have been quite generally advertised of late as remedies for many plant maladies.

For the work in Vineyard 6, 258 vines were used. Four vines were sprayed with each preparation, making the number treated 100, and the number untreated 158. The untreated vines were arranged so as to completely surround the treated, thereby severely testing the efficacy of the solutions as fungicides. In Vineyard 1, where the powders were applied, 72 vines were used; 32 of these, or eight for each preparation, were treated and the rest reserved as control. Six of the vines in each plat were Concords, and two were Clintons. The treated and untreated vines were arranged in alternate rows. The treatments, seven in number, were made in every case on the same day, the dates being as follows:

First treatment	May 11
Second treatment	May 23
Third treatment	June 1
Fourth treatment	June 14
Fifth treatment	June 28
Sixth treatment	July 16
Seventh treatment	Aug. 2

In applying the solutions a Johnson pump, fitted with a Vermorel nozzle, was used. The powders were applied with a Vermorel knapsack bellows. At the time of each treatment careful notes were made on the general condition of each plat with respect to rot and injury as a result of the work. On June 14, when the berries were fairly well formed and before the rot fungus had appeared on the fruit, a critical examination of all the plats was made in order to obtain information upon the following points:

(1) The general condition of each vine with regard to size and amount of foliage.

(2) The total height of each vine.

(3) The number of shoots on each.

(4) The average length of shoots.

(5) Average size of leaves on each vine.

(6) Condition of each vine with respect to injury from the treatments. Vines having all leaves, flowers, and fruit injured were marked 100. Those not so seriously injured were marked less according to the amount of damage.

(7) The total number of fruit clusters on each vine.

On September 16, critical notes were again made on the amount of growth, the condition of the new wood with respect to maturity, and the condition of the foliage and fruit with respect to injury from the treatments. The following day, September 17, all the fruit was gathered, the number of clusters on each plat being counted and weighed. Then three divisions were made of the fruit—viz, perfect clusters, part-perfect clusters, and diseased or worthless clusters. The first showed from one to five, the second six to ten, and the third eleven or more rotten berries. After making the divisions the number and weight of the clusters in each case were ascertained. The general results of the work may be summarized as follows:

(1) With the exception of cupric ferrocyanide mixture, ferrous ferrocyanide mixture, and ferric hydrate mixture, all the preparations more or less injured the foliage, flowers, fruit, and wood. Those which proved seriously injurious in this respect were copper borate mixture, ammoniacal solution of copper carbonate, tricupric orthophosphate mixture, copper silicate mixture, cupric polysulphide mixture, ferric chloride and phenol mixture, iron borate mixture, iron sulphide mixture, and zinc sulphide mixture. Those severely injurious were copper basic carbonate mixture, cupric sulphate, ammonia and soap mixture, zinc silicate mixture, and zinc borate mixture. The moderately injurious preparations were basic cupric acetate mixture, cupric hydrate black mixture, cupric hydroxide mixture (No. 7), cupric hydroxide mixture (No. 8), copper sucrate mixture, cupric oxychloride mixture (form A), cupric oxychloride mixture (form B—tribasic), and zinc ferrocyanide mixture.

(2) All of the powders severely injured the vines, while the Bordeaux mixture did no damage whatever.

(3) With the exception of cupric ferrocyanide mixture, ferrous ferrocyanide mixture, ferric hydrate mixture iron sulphide mixture, zinc ferrocyanide mixture, zinc sulphide mixture, and zinc silicate mixture, all the preparations were more or less successful in preventing rot. In two at least of the foregoing preparations—viz, iron sulphide mixture and zinc sulphide mixture—the injury they occasioned was so great that it was difficult to say what effect they had on rot. They are therefore placed with the noneffective preparations.

(4) All of the powders to a greater or less extent prevented rot, the precipitated sulphur standing first in this respect, flowers of sulphur next, and sulphosteatite last. None of the powders were as effective, however, as Bordeaux mixture. It must not be supposed that because a number of the mixtures and powders prevented rot that they can be unqualifiedly recommended for general field use. A number of other important considerations enter into the question, but they require too much space for discussion here.

EXPERIMENTS IN CALIFORNIA IN THE TREATMENT OF FUNGI AFFECTING THE ALMOND AND PRUNE.

In the Journal of Mycology (Vol. VII, No. 2), Mr. Newton B. Pierce, the special agent of the division located in California, has described and illustrated a serious disease of the almond caused by a fungus known as *Cercospora circumscissa* Sacc. The fungus attacks the leaves and young twigs, causing the former to fall early in the season. The premature shedding of the foliage, of course, seriously interferes with the normal functions of the tree, the fruit, if any, being imperfect and often worthless, and the wood maturing in poor condition for the next year's growth. Mr. Pierce's investigations, among other things, led to the discovery that infection of the first-formed leaves took place from spores, which lived over winter on the twigs of the previous year's growth. Further studies revealed the fact that the leaves on the outer branches were attacked first, the fungus gradually spreading from them toward the center of the tree. The facts as here set forth suggested certain lines of treatment, which were carried out during the year. In the work two fungicides were used: (1) ammoniacal solution of copper carbonate, and (2) modified eau celeste. The ammoniacal solution was made by dissolving 5 ounces of copper carbonate in 3 pints of concentrated ammonia and diluting with 45 gallons of water. The modified eau celeste was made by dissolving 4 pounds of copper sulphate in 10 or 12 gallons of water, adding 3 pints of concentrated ammonia, and diluting with 40 gallons of water. To this was added 6 or 8 gallons of water in which 5 pounds of sal soda had been previously dissolved.* The solutions were applied with a Nixon cart-sprayer fitted with rubber tubing and a Nixon nozzle.

A number of trees were treated with the fungicides on April 15, and again on May 12, a heavy rain having fallen in the interim. From 2½ to 3 gallons of the liquid were required for each tree; the time consumed in spraying being from five to ten minutes, depending on the state of the weather and the size of the tree. After the second spraying, on May 12, no further treatment was given, but traces of copper were observed as late as August 3 on all parts of the treated trees.

By June 14 it was observed that the foliage on the untreated trees was badly infected, while on the treated trees it remained in good condition. By August 1 the untreated trees were nearly bare, while the treated ones were still in nearly full leaf. Plates I and II, showing the treated and untreated trees, were made from photographs taken on August 3 and 4.

An examination of the thirty-four trees experimented with, eighteen treated and sixteen untreated, was made on August 3. It was found that where the ammoniacal copper carbonate solution was used an average of 91 per cent of the foliage remained on the tree, while the corresponding untreated trees retained only about 8 per cent, this being nearly twice as great as it would have been had there not been one of these untreated trees which was only slightly infested.

Trees treated with modified eau celeste gave a slightly better result. Here the treated trees retained on an average 94 per cent of their foliage and the untreated ones only about 12 per cent. The difference of 3 per cent in the effectiveness of the two fungicides is accounted for by the situation of the respective treated trees. Practically the two compounds are equally efficient.

In recommending treatments for the future, Mr. Pierce states that the first spraying should be made before the trees bloom, the second spraying should be made when the trees are in full leaf, and the third about a month later, when the spring rains have ceased. The fungicides may be diluted with from 10 to 15 per cent more water than the amount used in the experiment. If rain falls after the third spraying it would be advisable to give the trees a fourth treatment. The cost of treating a medium sized tree three times will vary from 5 to 9 cents.

The second disease treated by Mr. Pierce is caused by one of the rust fungi known as *Puccinia pruni-spinosæ*. The parasite is widely distributed throughout the country, occurring in California alone upon the peach, nectarine, apricot, cherry, almond, and plum. The time of appearance of the disease varies in different years, sometimes occurring early in the season and again late. When it appears late the damage is much less than when it is early.

* Differs from ordinary modified eau celeste inasmuch as the ammonia is added to the copper sulphate before the carbonate of soda.

WORK IN CALIFORNIA—ALMOND TREE TREATED FOR LEAF-BLIGHT.

WORK IN CALIFORNIA—ALMOND TREE UNTREATED, DEFOLIATED BY LEAF-BLIGHT FUNGUS.

WORK IN CALIFORNIA—PRUNE ORCHARD UNTREATED, DEFOLIATED BY RUST FUNGUS.

WORK IN CALIFORNIA—PRUNE ORCHARD TREATED FOR RUST.

When attacked by the fungus the leaves show yellowish or reddish blotches on the upper surface, the blotches varying greatly in size and shape. The spores make their appearance in brownish or blackish patches on the under surfaces of the leaves. As the parasite develops in the interior of the leaf, the treatments must be preventive, for after once obtaining an entrance it can not be affected by fungicides.

In using the fungicides Mr. Pierce found that where the trees are of small size and pruned low a knapsack sprayer answered admirably. For trees four or five years old a cart-machine holding one or two barrels is more convenient. It requires from one and one-half to three minutes to spray a small tree, and a third longer to spray a large one.

Inasmuch as the infection of the leaves appears to come from beneath, or at least the under surfaces of the leaves are most affected, it is essential that these portions receive the most thorough spraying. In order to effect this it is necessary to throw a very fine spray, and experience shows that a lateral is more efficient than a direct application.

The same fungicides were used as for the almond disease, already referred to, namely, ammoniacal solution of copper carbonate and modified eau celeste. They were made after the same formulæ also. For the present work it is believed that on the whole the former will be the more satisfactory. The cost is estimated at from 80 cents to $1 per 100 gallons, and counting the cost of chemicals and labor it is believed that each tree can be sprayed once for about 3 cents.

The number of treatments and the times at which they should be made will vary according to the season. In southern California Mr. Pierce believes two thorough sprayings will be sufficient, but for the same disease in the East, they should be made more frequently. As far as the results of one season's work go it is probable that the first spraying should be made about the time the prune ceases to bloom, and when the old wood is in full leaf. A second should be made when a fair amount of new wood and foliage has been formed. To approximate the dates, the first would be about May 1 and the second about June 1. In case the orchard be situated in a low or damp spot a third spraying two or three weeks after the second should be made. In the dry climate of southern California trees sprayed in May show traces of the fungicides on the leaves as late as October. Plate III shows the effect of the disease on untreated trees and Plate IV the result when trees are treated.

DESTRUCTION OF LICHENS ON PEAR TREES BY MEANS OF BORDEAUX MIXTURE.

In many parts of the South it is a common occurrence to see various kinds of fruit trees badly infested with lichens. It is a mooted question whether the lichens attack healthy trees and cause them to be less thrifty or whether the trees are attacked by the lichens because of a weakened condition. Be that as it may, it is certain that badly infested trees are generally weak and sickly and there can be no doubt that it would be advantageous to have these growths destroyed. The lichens not only live on the rough exfoliating bark of large branches, but on the smooth bark of smaller branches as well. In the latter case it is possible that they take something from the sap of the tree.

While at work in a large pear orchard near Scotland, Va., Mr. Waite noticed that many of the trees were literally covered with the plants under consideration. The lichens being so abundant it was decided to treat the trees in various ways in the hope of ridding them of the unsightly growths. Four fungicides were used for the purpose—viz, Bordeaux mixture, eau celeste, a 1:100 solution of chloride of lime, and a 1:1000 solution of bichloride of mercury. The Bordeaux mixture contained 6 pounds of copper sulphate and 4 pounds of lime to 11 gallons of water; the eau celeste was made according to the regular formula—*i. e.*, 1 pound of copper sulphate dissolved in 2 gallons of water with 1½ pints of ammonia added, then diluted to 22 gallons; the chloride of lime was used in a 1:100 solution. The strong Bordeaux mixture was used as a paint, the trunks and branches being covered by means of a whitewash brush. A few minutes after the lichens were wet they assumed a greenish ochraceous appearance, quite different from their characteristic gray. The painting was done about the middle of March and by the end of the first week in April the lichens were all dead. In addition to the painting, Bordeaux mixture of half strength—*i. e.*, 3 pounds of copper sulphate and 2 pounds of lime to 22 gallons of water—was used as a spray, and whenever the lichens were thoroughly wet with this they were invariably killed.

Spraying with eau celeste had but little effect on the lichens, while even in its most dilute form it injured the leaves of the trees. Where the chloride of lime and bichloride of mercury solutions were used there was also but little effect on the lichens, but a deleterious effect on the leaves was observed. The experiment showed conclusively that the Bordeaux mixture is an effective destroyer of lichens, and it can be recommended with confidence to those who wish to rid their trees of these growths. It should be applied in early spring by means of a good force pump provided with a Vermorel or other suitable nozzle. One thorough application will probably be sufficient to kill the lichens, after which they may be easily brushed or scraped from the tree.

MISCELLANEOUS EXPERIMENTS.

Under this heading several minor lines of work carried on during the year may be briefly described.

Early in the season it was noticed that potatoes in Maryland and adjoining States were being seriously injured by a fungus attacking the leaves and causing them to turn brown and dry up. The tops of nearly all of the early potatoes were destroyed in this way before the tubers were half grown; consequently the crop was very much shortened. The fungus causing the injury was found, upon examination, to be *Macrosporium solani*, a form widely distributed in this country upon the potato, tomato, and other plants of this family. Anticipating that the late crop of potatoes would also suffer from the ravages of the fungus, plans were made for a series of experiments to test the effect of spraying with fungicides upon the disease. The experiments were made in two separate fields with exceedingly gratifying results. It was found that by the application of Bordeaux mixture, normal strength, six times during the growing season, at a total cost of about $6 per acre, the yield was increased from 75 to 100 per cent. Bordeaux mixture containing but 3 pounds of copper and 2 pounds of lime gave fairly good results, while ammoniacal solution of copper carbonate and sulphosteatite were little better than no treatment at all. A full account of this work with observations on the life history of the fungus will be published in a subsequent paper.

Celery leaf-blight (*Cercospora apii*) was made the subject of a series of experiments. Nearly 3,000 plants were treated in various ways, some being sprayed and dusted with fungicides, some being shaded, and others subjected to various methods of culture. It was found that leaf-blight could be more readily prevented by proper methods of culture than by spraying or other means. Plenty of well-rotted manure, good drainage, and an abundance of water at all times seemed to be the most important factors in producing crops free from disease.

In New York, Mr. Fairchild made some interesting observations on a fungus used for some time by farmers as a means of eradicating the troublesome weed known as live-for-ever (*Sedum teliphium*). The disease has been disseminated by planting affected plants among healthy ones, but it was hoped that a more convenient and rapid method of distribution could be discovered. Attempts were accordingly made to grow the fungus in culture media, but these were unsuccessful. Mr. Fairchild also made an interesting tentative experiment to determine the effect of continuous rainfall upon trees at blooming time. One Mount Vernon pear tree was kept wet down with a spray of spring water from the city hydrant for nine consecutive days and nights during blooming time. The tree thus treated failed almost completely to produce fruit while trees of the same variety standing near by produced moderate crops. The effect on the foliage of the treatment, however, is most noteworthy and indicates a line of investigations which deserve to be further pursued. The leaves of the treated tree were much smaller than normal, were lacking in green coloring matter, and ripened fully too weeks earlier in the fall than the untreated adjacent trees.

PEACH YELLOWS AND PEACH ROSETTE.

Inasmuch as several lines of work upon the following diseases have practically been completed, it has been thought best to give a brief synopsis of the results to date. Dr. Erwin F. Smith, who has the investigations in charge, has, at my request, prepared the following notes:

YELLOWS.

(1) The literature of the subject, covering a period of nearly a hundred years, was first examined as thoroughly as possible, and found to be full of contradictions and uncertainties.

(2) The symptoms which clearly distinguish this disease from others have been determined by a careful study of thousands of cases in many orchards, and under the varying conditions due to different seasons, soils, and treatments. As a result, erroneous ideas have been set aside, and a clear notion obtained of the symptoms and general course of the disease.

(3) Bud inoculations from diseased to healthy trees have been tried several times on a large scale with the following results: (*a*) The yellows was communicated by diseased buds whenever the latter could be induced to unite with the stock. (*b*) In most instances the disease was also communicated by buds taken from the healthy-looking side of partly affected trees, showing that the cause of the disease exists in the tissues of the tree a considerable time before there are external symptoms. (*c*) Simple contact of cambium with cambium did not induce the disease—*i. e.*, whenever the inserted buds failed to heal on the trees remained healthy. (*d*) The shortest period between the insertion of the diseased buds and the appearance of the yellows in the stocks was about nine months and the longest period about two and a half years, but in the former case a part of the period was winter, and in the latter case the buds were taken from the healthy-looking side of partly affected trees. These experiments were carried on upon such a large scale, and with so many unbudded trees for comparison, that there can be no doubt as to the results. Moreover, all the results in one large experiment were obtained in a region free from yellows, so that the resulting symptoms could by no possibility be ascribed to anything but the inserted buds. The disease is readily communicated from tree to tree

by bud inoculation, and may be carried from nurseries to orchards in this way. Sometimes when little care has been exercised in the selection of buds it appears in the nursery itself before the trees are old enough to put upon the market.

(4) Many fruit-growers believe that yellows can be transmitted from diseased to healthy trees by pruning tools. To determine this, a row of twenty-three healthy trees was pruned and hacked in many places with tools on which diseased leaves and branches were crushed and rubbed each time before making the cuts. Holes were also bored into twenty-seven trees and tightly plugged after being filled with water in which badly-diseased leaves and young stems had been bruised. This work was done during the first half of May. Twenty of the pruned and eighteen of the bored trees contracted the disease within fourteen months, but no definite conclusions can be drawn, because during this period an unexpectedly large number of cases appeared in all parts of the two orchards in which the experiments were made. Obviously the best place for such an experiment is a region where yellows does not exist, but, of course, fruit-growers in such localities are loth to have it tried. The conclusions, however, would be reasonably trustworthy, even in an affected district, if many trees were pruned or bored and the proportion of cases found to be much larger in these than in the controls. Additional experiments will be tried.

(5) The development of the symptoms on part of a tree at first, and the perfectly healthy appearance of the remainder for half a year or more, is so common that two series of excision experiments were made to determine whether the disease could be cut out. All of the diseased branches were removed and along with them many which appeared to be perfectly healthy. The first year the excisions were made in September, and the next year in August. In all, fifty-two trees were tried, those being selected which appeared most favorable for the success of the experiment. In every case the disease reappeared.

(6) The yellows is not known to occur in plums or cherries, and after the discovery of the plum rosette in Georgia several experiments were made to determine whether yellows could be induced in these trees artificially. So far, only negative results have been obtained, but this line of inquiry is not yet completed.

(7) Many tons of earth from a diseased peach orchard have been buried around healthy peach trees in a region not subject to yellows, to determine whether the cause of the disease exists in the soil. This important experiment is not completed; but two seasons have passed and all of the trees are still healthy, even more vigorous than the controls.

(8) The progress of the disease on the Delaware and Chesapeake peninsula and in other parts of the United States has been studied carefully for a number of years with special reference to broad climatic variations, seasonal differences, and geological formations. The results of this inquiry are not yet ready for publication. In this connection it is important to examine all the principal peach regions of the United States, whether infected or still free from yellows.

(9) Department experiments with fertilizers now cover a period of four years and have been made in various orchards on a large scale to determine the following questions: (*a*) Is the disease due to starvation? (*b*) Can it be prevented or cured by addition to the soil of suitable plant foods? A full account of these experiments is given in Bulletin 4 of this division now in press. Potash, soda, magnesia, phosphoric acid, wood ashes, lime, nitrogen, and other plant foods were used repeatedly, separately, and together, often in large quantities, and frequently on as many as fifty to seventy-five trees, healthy and diseased. Some of the diseased trees improved in appearance, and probably lived longer than they would otherwise. but none of them recovered. Neither was it found possible to keep healthy trees in a state of health. They grew vigorously under the stimulus of the fertilizer, but contracted the disease just as readily as those which were left untreated for comparison. The following tables are inserted as samples of the progress of the disease in an orchard and the behavior of trees under treatment:

TABLE I.—*Showing the progress of peach yellows in the orchard of James W. Green, Magnolia, Del., from the time it was planted.*

[2,922 trees.]

Year.	Cases.	Per cent.	Year.	Cases.	Per cent.
1882	0	0	1889	254	8.7
1883	0	0	1890	858	29.4
1884	0	0	1891	671	23
1885	0	0	1892	456	15.5
1886	3	.1			
1887	255	8.7	Total	2,797	95.7
1888	311	10.6			

TABLE II.—*Showing the changes which have taken place in healthy trees in the orchard of James W. Green, Magnolia, Del., since the commencement of treatments in the spring of 1889.*

Areas.	Number of healthy trees.	Per cent of cases of yellows.				
		1889.	1890.	1891.	1892.	Total.
Entire orchard	2,350	10.8	34.8	30	19.4	95
Treated plats	999	9.5	38.3	27.7	20	95.6
Controls	1,046	6.9	30.2	33.2	23.6	93.9
Rejected portions	306	28.4	51.3	15	2.9	97.6
Orchards exclusive of treatments	1,351	11.8	34.9	29	18.9	94.6

In some cases even it seemed as though the excessive stimulation favored the development of the disease, but additional experiments will be necessary to settle this point beyond dispute and also to determine whether animal manure and large doses of nitrogen favor the appearance and spread of yellows. One conclusion, at least, can be drawn with certainty, viz: the addition to the soil of large quantities of the best fertilizers did not hinder the progress of the disease or save the orchards from complete destruction. The inference is, therefore, quite strong that this disease is not due to impoverished soils.

(10) Chemical analyses of diseased and healthy tissues were made to determine the amount of potash and other mineral substances in the ash. These analyses contradicted earlier determinations and lent no support to the hypothesis of soil impoverishment. Additional analyses were then secured from another chemist and these confirmed those already made by the Department. So far as any conclusions can be drawn from these analyses, they show an absolutely less quantity of ash in the diseased tissues. Concerning the constituents of the ash from diseased tissues, all that can be stated without qualification is that *lime is deficient* and *potash in excess*. Probably this means only that assimilation has been disturbed and retarded.

(11) Tobacco has been recommended as a cure for this disease under the belief that it is due to an aphis which is quite common on the roots of peach trees in New Jersey, Maryland, and Delaware. Tobacco dust was, therefore, procured in quantity and dug into the earth around many diseased trees. Two very liberal treatments were given in the fall and spring and the trees improved in appearance for a time, but none of them recovered. At the same time tobacco dust was tried upon trees suffering only from root aphides and the results were so striking as to make it almost certain that the two diseases were confounded by the horticultural writer who proclaimed tobacco as a remedy for yellows. Indeed, such confusion appears to be the explanation of the failure of many reputed cures.

(12) On the hypothesis that iron might be lacking, a dilute solution of ferrous sulphate was passed into the circulation of a number of diseased trees, but with no permanent benefit. They improved but slightly if at all, and all finally died.

(13) One-half bushel of gas lime was also dug into the earth around each of thirteen diseased trees. Some of them became considerably greener, but none recovered.

(14) Hot water in quantity was poured around the trunks and roots of six diseased trees without any favorable result. The following year they were very much worse. At the same time the main roots of a small tree suffering only from root aphides were uncovered and dosed with hot water. This tree did not regain its vigor, but on the contrary developed yellows the next season.

(15) In May, two diseased trees were very thoroughly drenched with Bordeaux mixture, so that all parts above ground were covered. This treatment exercised no appreciable influence on the progress of the disease. The foliage was not injured by the mixture.

(16) The experiments of other people, with known substances and with secret mixtures, have also been kept under observation, but nothing of moment has been developed. Many claim to have cures, but no such claims have been substantiated. In a number of instances fraud and humbug are apparent on the very face of the claims; in others, the claimants were found to be honestly mistaken, having identified and treated something else for yellows.

(17) A series of examinations has been undertaken to determine whether plums grafted upon peach roots can be grown successfully in regions subject to yellows—*i. e.*, whether the peach root is safe so long as it is wholly under ground and sends up no sprouts. The evidence up to date is somewhat conflicting, and the inquiry is still in progress.

(18) Experiments are also in progress to determine whether the use of plum roots will protect the peach tops. These also will be reported on later.

(19) Bacteriological examinations during one winter gave no conclusive results. This branch of the investigation is hardly more than under way.

(20) Considerable work has been done in the way of a microscopic examination of diseased and healthy tissues, but this line of inquiry is still in too fragmentary a condition to be reported on. Both 19 and 20 are very important inquiries, and will consume a good deal of time.

ROSETTE.

This is a new disease which has appeared in Georgia within the last ten or twelve years. It resembles yellows in a number of particulars, but differs in others and is undoubtedly distinct. Two distinctions are, absence of premature fruit and the much more tufted character of growths. Rosette occurs all over north Georgia and has been reported from South Carolina. It also occurs at Manhattan, Kans. Peach trees are killed in a short time, and some varieties of plums are also subject. Trees which contract the disease naturally usually show the first symptoms in early spring and die in about five months, but sometimes, as in yellows, a number of limbs do not show the disease until the following season. No trees have been known to live more than two years.

Field experiments have been carried on in Georgia during the past three years with the following results:

(1) The disease is virulently contagious and can be propagated readily from diseased to healthy trees by bud inoculations. In one experiment 121 out of 125 trees contracted the disease from inserted buds in less than one year.

(2) The rosette can also be conveyed by grafting fragments from the roots of diseased trees on to the roots of healthy trees.

(3) It requires a considerable time for the cause of the disease to pass from the point of infection to all parts of the tree. In many of the inoculated trees symptoms of rosette appeared on one side, or near the inserted bud, before they did on the other side, or farther away. It also took longer to produce symptoms in the tops of the trees when they were root-grafted than when they were budded above ground. Numerous bud inoculations also showed that one side of a certain tree was entirely free from taint at the very time that the other side was badly affected.

(4) The shortest period between the insertion of the diseased buds and the appearance of rosette in the stocks was about two months and the longest period about ten months; but one-half of the latter was winter, during which the trees were dormant.

(5) In no instance was the disease produced by simple contact, even under what seemed to be very favorable conditions—*i. e.*, close contact of diseased and healthy cambium. The disease appeared only in case the buds healed on.

(6) Numerous bud inoculations failed to transmit the disease to the Marianna plum.

(7) Other inoculations have cast some doubt on the identity of the peach and plum rosette, and additional experiments must be made to settle this point.

(8) The bacteriological investigations which were begun in 1891 will be continued. Such germs as were then isolated did not produce the rosette when inserted into healthy young trees.

(9) A histological study of diseased and healthy trees has been commenced, but is not yet in shape to be reported on.

A full account of this disease and of the results of the experiments is given in Bulletin 1 of this division and in the Journal of Mycology (Vol. VI, p. 143, and Vol. VII, No. 3).

INVESTIGATIONS OF THE SPECIAL AGENT IN CALIFORNIA.

The demand for work on plant diseases has steadily increased on the Pacific slope during the year. Horticulturists are becoming more and more convinced of the necessity of investigations of this kind, and especially of the value of field experiments leading to a knowledge of means of preventing various fungous diseases. The result is a constantly-increasing demand for the services of Mr. Pierce, so that now a considerable portion of his time is occupied in the examination of material, answering inquiries, and other general correspondence. To benefit the horticultural interests of the region in general, the California vine disease has been only one of several branches of study. These studies have been upon the following subjects:

(1) Black rot of navel oranges; (2) gummosis of citrus and deciduous

trees, including foot rot of the orange; (3) a disease of almond trees; (4) the fermentation of figs; (5) prune rust; (6) coulure, or the falling of grapes, and (7) the California vine disease.

Besides these, however, attention has been given to the fall of leaves of olive cuttings in hot beds, the damping off of seedling orange trees in seed beds, the black knot of walnut and other deciduous trees and of vines, the decay of lemons caused by *Penicillium digitatum*, and, finally, a disease affecting the fruit and leaves of the loquat.

Black rot of navel oranges is a fungous disease which has only recently attracted the attention of orange-growers in southern California. It has been found, however, that it has as wide a distribution in the State as the navel orange itself, and that it is caused by a new species of fungus belonging to the genus *Macrosporium*. Its more important effects are to cause the premature ripening and fall of the fruit. During the earlier stages of the disease there are usually no external signs of its action except this premature ripening, and when this occurs after the main portion of the crop has changed color the diseased oranges can not be easily distinguished before they fall from the tree. When work on the disease began, no correct estimate of the annual loss could be made, but when the amount of diseased fruit from a large number of varieties of navel oranges was studied it was ascertained that as high as 10 per cent of the Washington Navels were in some instances affected. A full description of the effects of this disease on the fruit, and the most promising method of combating it, has been prepared, and after the study of the life history of the fungus is completed the paper will be submitted for publication.

Up to within a recent date it was believed by most orange-growers in California that "foot-rot" would not injure to any serious extent the citrus industry. This and other similar diseases are beginning to attract attention, as many orchards are affected with one or another of the various forms generally spoken of as "gummosis." Within the past year the question of growing trees on sour stocks has been seriously considered, and Mr. Pierce has begun a systematic inquiry into the best manner of preventing the gum disease. The subject is of prime importance in a country where irrigation is practiced, to both the grower of citrus and deciduous trees. Every year a large number of apricot and other deciduous trees succumb to gummosis on irrigated lands. The indications at present are that foot-rot may be controlled somewhat more readily than in the humid region of Florida and under the private irrigation systems of Sicily. When the facts at hand warrant it, a special bulletin, having particular reference to the situation in the irrigation districts of California, will be prepared.

Reference is made in a previous portion of this report to the work on prevention of fungous diseases of the almond and of the prune, and these will not be further mentioned here. But another one of the industries of the State which has been greatly extended of late is seriously threatened. This is the growth and curing of figs. It has been observed since the cultivation of this fruit has been attempted that the grower had to contend with a destructive fermentation of the fruit which often caused the loss of nearly the entire crop. It may be fairly said that only a small per cent of the figs now grown in California ever reach the market in good condition. The main reasons for this are two: (1) It is often found impossible to bring the crop to a proper state for curing, as the figs sour upon the trees before becoming properly ripened; (2) the grower is unable to dry the produce owing to the fermentation which takes place on the drying board, and which, even when checked, causes both the color and the flavor of the output to be unsatisfactory. A series of field and laboratory investigations resulted in the isolation of an organism capable of exciting fermentation. This proved to be a yeast, which when pure cultures were made, was applied to fruit on both trees and the drying board. The result was the production of an exactly similar fermentation to that occurring naturally. Numerous experiments with powders and sprays were used on the trees but with entirely negative results. The cause probably lies in the fact that the fruit is inoculated by insects, the yeast cells being carried by them to the ripening fruits. It is the intention during the coming year to give further study to the matter, the results of which will be duly communicated.

In June, 1892, it was reported to the Department that the vine-growers of the San Joaquin Valley, especially in the vicinity of Fresno, had sustained a heavy loss from coulure—the premature falling of grapes. Early in July Mr. Pierce visited the region to ascertain the cause of the trouble, its extent, and if possible how it could be avoided. A thorough study of the vine region about Fresno and adjoining towns was made, and much information gathered. Unfavorable conditions of temperature and humidity at the blooming season seemed to have interfered with the proper fertilization of the flowers, and this is probably the leading cause of coulure. It is known that the Muscat of Alexandria, the variety sustaining the greatest loss from coulure, is exceedingly sensitive to changes of temperature, etc., at the time of flowering. There seems to be no practical and direct way for Californians to avoid this difficulty, but Mr. Pierce believes it possible to obtain hybrid vines nearly free from coulure, by crossing the Muscat of Alexandria with vines having hardier flowers, and to retain in the new hybrid all of the excellent qualities of the Muscat. Prof. Millardet states that this variety is very subject to coulure in Europe; and it is known that the loss from this cause is greater in Arizona than in California. The results obtained by M. Millardet in the accumulation of resistant qualities in the vine by hybridization have pointed to this line of work as the one most likely to give satisfactory results in the prevention of coulure.

The work of the past year on the vine disease of California was conducted in both field and laboratory. The field work has materially strengthened the more important positions taken in the bulletin noticed elsewhere. The facts maintained are:

(1) The cause of the disease exists in the affected district to-day, independent of any past direct climatic influence.

(2) It is still capable of affecting perfectly healthy vines and has done so within the past two years.

(3) There is less of the disease now than formerly; it is dying out in some sections before it is in others, and it is less virulent than in the past, diseased vines maturing their canes more perfectly, and in some cases showing signs of recovery.

(4) The disease now appears to exist independent of the influence of *Uncinula spiralis*.

(5) It is cumulative in its action on the diseased vines. A vine grown from a diseased cutting may live and grow to a large size, showing more and more disease each succeeding season, and eventually die.

The laboratory investigations during the year were largely bacteriological, and although a considerable amount of work was done it did not develop the cause of the disease. It is still an open question whether bacteria take an active part in causing the death of the vines.

This work, however, has not been fully completed. A comparative histological and physiological study of both diseased and healthy plants is now the line being pursued, and it is the intention to give to it as much time and attention as possible. This naturally follows the closing of the field work. Among other reasons why it appears necessary to undertake a study of the more minute histology of the vine is the fact that Prof. Viala, of Montpellier, France, has recently stated that he has observed, in the leaf parenchyma of the diseased vines, a species of slime mold belonging to the genus *Plasmodiophora*, and it is proper that this work should have full and careful consideration.

WORK ON PEAR BLIGHT, THE POLLINATION OF PEAR AND APPLE BLOSSOMS, ETC.

The investigations on the above subjects, which were placed in the hands of Mr. Waite, have been for the most part confined to the field. While no important discoveries bearing directly upon the prevention of blight have been made, some interesting and valuable results have been attained through a study of the relation of insects to the disease in question. It was pointed out in my last report that insects play a very important part in disseminating the blight germs. In fact, it seems doubtful now if any other really important means of distribution exists. This intimate connection between insects and the disease suggested a series of experiments, which were carried on at Brockport, N. Y. The experiments were designed primarily to ascertain if exclusion of insects from pear flowers would protect the latter from blight. The question as to the necessity of their visits for pollination was a secondary one, being considered only as a possible barrier to the adoption of any method of treatment which would wholly or in part exclude the insects from the blossoms.

The work proved, as briefly set forth in my last report, that all flowers from which the insects were excluded were protected from blight, but, as also mentioned, certain varieties of pears failed to set fruit in these cases. This discovery, the importance of which was not fully realized at the time, led to others which seemed to plainly indicate a fact hitherto generally overlooked by horticulturists, viz, that certain well-known horticultural varieties of pears, such as Bartlett, Anjou, Winter Nelis, etc., are incapable of self-fertilization. In other words, in order to secure a good crop of fruit on any of the foregoing trees it was necessary for their flowers to receive pollen from some other variety. This discovery opened up a wide field and suggested numerous experiments bearing on questions of considerable importance to fruit-growers. It is unnecessary to go into details of the subject here, it being sufficient to briefly describe some of the more important lines of work and the results they brought about.

In the spring of 1890, and thereafter at frequent intervals, the division received complaints from the firm of Franklin Davis & Co., Baltimore, Md., to the effect that a large pear orchard owned by the Old Dominion Fruit Company, and situated on the James River, near Scotland, Va., had for a number of years been unfruitful. It was thought by Mr. Davis that the unfruitfulness might be due to blight attacking the flowers or to diseases affecting the trees. Early in the spring of the present year Mr. Waite was authorized to visit the orchard and make such observations as might throw light on the cause of the trouble. It was found that the orchard consisted originally of 20,000 standard Bartlett pear trees, about five-sixths of which were still living. The orchard was planted seventeen or eighteen years ago, and although yielding fairly remunerative crops for the first few bearing years, it has been almost a dead loss during the past six or seven seasons. Several diseases were found in the orchard, blight being among the number. The general failure of the orchard, however, could not be satisfactorily accounted for by these causes, consequently attention was turned to the pollination of the flowers. A large number of the flowers were bagged and many others were pollinated by hand. The hand pollinations consisted in the application to the pistils of pollen from the following sources:

(1) From the same flowers.
(2) From another flower of the same cluster.
(3) From a different cluster on the same branch.
(4) From another tree of the same horticultural variety.
(5) From another tree of a different variety.

The flowers in the foregoing experiment had all their stamens removed previous to the hand pollinations. The results of this work, although carried on with a comparatively small number of blossoms, agreed with those obtained the previous year at Brockport, N. Y. No fruit whatever was formed where Bartlett pollen was applied to its own pistils even though it was taken from a separate tree. On the other hand, wherever the pollen of another variety was employed a high percentage of fruit was obtained. There seems no reason to doubt that the unfruitfulness of this large orchard is due largely to its isolation and to the fact that it consists, with less than a dozen exceptions, of Bartlett trees, which are incapable of self-fertilization. In other words, there is not sufficient pollen of the right kind in the orchard or in the neighborhood to fertilize the immense number of Bartlett flowers, and consequently little or no fruit is formed. The remedy in this case seems to be simple, viz, the introduction of other varieties either by planting or by top-grafting, or by both. This plan will be carried out during the coming winter, and if successful, and the orchard is brought up to its full fruiting capacity, the company estimate that their annual income will be increased more than $10,000.

In order to corroborate the results obtained in Virginia, Mr. Waite was sent to Rochester, N. Y., immediately after his return to Washington. Rochester was reached before the pear flowers had begun to open, and a large number of experiments along the same lines as those in Virginia were begun. The work was carried on in the orchard of Elwanger & Barry, where every facility was afforded for making a thorough test of the matter under consideration. In addition to the work at Rochester, similar experiments were carred on with apples at Brockport, N. Y. Mr. Fairchild also made a number of tests at Geneva, with both apples and pears. As a result of all this work, it was shown that about two-thirds of the commonly cultivated pears are more or less incapable of self-fertilization. In case of the apple the well-known varieties seem to be more commonly self-sterile than the pear. An examination of cross and self-fertilized fruits shows sufficient differences to enable one to decide that the latter rarely occur in nature, and that even those which are capable of self-fertilization are generally cross-fertilized, or might even be said to prefer foreign pollen. The cross and self-fertilized fruits are frequently quite different in appearance; the difference in the size and number of the seeds is still more striking.

Mr. Waite gives tentatively the following general principles as a result of this preliminary investigation:

(1) The majority of the cultivated varieties of pears and apples require cross-fertilization in order to bring about successful fruitage. By cross-fertilization is meant the transfer of pollen from a different horticultural variety and not from a different individual of the same variety.
(2) Bees and other insects perform the work of cross-fertilizing.
(3) The weather at the time of flowering has an important influence on the visits of bees and other insects and through these upon the setting of the fruit.

The practical application of the foregoing principles will be plainly apparent to horticulturists. For example, large solid blocks of varieties known to be wholly or partially self-sterile should not be planted without introducing kinds known to be active fertilizers. Of course, judgment must be exercised in the selection of pollinating varieties, otherwise there may be discrepancies in the time of blooming which will render them valueless so far as the object in view is concerned. Careful tests will also be necessary to ascertain what varieties have pollen of the greatest potency for the fertilization of the sorts which it is wished to grow.

In addition to the foregoing, Mr. Waite inaugurated in the Old Dominion orchard a series of experiments with chemical fertilizers which are designed to be continued for several years. The object of this work is to test the effect of different methods of feeding or fertilizing in their relation to blight, to other diseases, and to the growth, longevity, and fruitfulness of the trees. Nitrogenous, potash, and phosphoric acid fertilizers, singly and in various combinations, were applied, seven formulæ in all being used. Each fertilizer was applied to triplicate plats containing 32 trees each, making 96 trees for each formula, or 672 trees in all. One-fourth of the trees in each plat were treated with Bordeaux mixture five times, to test the effect of spraying and fertilizing combined. The results of the spraying, which will be fully discussed in the Journal of Mycology, were quite striking. As was expected, the fertilizers produced very little effect this year, but it is believed by another season the results will be noticeable. The main fertilizer experiment was supplemented by a number of smaller ones in which from one to three trees were treated with large quantities of the fertilizing substance. In some of these the effects of the treatment were evident this year. A new pear disease affecting the twigs and smaller branches, discovered on the first visit to this orchard, has been the subject of an experiment for a remedy. The treatment tried consists of pruning and spraying, and promises to be successful. An attempt to remove lichens from the trees by means of spraying with Bordeaux mixture and other preparations completed the work in the Old Dominion orchard. This work is noticed more fully in another part of this report.

INVESTIGATIONS IN FLORIDA UPON CITRUS FRUITS AND OTHER SUBTROPICAL PLANTS.

Owing to its slightly increased appropriation the division has at length been able to take up the study of the diseases of citrus fruits and of other subtropical plants in a more satisfactory manner than heretofore. As announced in my last report, some field work was done by Prof. L. M. Underwood and Mr. W. T. Swingle, but these studies only showed the utter impossibility of arriving at any valuable results without careful investigations carried out on the ground.

The long distance from Washington prevented the laboratory studies from being carried on at this place, as it was found impossible, on account of the warm climate and imperfect mail facilities, to obtain good material from Florida. Accordingly a laboratory has been established in the midst of the orange region, and two assistants, Mr. W. T. Swingle and Mr. H. J. Webber, have been detailed to carry on the work there. The citizens of the town of Eustis generously offered to donate a laboratory and grounds, and a public-spirited orange-grower residing near offered a 4-acre bearing orange grove for experiments. These generous offers have enabled the limited means at command to be used in the purchase of laboratory supplies and the conduction of experiments.

The subtropical laboratory has for its immediate object the study of the diseases of all economic plants of the far South, as well as the discovery and trial of remedies and preventives therefor. On account of the great importance of the citrus industry the main part of the investigation at present will be confined to such diseases as blight, foot-rot, scab, etc., of the orange. As yet only preliminary investigations have been made, the laboratory being unfinished, and the necessary books, apparatus, etc., not being at hand.

For the purpose of obtaining some information on the communicability of orange blight by budding, some experiments were inaugurated in July of the present year in the grove of Mr. John Fabyan, near Leesburg, who generously placed a number of trees at the disposal of the division. Twelve large, healthy, sweet orange trees were budded from trees showing blight. These experiments, together with those started in the summer of 1891, by budding from blighted trees on small sour orange stock, will no doubt settle in a few years the question of the communicability of the disease by budding. Other groves for experimenting with sprays and fertilizers, and for work looking toward the extirpation of blight, have been kindly offered. Some of this work is already underway, and more will be begun as the season advances. The greatest stress at first will be placed upon laboratory work. A study of the physiology and anatomy of the healthy plant will be taken up and pushed as rapidly as the time and means at hand will permit. The importance of this matter is discussed in the succeeding section; hence it is unnecessary to say anything upon the subject here.

In addition to the lines of work already indicated, there are others equally important, bearing directly upon the question of diseases and their prevention. A careful study of the liability to or exemption of different varieties from various diseases, and the introduction of new varieties, or their production by crossing and selection with special reference to their disease-resisting qualities, are lines of research too valuable to be neglected. Also the effects of various stocks on the scion in health and disease will be carefully considered as soon as the necessary means are at hand. The almost unknown allies of the orange should be given a thorough trial. The discovery of a blight-resisting stock or variety would be worth millions, and a stock that could withstand the influences causing an ordinary orange to have "die-back" would be of great value.

The introduction of such stocks and varieties should be undertaken only by the General Government, and should be subjected to the most careful inspection. Otherwise the danger of introducing new diseases and parasites, even more destructive than the old, is great. There is good reason for the belief that several of the many destructive diseases now present have been introduced, and there are many others which should be most carefully guarded against. This division could very properly take up such work, as well as take steps to ascertain the nature and extent of dangerous maladies liable to be introduced into the country. In no part of the country is this more important than in the tropical and subtropical regions. Already sugar cane and orange diseases are present in the West Indies, and strenuous efforts should be made to prevent their introduction. The dreaded "Sereh" cane disease of the East Indies, if introduced into Florida or Louisiana, would seriously cripple, if not destroy, the now promising sugar interests in these States.

Again, the influence of climatic and soil conditions on the orange and other citrus fruits is a subject demanding study. It can be taken up profitably only by trained men provided with special equipment. The extreme variability of soil and climate in adjoining fields is a fact well known in Florida. Perhaps arrangements might be made for a study of these matters in connection with meteorological work. The general relation of climate to plants should also be studied.

Finally, and most important of all, is the study of the influence of fertilizing on the health and fruitfulness of the trees. The time of application, the amount and kind for different soils, stocks, and varieties, and the effect of the various fertilizers on amount, size, and quality of the production, are questions that certainly need answering.

With fruit trees like the orange, such investigations are almost entirely wanting owing, partly, to the difficulty of making them, but more especially to the fact that many years of consecutive and painstaking work is required before the effects of a given fertilizer on a given soil can be determined. With the cereals and other annual plants, on the contrary, a single season gives results of positive value. There is much that goes to show that the blight of the orange and other diseases are often, to a considerable extent, controllable by judicious fertilizing. This clew can not profitably be neglected. In addition to the bearing of such studies on the effect of various elements of fertilizers on diseases of the orange or other plants, they would be of great direct value to the grower as pointing out rational methods of plant feeding. Such investigations, if begun, must be continued for a term of years, with different varieties and stocks, on various kinds of soil, and, if possible, under diverse climatic conditions.

To conduct the work in a proper manner, an increase in the funds at the disposal of the division will be necessary. Such an increase, I believe, will be fully compensated for if nothing more be accomplished than the awakening of an interest in the cultivation of subtropical plants commensurate with their importance.

WORK IN THE LABORATORY.

During the year, the work in the laboratory has been somewhat varied in character. A long series of chemical experiments was made in the preparation of the various mixtures used for the first time in the field as fungicides. In the work on wheat rust alone nearly two months were consumed in preliminary studies, in the hope of finding some means of making the various preparations used more thoroughly cover or wet the foliage.

The usual work of studying the life histories of a number of parasitic fungi and other organisms has been pushed forward as rapidly as circumstances would permit. This work can not be hurried without greatly endangering its value in both a scientific and practical way. Pear blight, peach yellows, rust of wheat, rust fungi affecting various fruits, blight, scab, and other diseases of the orange, the shot-hole or leaf-blight fungus of the almond, and prune rust are a few of the more important subjects investigated during the year. In connection with this work, some interesting physiological questions have been considered.

This brings me to a matter which, in my opinion, is of the highest importance to the division, viz, the urgent necessity of a thorough study of the normal physiology of a plant, as a groundwork for pathological investigations. It will, I think, be plainly evident to any one, on a moment's thought, that the study of a diseased plant alone in the hope of checking or preventing the disease is, to say the least, illogical. And yet this is the line of research usually followed in this country, and to a great extent abroad. The reason for this is doubtless to be found in the fact that plant pathology is a comparatively new subject, and, as is always the case under such circumstances, the problems promising the most ready solution have been considered first. Such work, which consists mainly in the tracing of a fungus or other organism through various stages of growth, has unquestionably yielded good results, but it seems to me that if our researches are to continue fruitful we must go deeper into the phenomena of plant life. There is no doubt that every investigation so far taken up by the division could have been made more valuable had the pathological studies been more strongly supported by physiological ones. Thus a knowledge of plant physiology has come to be looked upon by the specialist as an indispensable aid to his work. In many cases his investigations are brought to a stand because the limits of physiological knowledge have been reached. Many diseases with which the division has had to deal, and with which it has attained its most signal successes, have involved these physiological problems. The search for the most easily applicable and most effective fungicides is made more difficult by our lack of knowledge on these points. Such diseases as apple scab, plum rot, peach rot, and peach-curl, which seem so intimately connected with unfavorable weather conditions, are unexplainable from a pathological point merely, while it is certain that the most destructive diseases with which the division is dealing to-day must be studied from the standpoint of the physiologist as well as the pathologist, for the investigations of the latter alone have not and probably will not explain their causes. I refer to peach yellows, peach rosette, the California vine disease, and orange blight. The immunity from fungus parasites, which determines to a large extent the success of certain varieties of cultivated plants and their adaptability to various localities, is another question to be settled by the physiologist.

But there is an immense field entirely outside the lines of plant physiology in its relation to pathology which the division might very properly be enlarged to include. For example, it has been shown elsewhere in this report that certain varieties of pears and apples are incapable of self-fertilization. This is due to impotency of the pollen, but the cause of the impotency is not known and probably will not be until a thorough physiological and anatomical study of the flowers and other parts of the trees is made. The cause of the trouble once known, it may be possible by selection or other means to overcome the difficulty.

Many of the practices of horticulturists admit of physiological explanation, and not until definite principles take the place of the ordinary beliefs, can the best results be obtained. The relation of climate and soil to plants in health and disease might be considered a branch of this work, as well as the influence of fertilizers on the yield, size, color, keeping qualities, resistance to diseases, etc., of fruits and other crops. Other objects might be considered in this connection, but enough has been said to show the need for such investigation. At present the division is not adequately equipped for this work, but it is hoped ere long the necessary means for vigorously prosecuting it may be at hand.

REPORT OF THE POMOLOGIST.

SIR: I have the honor to submit my seventh annual report as Pomologist of this Department. There have been no changes in the office force of this division during the year. The work of tabulating the reports of correspondents preparatory to embodying the same in special reports is progressing as rapidly as possible with the force at command.

Mr. J. S. Harris, of Minnesota, was appointed a special agent to serve during August, September, and October, for the purpose of investigating the condition of fruit growing in the extreme northern part of the Mississippi Valley. His report is herewith transmitted, with the hope that it may enable those who live in that vast section of our country to proceed more intelligently in the culture of fruits.

Several other sections have been visited by members of the division, and the important points of information gained will be found in this report. Several national and State horticultural society meetings have been attended by representatives of the division, and it is believed that thereby good has been done.

No special publications have been issued during the year, because of the long time needed in their preparation and especially for the completion of the necessary illustrations. The complete monograph on our native wild grapes is ready for the printer and awaits the action of Congress to furnish the funds necessary for its publication.

Respectfully submitted,

H. E. VAN DEMAN,
Pomologist.

Hon. J. M. RUSK,
Secretary.

THE FRUIT CROP OF THE YEAR.

The fruit crop of the United States for the year 1892 was below the average, and some kinds of fruit were very scarce. Apples have been a failure in a large part of the territory where they are usually abundant. In the States of Maine, Connecticut, Colorado, Oregon, and Washington the crop has been reasonably good, and in northern Michigan, southern Missouri, and a few sections in New York, Virginia, and western North Carolina apple orchards have yielded fairly well, and in all cases the prices have ruled high.

Peaches have also been scarce. California led the country in the production of this fruit. Southern Connecticut had a fair crop, and the same is true of the western parts of Maryland, Michigan, and Colorado, also southern Missouri and a few places in Arkansas, Arizona, New Mexico, and Georgia.

The pear crop of the Pacific slope was very good, but in all the Eastern States the contrary is true. There is an increasing demand in the market for the Keiffer pear, notwithstanding its poor quality, except when cooked, and planters are trying to meet the demand. In the Southern States this pear is much better than when grown in the North, as it is not only larger, but of better flavor. The very vigorous constitution of the tree is a point in its favor, as it does not yield readily to fire-blight, and often bears when most varieties fail.

Plums (including varieties called prunes) were not so plentiful. The native varieties, such as Wild Goose, bore better than the larger and better European kinds, especially in the Eastern States. The varieties brought from Japan seem to be well adapted to this country and are now being generally planted both North and South. Some of them (especially one called Kelsey) are too tender except for the climate of the Gulf States, but the majority are as hardy as the European varieties. They bear profusely, and the fruit is of good size and quality.

Cherries have been remarkably scarce, except in the Pacific States. Oregon and Washington produced the most and the best. Quinces have, on the other hand, done fairly well, as the tree puts out its blossoms very late, and thus they escaped the spring frosts, which as a rule were very destructive to fruits this year.

The apricot is not grown with success on the Pacific side of the Rocky Mountains, except in a small way, because of the curculio. The crop in California has been quite abundant.

Citrus fruits have borne well, although spring frosts in 1891 cut short the crop of oranges by killing the blossoms in some parts of Florida and California. Notwithstanding this, the markets were well supplied with oranges of good quality and at reasonable prices. Foreign-grown oranges, especially those from the Mediterranean region, are not in favor when there is plenty of the native product, and as they arrive here principally in the spring and summer when our own oranges are out of season, they do not seriously interfere with the home-grown product. Early in September oranges are received from the West Indies, principally from Jamaica, and about a month later the first consignments of the Florida and Louisiana crop are sent to market. Mexico is sending large quantities of oranges of very good quality to this country, which come chiefly by way of El Paso, Tex. Although many of them have to be transported long distances overland packed on burros, they are shipped into the United States in fairly good condition and are meeting with good sale in St. Louis, Mo., and other Western markets. Our own growers are already feeling the effects of this competition, which was mentioned in my report of last year. They come early in the winter and thus compete with the Florida crop. Arizona oranges come next in point of season, and although the quantity is yet quite small, owing to the recent beginning of orange-planting there, the quality is good. The time is not far distant when Arizona oranges will make an impression on the market. California oranges ripen about two months later than the bulk of the Florida product and have for years been an important factor in the market, especially in the Western and central States. As yet, but few have been sent to the Eastern markets.

Last year I stated that an attempt was being made to ship oranges direct to England from Florida. Until this year only a few small lots had been sent, but on November 17 the steamer *Ethelwold* sailed for Liverpool from Fernandina with 9,566 boxes of oranges. The ship encountered rough weather and the hatches had to be shut down a part of the time, which caused some damage to the fruit, but the cargo sold at an average of $2 per box in London, and netted the grower $1.05 at Fernandina, Fla., which is a good price considering that some of the oranges were below the average sizes, including a good many russets; also that there was a very unusual glut of Mediterranean oranges then on the market, and the further fact that over half the cargo was held more than a week after landing, which added to the damage by rot. With improved ventilation on ship board there is no reason why Florida oranges may not be sold in large quantities at a profit in England.

The entire orange crop of the United States does not now exceed 5,000,000 boxes, but it is estimated that within ten years it will reach 40,000,000 boxes, judging from the present rate of planting. Allowing for an increased per capita consumption of oranges by our own people, there would still remain a large proportion of the crop which could be exported to foreign countries.

Grapes have been plentiful in all sections of the country and the price has been low. In California there is an overproduction of wine grapes, and the raisin crop is so large as to have almost reached the limit of profit to the producer. In New York there is complaint that grapes have been sold at ruinously low prices.

Berries of all kinds have been plentiful, especially the strawberry. The frost in some sections of the Southern States seriously damaged the strawberry crop, but in the North there was little trouble of this kind; drought at picking time prevented the proper development of the fruit. The general interest in the growing of small fruits is increasing, but there is plenty of room for improvement in this direction, especially by the ordinary farmers, who, as a rule, sadly neglect to supply their families with an abundance of these delicate and easily grown fruits.

THE STRAWBERRY DISTRICTS OF THE SOUTH ATLANTIC COAST.

In my last annual report mention was made of the large strawberry-growing interests of eastern Virginia, and the methods of cultivation and marketing prevailing there were described at some length. In pursuing further the investigation of the methods and practice followed in berry-growing districts, the assistant pomologist, Mr. W. A. Taylor, in April and May visited those parts of Florida, South Carolina, and North Carolina where the strawberry is grown for market on an extensive scale.

FLORIDA.

In Florida strawberries are grown in a small way, for home use and to supply the numerous winter-resort hotels, in almost all parts of the State. Owing to the lightness and dryness of the soil and the consequent difficulty experienced in maintaining the plants through the dry season, the growth of this berry for market on a large scale is limited to a few favorably situated localities.

The shipping districts are all in the northern part of the peninsula along the railroads leading northward to the great cities of the Atlantic coast. The largest acreage is in Alachua and Bradford counties, the principal shipping stations this year having been Gainesville, Starke, and Lawtey. At the last-named place the industry has been developed since the disastrous freeze of 1886 practically destroyed the orange groves, and it is now the leading fruit crop of that section.

The soil about Lawtey is a heavy sand from 1½ to 2 feet deep, containing a good deal of vegetable matter and resting on a compact clay subsoil. It is about 130 feet above sea level, flat, and during the rainy season is often covered with water to a depth of 1 or 2 inches, like the rest of the "flat woods" country. In consequence of this, the matter of drainage has to be looked after and is usually accomplished by throwing the land up into beds or "lands" from 8 to 20 feet in width, with deep furrows between. The soil is well plowed and a dressing of commercial fertilizer, rich in potash and phosphoric acid, is well harrowed in a few days before the planting time, which is found by the best growers to be late in August or September, near the end of the summer rains. If planted earlier, the blossom buds are found to develop so early in the winter as to be damaged by the frost in January and February. And while early fruit is the main object of the grower, it is found that there is a limit to profitable earliness, as the Northern demand is not heavy during the winter months.

Plants are taken from old beds left for the purpose, no particular care being taken except to secure new plants, either runners or seedlings, of which the old beds are full, owing to the large amount of seed left on the plants at the close of the picking season. The planting is done by hand, with spade or dibble, in rows 2 feet apart or in double rows close together, and 1 foot apart in the row. This requires about 20,000 to the acre and makes horse cultivation impossible. The ground is frequently stirred by wheel hoes and all weeds and grass are kept out by hand-weeding until the early blossoms appear, when a mulch of wire-grass or pine straw is applied and the plants are "laid by." By this time, if the season has been favorable, the plants have formed large stools, no runners having been allowed to root, and the field presents the appearance of having been planted in narrow rows, though the hill system is scrupulously followed.

In the absence of killing frosts the picking season from the same plants may be expected to continue for four or five months, beginning about February 1. A field of Neunan strawberries near Lawtey, planted in double rows, is shown in Plate I, Fig. 1.

The berries ripen very irregularly at first and, though an occasional quart is secured earlier, the shipping season proper does not begin until late in February nor continue later than April. The fruit is picked as soon as it shows color and until April is shipped in 32-quart crates, by open express, to points as far north as New York, Boston, and Chicago; but as soon as the spring is fairly opened in the North, and not till then do the larger pickings come, refrigeration during shipment is necessary. This is accomplished either by using the refrigerator car, now in general use for the transportation of perishable fruits, or the "pony" refrigerator, which answers the same purpose and has the advantage of being adapted to the needs of small shippers who desire to ship their own fruit. This is a cheap double-walled refrigerator made of dressed boards, in the bottom of which are two chambers holding from 32 to 128 or more quart baskets of berries. The ice is held in a galvanized-iron tray, which covers the entire top of the inner chambers and from which a flue of like material extends downward between them, affording an escape for the water from the melted ice, through holes covered with sponge. The best features of this refrigerator are covered by patents and the shippers pay a small royalty for the privilege of using them. The refrigerators are thoroughly cool before being filled with berries, and about 200 pounds of artificial ice, costing $1.50 per cwt., are required for icing a 2-bushel crate.

It will be observed that this method of shipment is expensive and only available when prices are high, as the freight and ice charges amount to about 10 cents per quart. For a few of the early shipments the selling price sometimes runs as high as 75 cents or $1 per quart, but the bulk of the crop rarely sells for more than 40 or 50 cents, with occasional shipments that reach the market in bad order, or during cold and stormy weather when the demand is light, selling very much lower. The lowest selling price for which growers feel that they can afford to risk the shipment of fruit is about 25 cents per quart, and when sales fall below that the shipping ceases.

The yield of marketable fruit varies greatly from year to year, depending on the damage done by frost and drought and the consequent length of the shipping season, as well as on the condition of the markets. It probably does not average more than 1,500 or 2,000 quarts per acre, with a balance of 500 quarts that ripen after the shipping season closes. These are only available for home use, wine-making, etc.

But one variety (the Neunan Improved—a seedling of the old Neunan, long grown through the South) is grown in any quantity. It is a small, rather rough, conical berry, of very poor quality until full ripe—a condition which it only reaches in these market plantations after the close of the shipping season. A few Hoffman plants are grown, but, though slightly earlier than the Neunan, this variety has not proved profitable in Florida. For home use, the Michel is the favorite among those who have tested the newer varieties. Most of the Northern varieties fail entirely on account of the spot blight, and the Neunan is often damaged by it. Two crops are usually picked from the same planting, the first furnishing the larger berries and the second the larger number of quarts.

The business is fairly profitable, considering the capital invested, and in some seasons very good results are obtained. Sometimes as high as $500 per acre has been secured from a single crop. The danger from the hard frosts in January, February, and March is great, however, and this, with the excessive transportation charges, sometimes amounting to more than $1,000 on a single car load, forms the chief drawback to a further increase of the acreage.

The method of culture is adapted to the garden rather than the field, and its most obvious drawbacks are the absence of horse cultivation and the practice of selecting plants for new beds from old ones exhausted by fruit production and full of miscellaneous seedlings—a practice almost certain to result in the degeneration of the variety.

SOUTH CAROLINA.

The Florida berries are followed in the markets by those from South Carolina. The principal shipping district is in the neighborhood of Charleston, where the business has been carried on for many years. The conditions here are very different from those at Lawtey. The berries are mostly grown on land worth from $100 to $500 per acre, and as a second crop. The soil is a sandy loam lying mainly less than 30 feet above the sea level. It is not deep, but is well underdrained and in a high state of cultivation, the growing of truck crops having been the leading industry there since the close of the late war. The common practice here is to follow a crop of early potatoes harvested in May on ground well fertilized, with strawberries planted in August. The ground is thoroughly prepared, and every precaution is taken to secure a uniform stand of strong plants. Plants are taken up with a simple transplanter having trowel-shaped blades and two handles, so that a ball of moist earth is taken with the roots, and their growth is but little checked by removal. Though an expensive method, the growers almost universally practice it, to insure a good "stand" and "start" in the new field.

The rows are $2\frac{1}{2}$ to 3 feet apart with plants 12 to 15 inches apart in the row, and when the cultivation and hoeing are thoroughly done, the growth is very rapid and vigorous. No runners are allowed to root, and as soon as fruit appears, cultivation is stopped and a heavy mulch of pine straw (needles, of the long-leaved pine) is applied over the entire surface. This material is secured by the car load, some 20 miles distant, at a cost of $10 or $12 per ton, and after the picking season is over it is raked off to be used a second season. A view of a field of Hoffman berries on the farm of Mr. John Nix at Mount Pleasant, near Charleston, is shown in Plate I, Fig 2.

The shipping begins about the last of March and continues through April. During this time the fields are picked over every day. The berries are shipped mainly by fast freight to New York, the total shipping expense being about $7\frac{1}{2}$ cents per quart. Such shipments are profitable till the wholesale price in New York drops below 20 cents. The yield of marketable fruit is estimated at 4,000 quarts per acre, and with the present acreage and prices the business is profitable, as the ground is only occupied by the strawberries from August to May. After the berries are picked enough plants are retained to furnish runners for the new beds, the remainder being at once plowed under.

The packing of the fruit is very carefully attended to at Charleston, the berries as they are brought in from the fields by the pickers being emptied, assorted, and repacked before being placed in the crates for shipping. To reduce the bruising of the fruit to a minimum in this process, an assorting device not seen elsewhere is in common use. This device consists of a horizontal endless belt of canvas 12 to 15 inches wide, which is kept in motion by wooden pulleys at each end and runs in the bottom of a smooth, shallow, flat, board trough 8 to 12 feet long. The motion of the belt is secured by turning a crank attached to one of the pulleys. This gives a broad soft moving surface on which the berries, poured from the picking baskets, pass before the assorters, who pick out the culls as they move along. At the end of the belt the stream of berries is divided by a smooth wedge-shaped block of wood and directed into two 1-quart baskets by the deft fingers of the packers, who see that the baskets are well filled and topped out. The assorting device is home-made, costs but a few dollars, and the Charleston shippers believe that by its use they realize prices enough higher to pay them well for the extra handling. Certain it is that the Charleston berries at the height of their season are not excelled for cleanness, uniformity of size, and careful packing—three of the important points in strawberry marketing.

No other variety is grown than the Hoffman, which originated with Mr. H. Hoffman, of Charleston, in 1877, from seed of the Neunan. Its characteristics are noted in my report on the Norfolk strawberry industry last year, therefore it is unnecessary to describe it further than to say that it is an early, smooth, dark crimson berry, very firm and rather sour till fully ripe. From observations made at Charleston it is evident that, as grown and marketed there, it is superior to the same variety grown at Norfolk, probably because of the more thorough cultivation and fertilization at the former place. The objects sought are the same at both points—that is, early firm fruit of good color. The

FIG. 1.—STRAWBERRY FIELD NEAR LAWTEY, FLA.

FIG. 2.—STRAWBERRY FIELD NEAR CHARLESTON, S. C.

Norfolk grower aims to secure this by planting in spring and allowing the runners to root till broad tangled rows are formed which prevent cultivation and permit the growth of grass and weeds. He secures clean and early fruit at the expense of size. He risks less expenditure of money and consequently loses less by killing frost than does the Charleston grower. The latter plants a smaller area and spares no reasonable expense in cultivation and care, and as a result gets a much larger yield of larger fruit and apparently nets more for it.

It is evident that the Norfolk method would not be profitable on the high-priced lands about Charleston, but it is not so clear that the Charleston method would not pay in the long run on the cheaper lands of Norfolk.

NORTH CAROLINA.

Until very recently there was a perceptible break in the supply of strawberries in the market between the wane of the Charleston crop and the first receipts from Norfolk. This was noticed by growers, and as a result of their investigation and testing of localities a considerable interest has been developed in eastern North Carolina. From Wilmington northward to Goldsboro, along the Wilmington and Weldon Railroad, and to some extent further west in this State, there are, at almost every station, market plantations of strawberries. Their distance from the coast renders them more liable to damage by frost than at Charleston; but to partially counterbalance this there is available for planting a large area of suitable low-priced land.

The berry fields of eastern North Carolina vary in elevation from 30 feet to 150 feet above sea level. The soil consists of light sandy loam, with a tenacious clay subsoil, often but a few inches below the gently rolling surface. The land needs underdraining, but most of the growers yet depend on surface furrows.

The system here is the narrow row, the plants being put out in February, 12 to 18 inches apart, in rows 3 feet apart on narrow ridges. Cultivation is continued through the winter. A heavy mulch of pine straw is then applied and left on till spring. For fertilizer, 40 or 50 bushels of cotton seed is cultivated in, close to the rows, in December, and in January or February a top-dressing of 450 to 500 pounds of commercial fertilizer, rich in potash, is broadcasted over the field. Picking, packing, and marketing are about the same as at Charleston, except that less care is taken and the fruit is not assorted. Shipping expenses probably average about 5½ cents per quart to New York, most of them going forward without refrigeration. Shipments begin from April 15 to May 1, and continue from two to six weeks, according to the season. The average yield is about 2,500 quarts per acre; and prices range from 40 cents down to 10 cents per quart. The lowest wholesale price which leaves a profit for the grower is 15 cents per quart. To secure a price above this is the aim of the growers, and in their endeavor to accomplish it, they have attempted to secure varieties that can be depended on to ripen with the Hoffman and be less susceptible to frost when in blossom than that variety.

A number of local varieties are grown extensively, notably the Westbrook and the Murray, both with imperfect blossoms, and the Porter and the Katie, which are perfect flowered varieties. The Hoffman has not been discarded, but is not grown as largely as it was a few years ago. It can not be said that any of these new varieties are better market berries than the Hoffman, where it succeeds; but for the needs of the section where they have originated, and to meet the demand for berries that will ripen between the Hoffman at Charleston and the same variety at Norfolk, there is a place for them. They are firm berries, rather light in color, and, except the Westbrook, irregular in outline, of only medium quality and size. Numerous other seedlings are being tested at various points, some of which promise to be of local value and perhaps for wider dissemination.

One point of particular interest here is the dependence placed by some of the leading growers in the frost predictions of the Weather Bureau. By watching these predictions they are able to determine with much accuracy the danger to be apprehended in their locality, and, as the news of threatened frost reaches them a few hours in advance of sunset, to partially guard against damage to the crops. By placing their entire working forces at work with light hand-rakes they are able to cover the plants with the mulch of pine straw that lies on the ground between the rows, and thus to protect the blossoms from injury.

FRUIT-GROWING IN COLORADO.

An official visit was made to Colorado during the last week in August and the first half of September for the purpose of obtaining definite information concerning the condition of fruit culture in that State. East of the mountains the country is a series of rolling plains which gradually merge into the foothills. There is no natural timber growth except narrow belts along the streams, composed principally of two species of cottonwood (*Populus angustifolia* and *P. monolifera*) and box-elder (*Acer negundo*). The wild grasses are not thickly set, and a scattering growth of sage-brush, with occasional clumps of cactus and yucca, together with a very dry surface, gives the country a desert appearance.

The soil is a sandy loam, loose and easily worked, with almost no stones or other obstructions, and in point of natural fertility is up to the average. The rainfall is very light, there being rarely more than 6 inches annually east of the mountains. Irrigation is essential, and where water is thus applied to the land crops that are grown in the Central States are very successful, except those requiring a long hot season. The climate is usually mild, but subject to sudden cold waves, which have a tendency to evaporate the moisture from trees and all fruit plants to a damaging degree. Hence it is necessary to lay down all grape vines, blackberry, and raspberry canes, etc., during winter, and to cover them with earth.

About Denver, Colorado Springs, and all the cities and towns east of the mountains, there is a large and increasing interest in berry culture. The strawberry seems to flourish well in this loose rich loam when irrigated. Jucunda, a variety thoroughly tested and long ago discarded in the Eastern States because of its weakly root system, is a favorite among market-growers in Colorado. Nothing that I have seen in any State exceeds the luxuriant growth of this strawberry in eastern Colorado. Of course, covering with straw or other mulch is necessary in winter time. I was much surprised to notice the flourishing condition of English gooseberries, which, on account of mildew, are rarely successful in the Eastern States. The reason they succeed so well in Colorado is perhaps on account of the cooler temperature, and, it may be, the unsuitability of dry air to the development and propagation of fungous diseases of all kinds. Grapes seem to have no

NONIRRIGATED ORCHARD OF APPLE AND PEAR TREES (4 YEARS OLD), NEAR LITTLETON, EASTERN COLORADO.

black-rot or mildew in this State, perhaps for the same reason. There is neither scab (*Fusicladium*) nor the dark fungous blotches so common to the apple and pear in the Eastern States. Instead, there is a most delicate, waxy exterior, and in many varieties a beautiful bloom on the apple which but faintly develops in any other State, and nowhere else to such an extent. The coloring of these apples is exceedingly delicate, and yet quite intense and often brilliant. To those who have never seen fruit from this region, it would at first seem too exquisitely colored to be natural. In size, the winter apples and pears of eastern Colorado are rather below the average because of the short season, but the early varieties are as large as they grow elsewhere. Berries of all kinds are fully up to the average, and blackberries which I saw the last week in August were as large as those produced in the height of the season. Doubtless irrigation is the cause of their large growth so late in the season. As to the very important matter of flavor, I took special pains to observe, and found that, except in case of excessive irrigation, it was equal to that of any fruit found elsewhere.

One serious disease noticed was fire-blight on the apple, pear, and quince trees. It seemed very prevalent about Denver, and especially where irrigation had been excessive, as this caused a rank growth, upon which the disease preyed with avidity. In some cases whole rows of pear trees had been destroyed. Transcendent crab apple was rarely exempt. Throughout the eastern part of the State insect enemies of various kinds, especially the codling moth in the apple and pear, have been annoying the fruit-grower. Spraying with arsenical preparations has proved effective in preventing their ravages. Every progressive orchardist uses these remedies with as much punctuality as he does his cultivators. One species of leaf-roller was very destructive to many kinds of fruits by destroying the foliage. About Denver there was also serious defoliation by a kind of grasshopper, which attacks not only many kinds of fruits, but vegetables and field crops. In point of fruitfulness there could be no complaint. The trees of all kinds were loaded with fruit. Owing to a general failure of the apple crop throughout the country, prices ranged high.

It might be well to state that in eastern Colorado the peach is not successfully grown, because of the tenderness of the tree. Some varieties of the apple have also proved tender, and many of the Russian kinds have been grown in the hope of finding some that might be hardy and valuable, at least for market purposes; but their almost uniformly poor quality and susceptibility to blight has proven that they are not very satisfactory.

It would be an oversight, indeed, were I to omit mention of the orchard of Stark Brothers, near Littleton, which is 8 miles south of Denver. There are 93 acres, all ordinary upland, and it is neither flat nor hilly, but generally sloping in several directions, principally to the northwest. It was planted four years ago to apple, pear, plum, and cherry. In all, there are over 12,000 trees. The remarkable thing is that there has been no irrigation in this orchard except a very little the first year, and the trees have made a fairly vigorous growth every year. I found on many of the trees a sufficiently heavy crop of fruit for trees so young, and although it was not so large as if irrigation had been practiced, it was by no means poor. There had been no rain of any consequence for several months, and yet the trees showed no signs of drought. Plate II is made from a photograph taken in this orchard, showing apple and pear trees alternately in the same row. Just across the fence was the wild prairie, which looked like a desert, as it was almost devoid of anything like life. The ground was not naturally subirrigated, for a ditch more than 10 feet deep, in which to lay a Denver City water main, was then being dug along one side of the orchard; it plainly showed no signs of seepage from the land on which the orchard stood. The whole secret of success lay in frequent but shallow cultivation.

I was told by the foreman of the farm that the whole orchard had been cultivated once a week since last spring. This was the regular order during the growing season unless the ground was too wet. The tools used are such as stir thoroughly, but not more than 3 or 4 inches deep. The Clark disk harrow, and another something like the Acme, but with a heavy slab-drag attachment, which at once presses and smooths the finely pulverized surface, are preferred. The smooth surface presents as little of the moist earth as possible to the evaporating influences of the sun and wind. Aside from suppressing a growth of weeds, the express purpose is to keep in the earth the moisture which is deposited by the rains. With only about one-eighth as much rainfall as is common in a large part of our country, scarcely a tree would have survived any of the four years they have stood, except for the cultivation. It prevents evaporation in much the same manner that a blanket preserves a chunk of ice. Accurate scientific experiments made at the State Experiment Station at Champaign, Ill., proved that an average tree extracted from the soil and dissipated into the air about 5 inches (in depth) of water in the course of one summer, and the Stark orchard seems to corroborate this theory on a large scale, and that, too, where the rarer air and the generally more intense evaporating influences prevail than at Champaign, Ill. The thin mulch of finely pulverized soil acts as a nonconducting stratum between the moist subsoil and the dry atmosphere.

One would be very dull who would not reasonably conclude that, if this orchard has been safely brought through the trying summers of Colorado with only a very scanty supply of moisture from the clouds, an Eastern cultivator need have no fear from the short droughts he is likely to experience. If he will keep shallow but wide cultivators going, he will not only keep down weeds by nipping them in the bud, and at a small expense, but he may defy any ordinary dry spell. Of course this method can be properly tested only where the soil is either naturally or artificially thoroughly underdrained. Especially after every rain should harrowing be done as soon as the ground can be worked. This one lesson in practical horticulture, if heeded, will be worth millions to the country. The Eastern horticulturist has much to learn from the experience of his Western colaborer. In California a modified form of the plan just described is practiced in the nonirrigated orchards and vineyards, and in a former report I mentioned the almost weedless orchards stretching out for miles and miles, which I was delighted to see there. If those who cultivate in other sections would practice the same doctrine, we would hear of fewer failures and immensely better crops. The fact is, we do not more than half cultivate our orchards, vineyards, and berry patches. Let there be a general reform.

From the eastern border counties I passed through Pueblo up the Arkansas River to Canon City and vicinity. This is on the edge of the mountains, and at an elevation of 5,400 feet above sea level. The general character of the soil is fine silt, which, in the lower lands along the river, is termed "adobe" (a-do′-by). The higher tables or mesa lands are more inclined to be sandy and gravelly, and seem to be better for fruits, provided water can be conveyed to them in ditches. Here I found an almost total failure of all kinds of fruits, owing to an unusually severe and untimely spring frost. A thorough survey of the fruit farms plainly showed that nearly all the standard fruits do well here, except the peach and the apricot. One orchard of 10 acres, that was planted very closely, had, within ten years from setting, yielded a gross income of over $17,000, and by a judicious cutting out of a part of the trees I believe it may yield as much more fruit in the next ten years. No blight was seen on any of the trees in that section, but insects were there, especially the codling-moth. The Rocky Mountains are at hand, and the river has here cut through a range forming the "Royal Gorge," which is some 3,000 feet deep. Passing through this on the railroad, and nearly 60 miles of desolate mountain region, a valley about 5 miles wide and 20 miles long is reached. In this is Salida, a thriving town, supported chiefly by the railroad and mining interests. The soil here is principally composed of rotten granite with a rather generous mixture of gravel. Very little is being done in regard to fruit culture. I think this is principally owing to neglect. One apple orchard visited, which is about 7,100 feet above sea level, was well loaded with fruit. It was under average size, but the color was very brilliant and the flavor was very good. No injurious insects or traces of their work were seen after a close investigation. Apples, pears, and a few of the hardier plums seemed hardy and productive. Small fruits flourished wherever reasonable care had been given. That fruits can be grown at so high an altitude is, indeed, encouraging to those who, for any reason, find it desirable to make their homes there, for they may not only find enjoyment but profit in seeing them grow; besides, they can have them fresh, which, as every one knows, is very desirable.

The next place of investigation was across the Continental Divide, at Montrose, where the elevation is 5,800 feet. This is the first settlement of importance where fruits are grown in the valley of the Uncompahgre, which is one of the tributaries of the Gunnison River. The lower valley lands are adobe, and in some places are saturated with alkali to such an extent as to be objectionable. The mesa lands, which are from 50 to 100 feet or more higher, are extremely well adapted to all kinds of deciduous fruits. Although but a short time was spent at this point, several orchards were carefully examined and found thrifty and productive. With the exception of codling-moth in apples and pears in some of the town lots not an insect or fungous disease was noticed.

Delta, which is near the junction of the Uncompahgre and Gunnison rivers, was next reached. The altitude is about 5,000 feet, and the character of the soil is much the same as about Montrose. The fruit interest here is beginning to override all others, and orchards are being planted in every direction. The table-lands or mesas, which are some 50 feet above the level plains next the rivers, are entirely free from alkaline properties and seem to be best for fruit. The peach, apricot, and all the deciduous fruits were bearing profusely. No insect enemies were seen or heard of in this vicinity.

A few miles up the Gunnison River from Delta is the mouth of the North Fork, which stream runs through a valley about 25 miles long and less than half as wide. This valley is really shut in on all sides either by high mountain ranges or rough barren areas which makes it a veritable oasis. The soil is remarkably fertile on the lower lands as well as on the mesas, and there is almost no alkali in either. Fruits do as well as anywhere in western Colorado, and there was not a sign of insect or fungous enemies. In the numerous orchards visited, not a sting or diseased leaf could be found. Apricots and plums were gathered from the ground and eaten without fear of being wormy. Apple, peach, and pear trees hung loaded with fruit, to a degree dangerous to the trees, and I was told by all persons questioned that a failure is so far unknown. Plate III represents a tree of Wagener apple, 6 years old, in the orchard of W. S. Coburn, near Paonia, which I photographed during my visit. It was truly representative of what was seen in many other orchards in the same vicinity. In all my travels I have not seen a more profitable and delightful place to grow fruit than the North Fork of the Gunnison River. Two notable features of this particular valley are the abundant supply of water in the river for irrigation, and its freedom from alkaline or other impurities. If ditches were built to conduct water to every acre of arable land in the valley, there would yet be a good supply in the stream, even at its lowest stage. The water is as clear and cold as if it came directly from a spring, and I venture the assertion that there is no purer water in any river in the country.

Returning to Delta I followed down the Gunnison River to Grand Junction, which is near the confluence of the Gunnison and Grand rivers. These being united form the Colorado, which, not far below, enters the Grand Canon. Utah is but 17 miles to the westward. The soil and general character of the country are similar to that about Delta, but the altitude is about 400 feet lower, or 4,600 feet. There are some very thrifty orchards in the lower adobe lands, but tree-planting is being much more rapidly pushed on the table-lands whenever water for irrigation is available. There are large tracts yet owned by the Government that might become equally as valuable as any now under cultivation. Turning eastward at this point I pushed my way for more than 50 miles up the Grand River, through a series of valleys similar to those mentioned, and saw abundant evidence that fruits of the choicest qualities are being grown. It has been but eleven years since the Ute Indians took down their "wick-a-ups" and moved their squaws, pappooses, ponies, and dogs from these fertile valleys of western Colorado. Now there is every evidence of advanced civilization and prosperity. While stock-raising is one of the leading industries, fruit-growing is found much more profitable, and large commercial orchards are already planted. The nearness to the mines makes the price of fruit high, for, owing to the climate of those higher regions, the inhabitants must be large consumers of fruit. Hand-picked apples were selling in the orchard at 5 cents per pound, and windfalls at 3 cents, with other fruit in proportion. A most serious evil which threatens many sections of Colorado is the spread of noxious insects. Too much care can not be exercised to prevent their introduction, nor too stringent means adopted by the State for their suppression where they already exist. The whole of the region west of the mountain passes is practically exempt from them so far, except that in the town of Montrose and on one farm near Colorow the codling-moth has a foothold. If prompt action be taken by passing a law and enforcing it, as in some other States, or if the fruit-growers will organize and purchase and destroy all wormy or even suspected fruit, this insect will soon disappear. A saving of many thousands or even millions of dollars may thus be made at a very small expense by promptly carrying into effect some such plan.

A serious mistake made by some fruit-growers is in excessive irrigation and a corresponding lack of stirring of the soil. They try to make up with water what they fail to do with the plow and cultivator, but the effects are weedy orchards, fruits of poor quality, and diseased roots. The latter often seriously affect the life of the tree or plant. If the soil be kept moist, loose, and free from weeds, it is in the best possible condition

WAGENER APPLE TREE (6 YEARS OLD), NEAR PAONIA, WESTERN COLORADO. (IRRIGATED.)

for the production of good fruit, and the less irrigation that is necessary the better. The more successful growers have come to this decision.

Overfruitfulness is the rule, and so is early bearing. Many varieties of apple that bear too sparingly in the Eastern States are entirely free from this fault in Colorado. As proof of this I saw trees of Grimes Golden, Summer Pearmain, and Northern Spy, less than eight years set, that were bearing freely. Yellow Transparent, which is an early bearer everywhere, is so loaded in Colorado at two or three years after being set as to need vigorous thinning to save the trees. Contrary to what might be expected in the warmer valleys of Colorado, winter apples produced there keep very well, and, judging by those seen, I think they are in season with the apples of Ohio.

Among the disadvantages of fruit-growing in Colorado are the high prices of land in some sections and the cost of water for irrigation; but, all things considered, there is perhaps no State that offers greater inducements to the energetic and industrious, whether possessed of large or small means.

SEEDS, PLANTS, AND SCIONS DISTRIBUTED.

Such importations of fruit-tree seeds, plants, and scions as could be made at small expense have been secured and placed with experiment stations and private individuals for testing. A number of seedling fruit trees, plants, and scions have been sent to the division by the originators for distribution, and all such contributions have been distributed to experimenters located in the various parts of the country where they are likely to succeed and become valuable.

CHESTNUT.

From Sicily there was obtained, through the kindness of Hon. Charles Heath, United States consul at Catania, 1 bushel of fresh Italian chestnuts grown on the slopes of Mount Ætna, and regarded as one of their most valuable nuts. These were sent to about 150 correspondents for planting.

KAKI.

Two varieties, Mestio and Kako, were received from Prof. Kizo Tamari, Imperial College of Agriculture, Komaba, Tokio, Japan. These were trees grafted under Prof. Tamari's directions from what he considers the best varieties in the coldest region where the kaki is grown. The trees have been placed in Florida for propagation, and are reported to have made a fine growth during the summer. Some time must elapse before they can be widely distributed, however, owing to the fact that of one variety but a single tree, and of the other, but two trees, could be had. Scions of another variety sent without name from Korea by H. N. Allen, an American residing there, were also received and placed with propagators. Mr. Allen reports this variety as growing well in that cold climate, and thinks it probable that it will succeed in the region of our Great Lakes.

Scions of eight of the leading varieties now growing in this country, the nomenclature of which may now be considered to be fairly settled, were sent to a number of the experiment stations and leading nurserymen of the South to afford means of comparison, to determine the identity of the varieties they may be growing, and to aid in the work of getting at the relative merits of each.

ORANGE.

There being some doubt as to whether the true Selecta orange of Brazil has been introduced into this country, an importation of five trees of this variety was secured through the consul-general of the United States at Rio Janeiro. These were placed in Florida, Louisiana, Arizona, and California to give the variety a wide test, and to determine its value as soon as practicable.

MISCELLANEOUS.

Scions of five varieties of apple were distributed. Also vines and cuttings of eighteen varieties of grapes, one of currants; scions of two varieties of quince, one of American chestnut, five of hickory, three of pecan, two of hazel, one of native persimmon, eight of plum, and three varieties of strawberry plants. Of fruit seeds there were secured and distributed some eight species. Altogether about four hundred lots were sent out during the year.

PROMISING NEW FRUITS.

Brief descriptions of some of the most promising new fruits received during the year are noted below, for the benefit of planters and experimenters.

APPLES.

Brightwater (G. F. Kennan & Son, Rogers, Ark.).—Large, round conical with a greenish yellow surface somewhat mottled with russet, and heavily splashed, striped, and shaded with dull red; dots minute, yellow and brown; skin thick; flesh greenish yellow, fine-grained, juicy; core large, conical, closed, clasping; calyx tube very long; seeds few, large, pointed, brown; flavor subacid, quality good; season winter. Said by Mr. Kennan to be a moderate bearer until it reaches the age of 12 or 15 years, after which it is productive. Tree resembles Limbertwig, but is coarser in growth. It is hardy in Arkansas.

Bryant (G. W. Bryant, Vienna, Va.).—Fruit large, roundish oblate, smooth; color greenish yellow shaded and splashed with dull red, striped with darker red and covered with gray over color; dots numerous, large, gray russet, many of them being aureole, or with prominent rough centers. Flesh yellow, coarse-grained, tender, juicy; core conical, closed, clasping; seeds plump, medium sized, brown; flavor mild subacid; quality very good. Season late winter to spring in Virginia. Very promising as a long keeper for the apple regions of the South.

——— (J. G. Brown, Wyoming, Del.).—Fruit large, roundish oblate; surface smooth, greenish yellow, shaded and striped with red and overspread with gray at the base; cavity large, regular russeted; dots numerous, large, gray; stems short or medium, slender; basin medium, regular, folded; calyx segments short, broad, slightly reflex; eye large, open; skin thick; flesh greenish yellow, fine grained, breaking; core wide conical, closed, clasping; seeds plump, large, brown; flavor mild subacid; quality very good. Season, late winter and spring in Maryland and Delaware. This apple originated on the farm of Thomas Jackson in Kent County, Del. Mr. Brown describes the tree as a poor grower, weeping badly, and thus showing most of the fruit on the limbs.

Yacob (Henry G. Schantz, Zionsville, Pa.).—Fruit large, globular oblate; surface smooth, yellow, striped and splashed with crimson; dots few, gray; cavity regular deep, abrupt, green; stem short, slender; basin regular, deep, abrupt folded; calyx segments curled or twisted; eye small, closed; flesh yellowish white, slightly tinged with red, fine-grained, tender, juicy; core wide, open, clasping; seeds plump, pointed, brown; flavor mild subacid, spicy; quality good. Season, late winter in Pennsylvania. The original tree is a vigorous grower, forming a large, round-headed, half spreading orchard tree. It is a good bearer, though more than a hundred years old.

Mickel No. 1. (A. D. Barnes, Waupaca, Wis.).—Large, oblate; surface smooth, glossy, greenish white, striped with light red; dots few, white; cavity large, very deep, slightly russeted; stem short, slender; basin medium, deep, abrupt, folded;

segments wide, short, converging; eye small, closed; flesh white, fine-grained, tender, juicy; core wide, conical, clasping, nearly closed; seeds plump, medium, brown; flavor slightly subacid; quality good. Season, last of September in Wisconsin.

Perry (Edward W. Perry, Lattas, Ohio).—A fruit of medium size, oblate, regular; surface smooth except for numerous large russet dots; color yellow, striped and shaded with bright red; cavity large, deep, russet; stem short, medium; basin regular, medium, folded; calyx segments short, slightly reflexed; eye small, closed; flesh yellow, fine-grained, tender, juicy; core wide, closed, clasping; seeds large, brown, plump; flavor mild subacid; quality very good. Season, late spring in Ohio. A good bearer and long keeper.

Story (D. B. Story, Hemlock Grove, Ohio).—Size above medium, roundish conical; surface smooth, light red shaded and splashed with dark red and overshaded with gray; dots few, minute; cavity medium, russeted; stem short, fleshy at base; basin irregular, large, abrupt, folded; calyx segments short, broad, reflexed; skin thick, tough; flesh greenish yellow, fine-grained, melting; core large, open, conical, clasping; seeds numerous, plump, large, dark brown; flavor sweet; quality good to very good. Season, late winter in Ohio. A very promising long keeping, red, sweet, winter apple. This variety was found by Mr. Story in a neighbor's orchard planted about 1845. There is but the one tree and it is thrifty, bearing annual crops. The source from which the trees were obtained is unknown by the man who aided in planting the orchard, and it is apparently a seedling.

Upp (Henry W. Hope, Paint, Ohio).—Medium in size, oblate conical; surface smooth except for a few russet knobs, yellowish green, mostly covered with red; dots few, conspicuous and prominent at base, small toward apex; cavity large, russeted; stem very short; basin medium folded, ribbed; eye medium, closed; flesh yellowish, moderately tender; core medium, nearly closed, conical; flavor mild subacid; quality good. Season, August to January in Ohio.

RUSSIAN APPLES.

White Russet, No. 981 (Dr. T. H. Hoskins, Newport, Vt.).—Large, roundish, truncated; surface smooth, oily, pitted; greenish white shading into yellow, with a faint blush; dots green or red; flesh white, fine grained, juicy; core large, wide, conical, clasping, nearly open; flavor brisk subacid; quality good. Season, early winter in northern Vermont.

Cross No. 15 M. (Prof. J. L. Budd, Ames, Iowa).—Fruit medium, roundish, oblate, regular; surface smooth, pale green with slight traces of russet near base and raised russet dots; cavity medium, russeted; stem medium; basin medium, ribbed and knobbed; eye small; flesh greenish white, firm but tender; core oblate, somewhat open, meeting the eye; seeds long, plump, below medium in size, reddish brown; flavor rather acid; quality good. Season, winter in Iowa. These two varieties may be classed as Russians of good quality that keep fairly well. The name "Cross," which is a translation from the Russian, unfortunately conflicts with that of a variety long grown in Maryland and Virginia under the same name, and mentioned in my report last year.

CRAB APPLE.

Snyder (A. L. Hatch, Ithaca, Wis.).—Fruit large, oblate conical, smooth, yellow, splashed and striped with bright carmine and overcolored with gray toward the base; dots medium to large, indented, yellow; cavity regular, medium, deep, russeted; stem short, slender; basin shallow, finely plaited; calyx segments wide, medium length, reflexed; eye small, closed, flesh yellowish, medium, fine-grained, juicy; core large, closed, clasping, conical; seeds plump, short, small, brown, few; flavor mild subacid, sprightly; quality very good. Season, September in Wisconsin.

PEAR.

Fitzwater (Herbert A. Jones, Himrods, N. Y.).—Small, obovate, obtuse pyriform; surface smooth, yellow, with splashes and patches of russet; stem 1 inch in length, slender, with bracts, set in a regular cavity of medium size and depth, lined with russet; basin regular, large, medium depth, russeted; calyx segments rather long, spreading, connected at base; eye medium, open; dots numerous, small, brown; flesh yellowish white, fine-grained, juicy, buttery; core medium size, oval, closed, clasping; seeds mostly imperfect, dark brown; flavor mild, sweet, aromatic; quality good. Season, winter. This pear very closely resembles Lawrence, but is claimed by the introducer to be distinct.

Longworth (M. J. Graham, Adel, Iowa).—Above medium size, moderately smooth; greenish yellow with a delicate blush on the sunny side and a few patches of russet;

dots numerous, brown; flesh whitish, medium fine-grained, dry; flavor sweet; quality medium. Season, September in Iowa. Originated with William Longworth, of Dubuque. Tree stands and bears well up to the north line of the State. It is not only hardy but resists blight. Valuable for the northwest, where most varieties winter-kill.

Max (L. M. Ayers, Urbana, Ohio).—Fruit medium size, obovate pyriform, regular; surface smooth, lustrous, yellowish green with bright blush in the sun; dots numerous, small, depressed, russet; flesh white; flavor, vinous, almost subacid; quality, fairly good. Season, September in Ohio. A seedling from Flemish Beauty, crossed with Louise Bonne.

Mission (J. B. Mathews, Capistrano, Cal.).—Fruit irregular acute pyriform; yellow, thinly covered with russet and a tinge of brownish red in the sun; dots numerous, light brown, some quite large; stem medium, stout, set on obliquely with a lip; basin regular, medium size, folded; calyx segments medium, stiff, variable, some erect, others recurved; eye small, closed; flesh white, fine-grained, buttery; core regular, small, nearly closed, meeting the eye; seeds few, large, very dark brown; flavor very mild, almost sweet; quality good. Valuable for cooking and preserving. Season, September and October. The original tree is near the Mission at Capistrano, and is supposed to have been grown from seed by the priests. It has been somewhat propagated by means of suckers. Tree is about 100 years old, 39 inches in diameter, at 4 feet from the ground; is 60 feet high, and produces annually about 1,200 pounds of fruit.

Victor (Stark Bros., Louisiana, Mo.).—Fruit large, pyriform; surface very smooth; color greenish yellow with a slight blush; dots numerous, small; flesh yellowish; core long, oval, closed, meeting the eye; seeds angular, small, brown; flavor very mild, almost sweet; quality good. Season, September. The tree is a very poor grower in nursery, but is said to make a healthy orchard tree, little affected by blight. This pear was brought from Pennsylvania by Judge Samuel Miller. It was there known locally as "Vicker," but to avoid confusion with the well-known Vicar (of Winkfield) it has been renamed "Victor."

CHERRY.

Bing (Plate IV, *a*—Seth Lewelling, Milwaukee, Oregon).—Fruit very large, broad heart-shaped, compressed, slightly angular; surface bright, glossy; color very dark crimson to black; dots numerous, often elongated; cavity broad, stem long, suture very broad, apex slightly depressed; skin thick, very firm, but not tough; flesh deep crimson, very firm, juicy; flavor vinous, sweet; quality very good. Season, first half of July in Oregon. This is the largest cherry ever received at this office. It is an excellent shipper. A seedling of Black Republican. For comparison with Bing, on Plate IV, *b*, will be found an illustration of Napoleon, a popular old variety of European origin, which is widely grown in California and Oregon, sometimes under the synonym "Royal Ann." It is too well known to fruit-growers everywhere to need a detailed description.

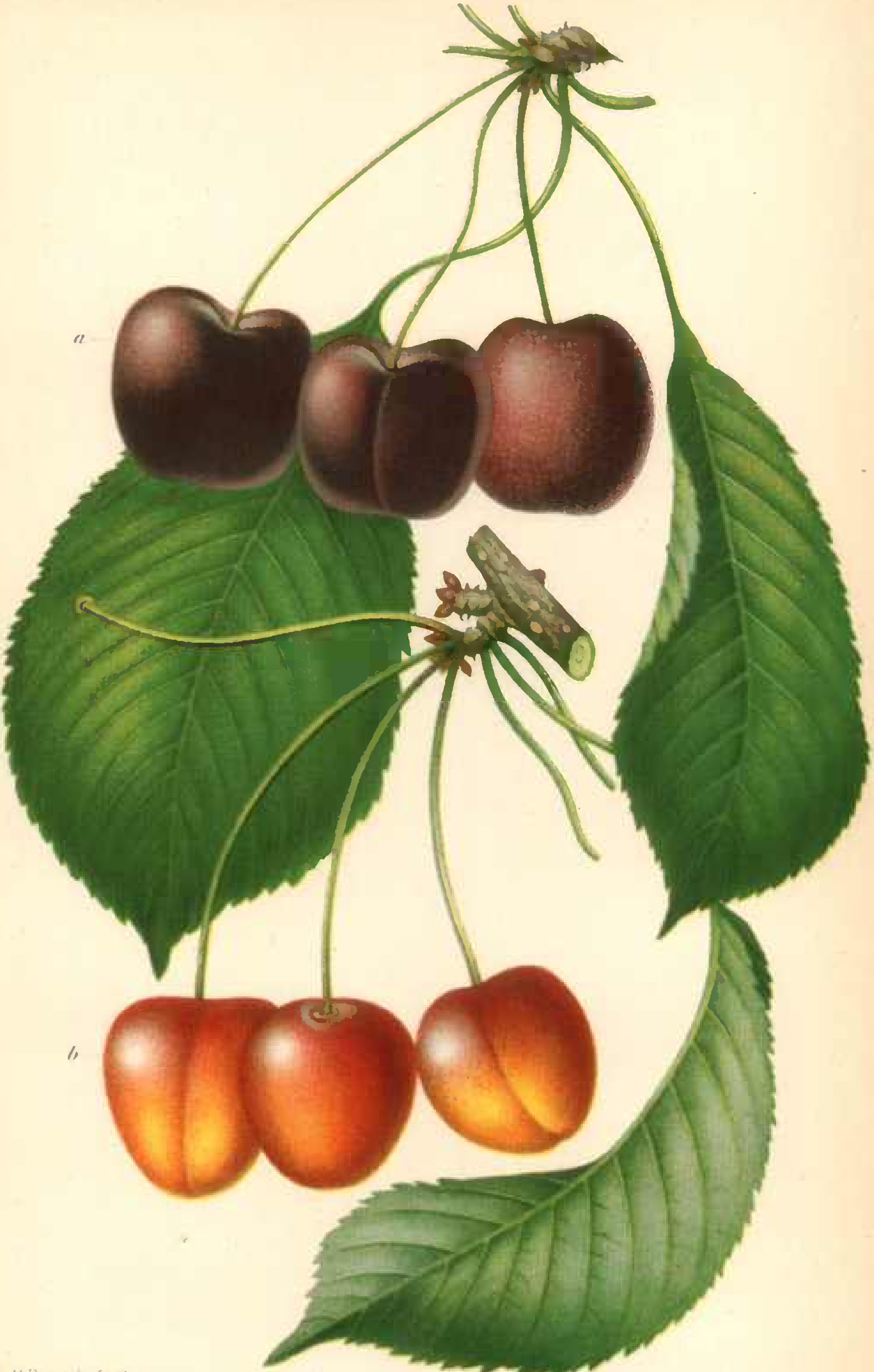
Hoskins (C. E. Hoskins, Newberg, Oregon).—Fruit large, roundish, heart shaped; cavity round, regular; suture a mere line; stem rather short, set in a regular round cavity of medium depth; color dull purplish red; dots elongated; skin medium; flesh purple, with light veins, firm; flavor sprightly, sweet; quality good. Season, medium. An excellent shipping cherry in Oregon. The tree is a somewhat spreading, upright grower, very vigorous, with large coarsely dentate ovate leaves having two large reniform glands.

Matilda (C. E. Hoskins, Newberg, Oregon).—Fruit medium to large, broad heart shaped; surface smooth, glossy, dark red, nearly black; dots very fine; flesh liver color, firm; flavor sprightly, sweet; quality very good. Another promising market sort. Season, middle of June in Oregon.

Mercer (Plate V—Joseph H. Black, Son & Co., Hightstown, N. J.).—A medium sized, irregular, heart shaped cherry; cavity round, wide, irregular; stem medium length, rather slender; surface irregular, angular, glossy, bright red, with darker mottlings and blotches; dots minute, depressed; skin rather thin, moderately tough; flesh pinkish, meaty; flavor subacid, lively, rich; quality very good. Season, middle of June in New Jersey. Fruits in clusters of two or three. A very productive variety. Tree a vigorous grower, hardy in New Jersey. Original tree is said to bear 10 to 18 bushels per year.

Quaker (C. E. Hoskins, Newberg, Oregon).—Another of Mr. Hoskins' seedlings, and of most excellent quality. Fruit medium size, dark red, almost black, dots numerous; flesh firm, dark purple; flavor sprightly, sweet; quality very good. Season, early in July in Oregon.

Vesta (C. E. Hoskins, Newberg, Oregon).—Fruit medium size, blunt heart shaped, very dark; flesh firm, sweet, good. Season early, middle of June in Oregon.



Wm H. Prestele fecit

A. Hoen & Co. Lithocaustic

CHERRIES; A BING; B NAPOLEON

Wm H Prestele, fecit

A Hoen & Co., Lithocaustic

MERCER CHERRY

Wm. H. Prestele, fecit.

A. Hoen & Co. Lithocaustic

SOPHIE PLUM.

PEACH.

Guadalupe (G. Onderdonk, Nursery, Tex.).—One of the Spanish class. Glands reniform. Fruit roundish oblate, conical, of medium size, with a prominent tip and deep suture; surface rather harsh because of the short persistent down; color dull creamy white; skin thick, tough; flesh white, faintly tinged with red; clings to the stone; flavor vinous aromatic; quality very good. Season late, ripening in August in southern Texas.

Oro (C. S. Bell, Oroville, Cal.).—Large, oblate conical, yellow-fleshed free stone; surface smooth, reddish yellow with bright red blotches where exposed to the sun; skin thin, tender; flesh reddish yellow, melting, juicy; flavor vinous, almost subacid, like Crawford. Season late; last of September at Oroville. Glands reniform.

Rose (G. Onderdonk, Nursery, Tex.).—"The earliest of the Spanish race." Medium size, round conical; surface smooth, dark red; skin thick; flesh greenish white, melting, juicy; flavor sprightly, vinous; quality good. Likely to be of value on account of its earliness as compared with most of its type.

Stinson Late (H. E. McKay, Madison Station, Miss.).—Fruit large, broad oval; surface soft, velvety; color creamy white, shaded on sunny side with dark purple; skin thin, tough; flesh white, veined with red, quite red at the stone, to which it adheres; flavor mild, subacid; quality good. Season late; first half of October in central Mississippi.

Zane (Joseph Morrison, Cadiz, Ohio).—Fruit medium size, roundish oblate, with a deep cavity and very shallow suture, except at apex, which is deeply depressed; surface soft, velvety, yellow, shaded with bright red and a dark purple cheek in the sun; down short, adherent; skin thin, but tenacious; flesh yellow, red next the stone, free, melting, juicy, mild subacid, good. Season, first half of September in eastern Ohio. The original tree is a sprout below the bud in a garden on Wheeling Island in the Ohio River. It is nine years old, and bore this year eight bushels of peaches, other varieties having but little fruit. The tree is a strong grower, leaves have small globose glands. It somewhat resembles the Crosby described in my report for last year, but is evidently distinct from that variety.

PLUM.

Grace (W. R. Grace, Garden City, Kans.).—Fruit above medium size, oblong; surface smooth, glossy, yellow, striped with red, and mottled and washed with dull purple; dots numerous, light yellow; bloom light, thin; skin thick, not bitter; flesh yellow, translucent, melting, juicy, with very little pulp, clinging to the oval stone; flavor rich, sweet, vinous; quality very good. A delicious plum, apparently of the *Americana* type. Season, September in Kansas.

Golden (Luther Burbank, Santa Rosa, Cal.).—Fruit large, round oblate, smooth, yellow, washed and shaded with light red and a few patches of russet; dots numerous, yellow; flesh golden yellow, with white fibrous veins; flavor rich, sweet; quality very good. Season, beginning of September at Santa Rosa. A seedling of Kelsey fertilized by Burbank.

Harlow (S. C. Harlow, Bangor, Me.).—Fruit large, oblong oval, smooth, glistening; color red to dark purple; dots numerous, small, fawn color; bloom light blue; flesh greenish amber, melting, somewhat fibrous; flavor mild subacid, skin slightly bitter. Season early, beginning of September in Maine. Quite like Bradshaw, of which it is supposed to be a seedling, but ripens a week or ten days earlier. Tree reported to be a vigorous grower, hardy at Bangor, and exceedingly productive.

Jessie (Martin Nursery Co., Winfield, Kans.).—This plum is a wild seedling of the *Americana* type. Fruit large, ovate or ovate-compressed; surface waxy; color wine red with small or numerous dots; flesh reddish yellow, melting, somewhat stringy; flavor slightly subacid, almost sweet when ripe; quality very good. Said to be very productive. Season, last of July and first of August in Kansas. The tree is said to be vigorous and healthy, though with a tendency to sucker badly. This is overcome by grafting it on other stocks. It has stood a temperature of 16 degrees below zero without being injured.

Perfection (Luther Burbank, Santa Rosa, Cal.).—A seedling of Kelsey crossed by Burbank. Fruit above medium size, heart shaped; red, shading into very dark red at apex, with numerous light dots; quality very good. Season, August at Santa Rosa. Mr. Burbank reports the tree to be a strong, stocky, upright grower and very productive. He regards it as combining all the best qualities of the parents.

Sophie (Plate VI—J. W. Kerr, Denton, Md.).—This is a novelty among our new plums, being the result of a supposed cross of German Prune on Wild Goose. Fruit of medium size, varying in form from ovate to oblique obovate; surface smooth, glossy, under a whitish bloom; color dark amber red, modified by numerous small light dots; skin thick, tough, quite tart, slightly acerb; flesh orange yellow, firm yet melting; flavor vinous, sprightly; quality good. A promising sort for market, being a much better shipper than Wild Goose. Season, first half of September in eastern Maryland.

Theresa (Mrs. Theresa M. Morris, Bloomingburg, Ohio).—Fruit medium size, roundish oval; color reddish purple, covered with a heavy light blue bloom; flesh yellowish green; flavor very mild, rather sweet when fully ripe; quality only good. The tree is a heavy and regular bearer, hardy in Ohio, hence may be valuable in some sections where other varieties fail because of tenderness or lack of productiveness. Season, beginning of August in Ohio.

GRAPE.

Critic (J. S. Breece, Fayetteville, N. C.).—A seedling of Jefferson much resembling Delaware in appearance and ripening earlier than Brighton; quality hardly equal to Delaware. The vine has proved freer from mildew than Delaware and is promising as a market grape.

Hosford (George Hosford, Ionia, Mich.).—A large grape of the Labrusca type a few days earlier than Concord. The cluster is very large, slightly shouldered, tapering; berry very large, spherical, smooth, black, with rather thin bloom; skin rather thin, tender; pulp clear, tender, juicy; seeds few and small; flavor sweet, pure, brisk, not foxy; quality good.

Lawrence (Dr. R. B. Clark, Fay, Pa.).—Cluster large, long, tapering, slightly shouldered; berry medium to large, round, adhering well to cluster; color dark purple to black with thin bloom; skin medium in thickness; pulp very firm, breaking; seeds few, flavor vinous, subacid, not equal to Concord. Season, medium to late. This grape vine is said to have been found growing in a fence corner some twelve years ago, and transplanted to a garden. It began to bear early and has been fruitful every year and free from mildew and black rot.

Ohio (E. H. Cushman, Euclid, Ohio).—Originated with R. H. Hunt, of Euclid. Cluster large, tapering, slightly shouldered; berry rather large, round, black with slight bloom; skin rather thick, tender; pulp moderately juicy, tender; seeds small, three or four in number; flavor mild, slightly subacid; quality medium. Season early.

BLACKBERRY.

Eldorado (E. M. Buechly, Greenville, Ohio).—This berry was noticed last year and it seems to be of so much promise as a dessert fruit that an illustration of it is presented on Plate VII. It is an oblong, irregular berry of large size, fruiting in pendulous, slender, hairy spikes, with few thorns. Color brownish black; flesh deep crimson with tender core; flavor sweet, rich; quality very good.

Primus (Plate VIII—Luther Burbank, Santa Rosa, Cal.).—This berry is the result of a cross between a Siberian raspberry (*Rubus cratægifolius*) and the Pacific coast dewberry (*Rubus ursinus*). It is classed with the blackberries because it most resembles them in appearance, and the fruit generally adheres to the receptacle, like the blackberries. The fruit is large, long, blunt, conical or oval, composed of drupes of medium size, containing rather large, curved, flat seeds, firmly attached to a tender core; juicy, subacid, aromatic, resembling the raspberry in flavor. Season varies from latter part of April to May, at Santa Rosa, about with Hansell raspberry. The plant is a strong vigorous grower, having in part the trailing habit of the pistillate parent; is thickly covered with short blunt prickles and requires tying up. It is very productive. It is somewhat harder to propagate than other blackberries or raspberries, but can be grown by rooting tips as in the black raspberry. It does not start readily from root cuttings. It is illustrated as a promising new fruit, one result of the careful and extended experiments made by Mr. Burbank in crossing and hybridizing to produce new varieties and types of commercial value. Enough has already been accomplished in this line by him and others to warrant the prediction that we are soon to witness a marked addition to the variety and quality of our cultivated fruits.

Truman Thornless (G. P. Peffer, Pewaukee, Wis.).—A medium to large oval berry with dull color, firm, sweet, fragrant; quality good. Said by Mr. Peffer to have come from New England. As hardy as Snyder, earlier, and of a better quality. It is nearly thornless.

GOOSEBERRY.

Columbus (Ellwanger & Barry, Rochester, N. Y.).—A very large berry of the English type. Single specimens were $1\frac{3}{8}$ by 1 inch in size. Form roundish oblong to obovate; color greenish yellow, transparent; flavor subacid; very good. A promising garden variety.

D. G. Passmore fecit

A. Hoen & Co. Lithocaustic

ELDORADO BLACKBERRY

Wm. H. Prestele, fecit

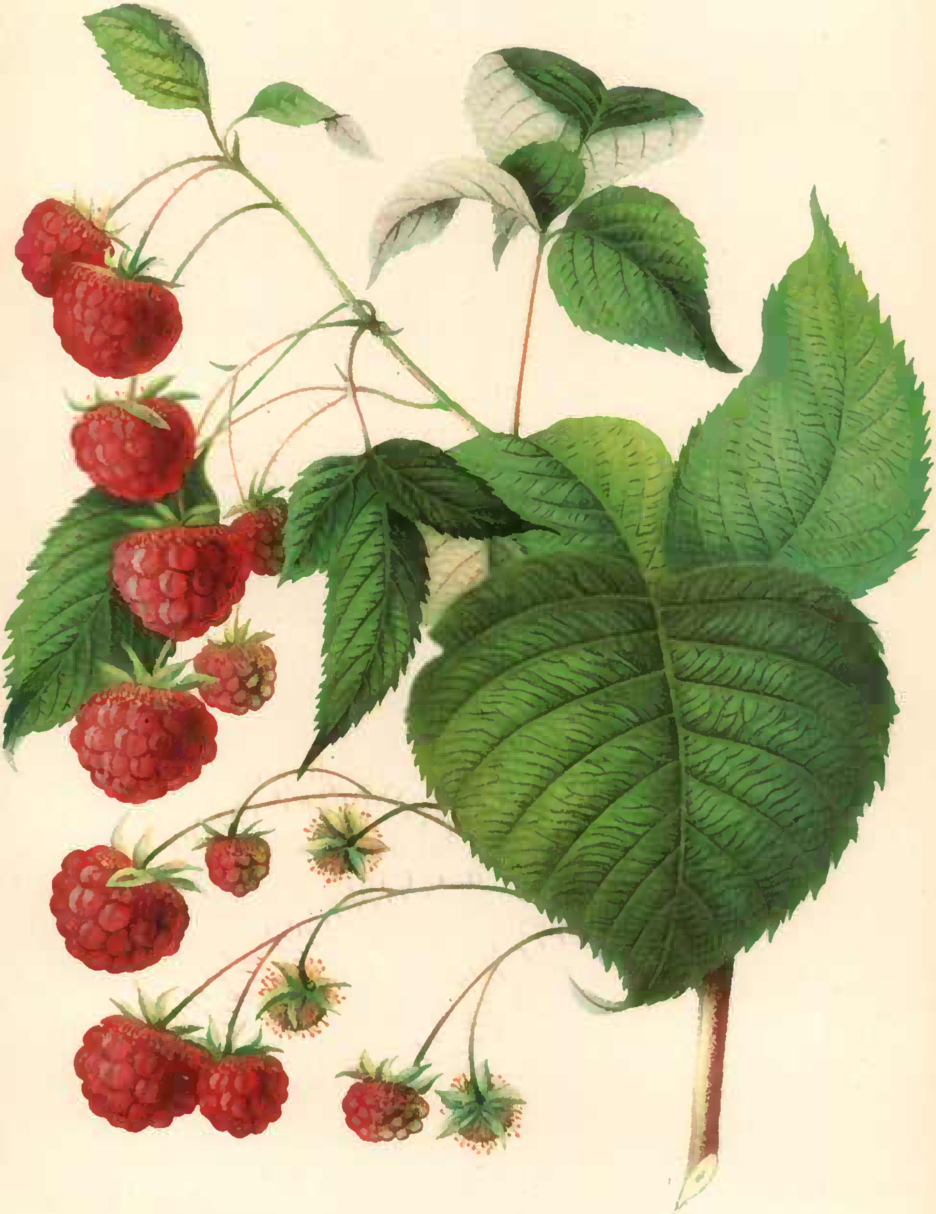
A. Hoen & Co., Lithocaustic.

PRIMUS, HYBRID BETWEEN RUBUS URSINUS AND R. CRATAEGIFOLIUS.

Wm. H. Prestele fecit.

A. Hoen & Co., Lithocaustic.

HANNIBAL RASPBERRY.



Wm. H. Prestele, fecit

A. Hoen & Co., Lithocaustic

ROYAL CHURCH RASPBERRY.

Red Jacket (George S. Josselyn, Fredonia, N. Y.).—Fruit large, roundish or elongated; color reddish green, shading into solid red, quite transparent until fully ripe; skin rather tender; flesh light red, fine, pulpy, juicy, rich, fragrant; quality very good.

RASPBERRY (BLACK).

Babbitt (W. R. Laughlin, College Springs, Iowa).—A black cap of medium size specially commended for hardiness. Round, oblate, with drupes small and rather numerous, dull black, without bloom; moderately firm, juicy, subacid quality good. On plants of same age it this year yielded 50 per cent more than Hopkins. A strong vigorous grower, with a long ripening season.

Hannibal (Plate IX—W. J. Bradt, North Hannibal, N. Y.).—This berry was mentioned in the report for last year as "Extra Late." At our suggestion it has been named Hannibal. As the plate shows, it is a very large round black cap, with drupes rather regular and numerous. It is a fine berry of excellent quality, apparently vigorous and productive. Its chief value is in its late season of ripening, being several days later than Gregg.

RASPBERRY (PURPLE).

Colossal (I. F. Street, West Middleton, Ind.).—A seedling of Shaffer, very closely resembling its parent.

RASPBERRY (RED).

Cardinal (A. H. Griesa, Lawrence, Kans.).—A late red berry of medium size, very productive, and with a long ripening season.

King (Cleveland Nursery Co., Rio Vista, Va.).—Round, medium size, light crimson color; drupes large, few, with suture very plainly marked; moderately firm, juicy; flavor subacid; quality good. A seedling of Thompson ripening at about the same time, but larger and more productive.

Royal Church (Plate X—Royal Church, Harrisonville, Ohio).—This berry, mentioned last year, continues to promise well notwithstanding the unfavorable season in Ohio. It is a roundish crimson berry with large drupes, moderately firm and of excellent quality. The plant is a vigorous grower and is reported to be hardy in Ohio and New York.

STRAWBERRY.

California (H. T. Curtiss, Ridgely, Md.).—Large, long conical, sometimes compressed and coxcombed; calyx large, stem stout; color very deep crimson, glossy, with seeds little depressed; flesh bright crimson, firm, juicy; flavor subacid, pleasant; quality good. A valuable market berry for strong lands and narrow row culture. It was at one time thought to be Belmont, but is now regarded as distinct. It is a good pollenizer, blooming with Crescent.

Columbian (R. H. C. Mitchell, Fruitland, Tenn.).—A new berry from Tennessee, claimed to be earlier than Crystal City, and valuable as a market berry. The specimens received were large, broad conical, rather irregular berries of a light crimson color with seeds slightly depressed. Calyx medium size, smooth, bright green; stem stout; texture rather soft, about like Crescent; flavor subacid, pleasant.

Murray [*Imperfect*] (J. S. Westbrook, Faison, N. C.).—A North Carolina berry valued for its earliness and productiveness. A medium to large, broad conical berry, often compressed or double at the top. Size medium to large; light crimson; firm; rather sharp acid; quality medium; a good shipper.

Omega [*Imperfect*] (John Willcox, Bridgeton, N. J.).—Blunt conical, medium to large, with a deeply depressed calyx; slightly irregular, light crimson; flesh scarlet, moderately firm. Of fair quality. It is worth testing as a late berry.

TROPICAL AND SEMI-TROPICAL FRUITS.

KAKI.

Costata (Plate XI—G. L. Taber, Glen St. Mary, Fla.).—Medium size, conical, slightly four-sided, calyx considerably depressed and basal markings quite distinct; surface smooth, salmon yellow, rarely cracked; flesh yellow, with few seeds, astringent till ripe; late and keeps well. The tree is a strong upright grower, very distinct in form, with broad roundish leaves, making it also valuable as an ornament.

LOQUAT.

Giant [*Eriobotrya Japonica*] (Plate XII—Luther Burbank, Santa Rosa, Cal.).—This Japanese fruit, long grown in a small way in the Southern States under the name Japanese Medlar, or erroneously "Japanese Plum," is rarely seen in the Northern markets. In the cities of Florida and Louisiana it can now usually be found during the months of March, April, and May, and somewhat later and less abundant in the warmer parts of California. It is a small fruit somewhat resembling a yellow plum in appearance, but covered with a short fine down. It is borne in large terminal spikes on a dwarfish somewhat straggling tree with large oblong rugose evergreen leaves that are downy beneath. The fruit contains one or more large, smooth, brown seeds, and is of a delicious, slightly acid, flavor. It is marketed in small baskets like strawberries. Near New Orleans, La., and Jacksonville, Fla., its culture has been found exceedingly profitable on well-drained, moist, rich lands. It does not succeed so well in California owing to the damage done to the blossoms by frost, as it blooms in winter. The variety illustrated is the "Giant," regarded by the Japanese as the best they have. Its conduct in this country does not indicate that it is superior to many seedling trees in any essential point.

ORANGES.

Boone (C. A. Boone, Orlando, Fla.).—An early orange grown from seed secured from oranges bought from a foreign vessel at Tampa, thirty-five years ago. Valued for its earliness and good quality; fruit large, roundish, with a moderately smooth skin, slightly tinged with red and very thin; flesh tender, juicy, sprightly, quality good.

Higley Late (E. H. Hart, Federal Point, Fla.).—A late, medium-sized orange, rather dark in color. A good keeper and shipper, of fair quality.

Onoro (Lyman Phelps, Sanford, Fla.).—A light colored orange of medium size, thin skin, heavy juice, and brisk, sprightly flavor; quality excellent. Season early. A very good orange in December and continuing until April.

Tephi (Lyman Phelps, Sanford, Fla.).—Large, round, light orange in color, with a thin skin and delicious tender pulp. The name is from the Hebrew, signifying tender.

LEMON.

Agnes (F. A. Kimball, National City, Cal.).—Seedling grown by Mr. Kimball from seed taken from a lemon sent him by Mrs. Agnes Harris, wife of United States Senator John S. Harris, of Louisiana. The tree is nearly thornless and has very heavy foliage. Buds set in a lime root in 1881 produced before the end of the third year 1,060 marketable lemons. Fruit medium size, oblong, with a very large irregular oblique point. Acid sharp, pleasant. A promising variety with almost no seeds.

PROMISING WILD FRUITS.

Buffalo Berry [*Shepherdea argentea*] (Plate XIII—Agnes M. Johnson, Laurel, S. Dak.).—This wild fruit recently introduced to cultivation is worthy of attention in the cold northwest. It is perfectly hardy and exceedingly productive, the branches being thickly studded with the currant-like fruit. It is a shrub from 5 to 18 feet high, with cuneate oblong leaves, silvery on both sides, and holds its fruit well into the winter. The fruit is both red and yellow in color, with a single slender seed and agreeable acid pulp. It makes an excellent jelly and is delicious for dessert when dried with sugar. It is easily propagated from seeds, but being diœcious is better propagated by layers or suckers from pistillate individuals with a few staminate plants to insure the setting of the fruit.

PERSIMMON.

Marion (Samuel Miller, Bluffton, Mo.).—This native persimmon is a large handsome fruit with few seeds, ripening in October. The original tree was found growing near Fulton, Mo., on land owned by J. H. Marion and is said to have larger leaves and blossoms than the common persimmon. J. L. Normand, of Marksville, La., also sent two varieties, one very large, and one nearly seedless, that are promising.

Passmore, fecit.

A Hoen & Co. Lithocaustic

COSTATA, JAPANESE PERSIMMON (DIOSPYROS KAKI).

Wm. H. Prestele, fecit

A. Hoen & Co., Lithocaustic

GIANT LOQUAT (ERIOBOTRYA JAPONICA)

A. Hoen & Co., Lithocaustic.

D. G. Passmore fecit

BUFFALO BERRY (SHEPHERDIA ARGENTIA).

NUTS.

Hales (Henry Hales, Ridgewood, N. J.).—This hickory nut was illustrated in 1884 by Mr. Andrew S. Fuller, who says he first became acquainted with it about 1869. This nut is among the largest of the little shellbark species. Its shell is very thin; in cracking qualities it is not best, many halves of the kernels being broken or marred by the shallow, though clasping partition walls. It ranks among the best having a large plump kernel of high quality.

Curtis (A. J. Coe, Meriden, Conn.).—A hickory nut raised by Curtis Coe, an uncle of our correspondent and the originator of the Coe Transparent cherry. He planted the nut from which this came in 1859. The tree is now 8 inches in diameter at 6 feet above the ground; it stands near the original tree of the cherry. The nut is medium in size, has very slight angles and may be rated among the best in thinness of shell, fullness of kernel, and ease with which the kernel can be removed in halves. Its flavor is good and it is said to be very productive.

Ideal (George J. Streator, Garrettsville, Ohio).—A hickory nut, in size among the largest of the little shellbarks. The shell is moderately thin, but the cracking qualities are not the best. The quality of the kernel is good.

REVISION OF FRUIT NOMENCLATURE.

The work of revising our fruit nomenclature may now be considered as well begun. The apple list is under way and it is hoped will be ready for publication during the year. By this revision it is aimed to make a simplified list of all known varieties grown in this country, indicating as far as possible their proper synonyms and dates of origin. For the convenience of those who have no means of access to the rules of the American Pomological Society, in accordance with which the work is being done by this division, they are published in this report, with the additions made at the last biennial session:

RULES FOR NAMING AND DESCRIBING FRUITS.

Rule 1.—The originator or introducer (in the order named) has the prior right to bestow a name upon a new or unnamed fruit.

Rule 2.—The society reserves the right, in case of long, inappropriate, or otherwise objectionable names, to shorten, modify, or wholly change the same when they shall occur in its discussions or reports; and also to recommend such changes for general adoption.

Rule 3.—The name of a fruit should preferably express, as far as practicable by a single word, a characteristic of the variety, the name of the originator, or the place of its origin. Under no ordinary circumstances should more than a single word be employed.

Rule 4.—Should the question of priority arise between different names for the same variety of fruit, other circumstances being equal the name first publicly bestowed will be given precedence.

Rule 5.—To entitle a new fruit to the award or commendation of the society, it must possess (at least for the locality for which it is recommended) some valuable or desirable quality or combination of qualities in a higher degree than any previously known variety of its class and season.

Rule 6.—A variety of fruit having been once exhibited, examined, and reported upon, as a new fruit, by a committee of the society, will not thereafter be recognized as such so far as subsequent reports are concerned.

A rule governing the revision of names was authorized by the society at its meeting in Washington in September, 1891, as follows:

Prefixes, suffixes, apostrophic terminations, and secondary words, together with words whose significations are expressed in the descriptive columns of the catalogue, are eliminated from the names of fruits, save in a few cases in which they may be needful to insure the identity of a variety and in a few time-honored names.

The anglicising of foreign names is resorted to only in the interest of brevity or pronounceability.

In questionable cases, subsidiary words are retained in parentheses.

A TREE PROTECTOR.

There is a pressing need for something to prevent injury to the trunks of trees. In the central prairie States, in particular, rabbits often destroy whole orchards by gnawing off the bark in winter time. In

Texas I have seen the same thing occur in midsummer, as rabbits are usually numerous there. In the extreme Northern States the severity of the winter often causes the trunks of apple trees to become diseased and in some cases to die. The very hot sun in midsummer also seriously affects the south side of trees, making large blemishes, which sometimes prove fatal.

In addition to the testimony of many correspondents, I know, from about twenty years' personal experience in Kansas, that it is useless to depend on washes of any kind to prevent under all circumstances the depredations of rabbits. The only sure method is to surround the bodies of the trees with some material which they will not gnaw. Cornstalks and coarse grass tied fast with strings, hay ropes, rags, and paper wound about them, are commonly used and are cheap, but perishable, and have to be annually renewed. A piece of closely-woven wire netting, about 12 by 18 inches, bent about the trée and fastened by a wire makes a surer protection, and costs about 3 cents. It will also stop the eating of the bark by mice and prevent the beetle of the round-headed borer from laying eggs and will last for several years. A bunch of soft grass stuck in the top will keep it in proper position and allow no chafing of the tree. Another cheap and durable protection is made from wire and plastering lath or other wooden strips. It has been used in a small way for many years, but only within the last three years has it been put prominently before the public. Mr. A. J. Phillips, of Wisconsin, has led in this work. Prof. E. S. Goff gave an accurate description of this method in the Report of the Wisconsin Horticultural Society for 1891. Cypress or cedar plastering laths are best where easily procured, but those of pine will last very well. Cut in two pieces they are about the right length, but longer strips can be used if necessary for the better protection of tall trunks. Six laths make a protector large enough for a small tree, but seven or eight are more commonly needed to prevent renewal until the trees have attained an independent age. The accompanying drawings will, in a measure, explain themselves (Fig. 1 showing the method of manufacture and Fig. 2 the protected tree). The following description of the protector and directions for making are quoted from Prof. Goff, with some amendments:

The wire used is about No. 18 in size, and may be of iron, brass, or copper. Brass and copper are more durable than iron, but their greater cost will overbalance this advantage. As a rapid means of measuring off the wire it may be wound length-

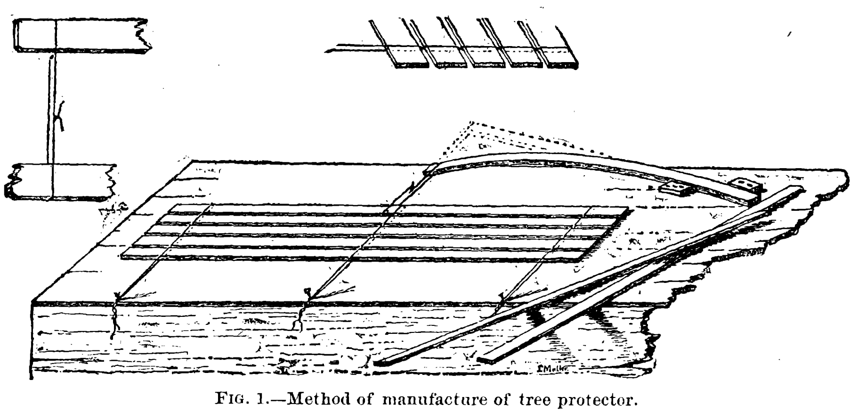


FIG. 1.—Method of manufacture of tree protector.

wise about a piece of board 18 inches long for an eight-lath protector or 16½ inches if seven laths are to be used. The wires may then be cut at one end of the board with the cold chisel or tinner's shears. The protectors may be rapidly put together on a common work bench by means of the simple device shown in Fig. 1. Procure a piece of strong elastic wood about 4 feet long and three-fourths of an inch thick to serve as the spring shown in the drawing. Then tack two blocks to the top of the bench near the rear side to serve as a support for the spring. Now, drive three nails into the bench near the front side, at the distance apart at which the wires are to be placed on the protector. The end wire should be about 3 inches from the end of the laths. Next, twist the ends of the wires together for a short distance, beginning about 3 inches from the end, and place one of the wires about each of the nails in the front of the bench, as shown. Place another shorter wire, having the ends bent into hooks, as shown at the left side of the drawing, about the outer end of the spring and slip the first lath through the six wires, as shown in the drawing, bend-

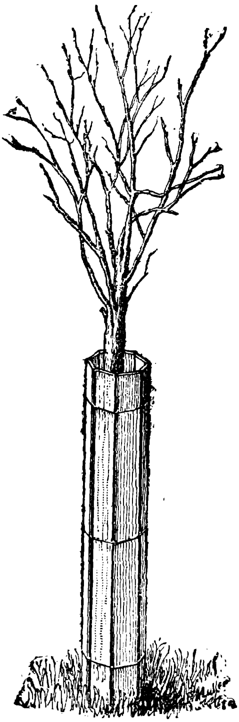


FIG. 2.—The protected tree.

ing the springs sufficiently to make this possible. The spring now acts as a tension to keep the wires taut. Insert the second lath, lifting up the lower strand of wire and slipping the lath between that and over the other strand, thus crossing the two strands. Then with a hammer gently drive up the second lath toward the first till the two are about one-fourth of an inch apart. Insert the other laths in the same manner, after which unhook the wire connecting the spring with the first lath and loosen it from the protector. In placing the protector about the tree, simply bend it around and insert the free ends of the wires beneath the wire of the first or second lath, clinching it enough to hold securely as shown in Fig. 2. The protector is to be left on summer and winter, until the tree outgrows it, or the wires rust off. The protector not only prevent sun-scald on the trunk, but is an effectual preventive from rabbits and other rodents, as well as from whiffle-trees used in cultivation.

FRUIT CULTURE IN MINNESOTA, WISCONSIN, SOUTH DAKOTA, AND IOWA.

By JOHN S. HARRIS, *Special Agent.*

The territory in which my work has been located is so vast in extent that only a small proportion of it could be gone over, and that very hastily, in the three months' time allotted me. Minnesota alone extends north and south 500 or 600 miles and shows a great diversity of soil and climate. There are three or four districts in the region lying between Lake Michigan and the Rocky Mountains, north central Iowa and Minnesota, that differ so greatly in climatic conditions that they will probably require specific varieties for each. In some of them it is not unlikely that we may be in the future largely dependent for fruit upon improvements—not yet accomplished—of varieties and species nearest indigenous to these points, unless our experiment stations develop the fact that trees and plants procured from like climes may be found to flourish here. For some time to come fruit culture here must necessarily be experimental work. There are a few men in portions of the region who are succeeding reasonably well with a few varieties. They are giving them intelligent attention with the head, the hand, and the heart; that is, they study the business, enter into it with a spirit of determination, make judicious selections of varieties, and give them good cultivation and almost undivided attention. Their experiments have been costly ones in the past, and the work is still too great and costly for individuals to undertake. I believe it is entirely safe and within bounds to make the statement that of all the apple trees planted in Minnesota between the years 1852 and 1885, aside from the Oldenburgh, Tetofsky, and Wealthy, and some half dozen belonging to the Siberian species, not over one tree in fifty has lived and thrived long enough to produce for the planter to exceed one peck of apples each; while the exceptions named, when properly planted in suitable locations and properly protected, have very generally rewarded the planter with liberal quantities of fruit, and have frequently proved the most paying investment on the farm.

Since the great disaster of 1884-'85 our people have been more careful in the selection of varieties, making the Oldenburgh the leading one, and filling out with the Wealthy and such of the newer Russians as could be secured, The results in the last three years indicate that this will become a very good apple-producing country as soon as hardy varieties can be found to prolong the season, and the people become educated up to the better methods of planting and managing orchards

THE FRUIT CROP OF 1892.

In some respects the season of 1892 was an unfavorable one for orchards. Although the previous winter was not an unusually severe one, and the spring opened as early as the average, vegetation came forward very slowly. Fruit trees and plants were from fourteen to sixteen days later in coming into bloom than in the preceding year. The bloom was more profuse, and the promise seemed better than in any previous year, but the final result was a partial failure or short crop of all fruits but the blackberry, except in a few of the more favored localities. My investigations would lead me to attribute this to (1) excessive rainfall during the blooming season, low temperature at some periods, and a very general scarcity of the insects that usually work on flowers and effect pollination; (2) the mildew and leaf-blight or scab, induced by sudden changes in the temperature, an atmosphere overcharged with moisture and a lack of sunshine. The latter occurred or became visible between the 1st and 10th of June. It first appeared as a grayish mildew on the underside of the foliage, on the stalks of the leaves, and stems of the newly formed fruit. In many instances the leaves turned yellow and brown, and finally dropped off, leaving some varieties nearly defoliated and presenting a sad appearance; the fruit also dropped to the ground. All varieties were not affected alike, nor did all localities suffer in the same degree; in fact, some varieties were entirely exempt, at least in certain sections. This trouble extended over the greater portions of the States of Wisconsin, Minnesota, and the extreme northern part of Iowa, being found at its worst in Wisconsin, and along the eastern borders of Minnesota and Iowa, gradually assuming a milder form farther west on the high table-lands and prairies beyond the Mississippi River. The fruits most affected were, (1) the native plum (*Prunus Americana*), the crop of fruit proving a total failure except in rare instances, while the trees of some varieties have suffered great injury to the season's growth; (2) the Siberian crab-apple species, the Transcendent, which is the variety most extensively grown, being about the worst (only in the most favored localities was any of this class of fruit produced); (3) what are termed American varieties of the apple, or varieties that have had their origin in this country, and are descendants of the varieties originally introduced from western Europe, or that have long been cultivated in this country. These have fared about in the order named: Fall Queen (synonym *Haas*), Edgar Red Streak (synonym *Walbridge*), Tolman Sweet, Fameuse, Golden Russet, Ben Davis, Willow, Perry Russet, Plumb Cider, Bailey Sweet, St. Lawrence, Malinda, Utter, McMahon, and Wealthy. This list comprises all of the varieties of American apples that have at any time been successfully grown there.

The Oldenburgh, a considerable number of the Russian varieties of recent introduction, and a number that have been originated from seed of the Oldenburgh, have proved nearly or entirely exempt from this malady, and wherever the orchards of them have reached a bearing age they have produced good crops of fair fruit, except in some of the lower valleys and very sheltered locations; and even there the foliage and the season's growth have been good. It is true that of the newer Russians and their seedlings, but few have been planted long enough and in sufficient quantity to determine what they might do under all circumstances. The Oldenburgh is pretty thoroughly tested, and has proved to be all right in foliage, while the fruit is entirely free from scab. This one variety comprises at least one-third of all the fruit produced in the Northwest, and probably two-thirds of all that is produced in excess of the wants of the grower. The crop of the Wealthy has been next in magnitude and perhaps equal in value, because, being less perishable, it need not be rushed to market in excess of the demand. The remainder of the apple crop has been divided among a considerable number of varieties that have generally been planted in such limited quantities or numbers that their commercial value is almost untested. It is noticeable that every seedling that can be traced directly to the Oldenburgh for origin is more healthy in tree and in foliage than are seedlings of American origin; but only a few have keeping qualities, and the fruit of many of them is lacking in the finest quality and flavor.

FRUIT AT THE FAIRS.

INTERSTATE FAIR (LACROSSE, WIS.).

At the Interstate Fair, held at Lacrosse, Wis., August 29 to September 3, there was quite a large exhibit of apples, made mostly by professional growers, as follows: E. Wilcox & Sons, of Lacrosse; A. J. Phillips, West Salem; William Fox, Baraboo, and C. Morgan, of Forestville, Minn. Owing to the earliness of the fair and the extreme backwardness of the season, only the earliest varieties were in fit condition for showing to the best advantage, and winter varieties were not colored up or full grown. Russian varieties showed best, being generally nearer mature, smoother, and more shapely, and nearly or entirely free from scab. The Transparent and Oldenburgh families were fine and fully ripe, and in better condition than they are usually at our fairs. Patten Greening and Iowa Beauty were unusually fine. The leading American varieties were not as fine as usual and were badly affected with scab. The Siberian species were conspicuous by their scarcity, but very few plates being shown. Whitney alone was up to the usual standard in size, quality, and beauty of appearance. A few varieties of seedlings were on exhibition, but were not mature enough to test their merits. No grapes were ripe enough to make a good showing. The crop of native plums being a failure, none of them were shown.

MINNESOTA STATE FAIR.

The Minnesota State Fair was held at Hamlin, Minn., September 5–10. A week of pleasant weather had wrought great improvement in the condition of the fruit, although many varieties were not yet mature. The exhibit of apples was large, fully as large as has ever been made in the State, numbering altogether some 1,500 plates. Many of the varieties were not as large and finely colored as in some previous years. The exhibition was chiefly from Hennepin, Washington, Ramsey, Dakota, Carver, Rice, Wabasha, Goodhue, and Nobles counties; but small exhibits of single or few varieties from other quite remote sections of the State were seen. In quantity Ramsey County took the lead, closely followed by Hennepin, Rice, Dakota, and Carver counties. Owing to the chaotic condition of the nomenclature of the new Russians, I am unable to state how many varieties of them were on exhibition. Nearly one hundred were claimed, but I could not distinguish with certainty more than sixty, and I think that thirty of those would not be seriously missed if they were lost altogether. The best single collection of new Russians was shown by Andrew Peterson, of Carver County—the best because all were fair in size and appearance, and the varieties, twenty in all, were not shown under more than one name each. In native seedlings, J. G. Miller, of Rice County, showed the greatest and most promising collection—about twenty varieties. A number of single varieties were shown from various parts of the State.

The grape exhibit was very large, comprising more than fifty varieties, but the fruit was not sufficiently ripe to show at its best, few varieties being fit for eating. The grape interest promises to become a large one in this State, and I am glad to be able to report that backward as the season has been, the crop fully matured and was saved before the occurrence of killing frosts.

WISCONSIN STATE FAIR.

The Wisconsin State Fair was held at Milwaukee, Wis., September 12–17. The exhibition of fruit at this fair was a surprise to the great majority of the visitors present, because the impression had gone out that the fruit crop was a failure. In the southeastern section of the State, which has always in the past contributed the larger portion of the exhibits of the fairs, the crop was a failure, and in only a few limited sections was it really good. The entire exhibit comprised over 3,000 plates of apples, besides the grape show of several hundred plates. A very large proportion of this fruit came from Sauk County, and was grown on the highlands about Baraboo. A fine exhibit was also made from Richland County that was grown on the highlands between the Wisconsin and Mississippi rivers. Another good exhibit came from Lacrosse County, grown on the bluffs from 400 to 500 feet above the valley. There was also a small exhibit from Oconto County, which is the most northern limit where orcharding has been tried. I was disappointed in not seeing some of the noted Waupaca seedlings among the exhibit. The show of Russian varieties was large and fine, nearly one hundred varieties being claimed; in fact, had they not been in the exhibit the fruit part of the fair would have been decidedly inferior. Almost all of the older American varieties were below the average in appearance, on account of this being a nonbearing year and the unusual prevalence of the scab, while the Russian varieties were fair, well developed, and free from scab. A considerable proportion of the Russians are early varieties, and but a few of them really late, long keepers. As the season was unusually backward (estimated to be fully three weeks), a number of varieties were shown in their greatest perfection that ordinarily are not seen at our fairs on account of their earliness and perishable nature. The largest exhibit of Russians was made by A. G. Tuttle, of Baraboo, who has the oldest and largest orchards of them in the Northwest. Other exhibitors of Russians were C. Hirschinger, George Townsend, Mr. Palmer, and William Fox, of Sauk County, and A. L. Hatch, of Richland County. Samples of the best of these, except the extremely early, were selected and forwarded to the Department of Agriculture, at Washington. I found here, as in Minnesota, that the nomenclature of the Russian varieties is very uncertain, and that it will require years of careful work to sift out the correct names and get them placed where they belong, and then sift them down to one or two of the best of each family and season. As an example, of the Oldenburgh class (which resemble each other in tree, fruit, and season so closely that if mixed together a committee of experts could not sort them out) there were shown Charlamoff, Glass Green, Arabian, Borovinka, and two or three others. Then there is the Hibernal, Lieby, Ostrokoff Glass, and Recumbent that, if not one and the same variety, do not differ enough to make more than one of them desirable in any orchard. A very fair exhibit of pears was made; but this fruit can not be successfully grown, except near the shores of Lake Michigan. There were a few new seedlings on exhibition, but they very generally showed too much scab to be really valuable. Among seedlings of recent introduction the specimens of Patten Greening were perfect in appearance, rivaling the Wolf River and McMahon in size. The exhibition of plums was very light, only four or five varieties altogether, the Lombard taking the lead.

HOUSTON COUNTY (MINN.) FAIR.

At the Houston County Fair, held at Caledonia, September 20–24, the exhibition of apples was small, but very select, and about equally divided between Russians and Americans. I here got track of a number of varieties of seedlings, and some which seem to be really promising.

FREEBORN COUNTY (MINN.) FAIR.

The last fair visited was that of Freeborn County, Minn., September 29–October 1. The exhibition of apples at this fair was by far the finest I have seen anywhere this year, and the best, considering the number of varieties—some fourteen of the older ones and about thirty of the new Russians, new seedlings, and varieties of recent introduction. The great bulk of the exhibit was composed of the Oldenburgh and Wealthy, they being the only varieties planted in large quantities. The Utter, Malinda, Patten Greening, and Hibernal are succeeding so well in this county that they will be planted more freely in the future until something better and more reliable is found.

ORCHARDS VISITED.

SAUK COUNTY, WIS.

At Baraboo, Wis., A. G. Tuttle has an orchard devoted exclusively to the newer Russian apples. It originally contained about a hundred varieties. Some varieties proved too tender for the climate, or so subject to blight that they have died out, but about sixty still remain. These, with the exception of two or three varieties, appear to be healthy, thrifty, and vigorous. The foliage was not apparently affected in the least by the scab or leaf blight, and they were generally carrying a good crop of fruit. An Oldenburgh orchard adjoining is also free from the same trouble, while in an orchard of mixed American varieties near by the trees are badly affected, none of them producing much fruit and some of them being half defoliated. Fameuse, Fall Queen (synonym *Haas*), Plumb Cider, Tolman Sweet, and Golden Russet were among the worst. The most valuable of the new Russians seem to be Glass Green, Yellow and White Transparent, Charlamoff, Hibernal, Antonovka, Vargul, Red Wine, Czar Thorn, Zusoff Winter, Longfield, Early Champagne, and Beautiful Arcad. The Repka Malenka also appears to be a good tree, and the longest keeper of them all, but the fruit is too small to become popular.

LACROSSE COUNTY, WIS.

In the orchard of E. Wilcox & Sons, of Lacrosse, Wis., the crop of fruit was below medium in quantity and quality, having suffered severely from scab, blight, and curculio. In this orchard but few new Russians are yet in bearing. No variety looks more promising than Hibernal. Scott Winter apple is apparently hardy when top-worked on crab stock and bears heavily every year. It has some scab this year. Mr. Wilcox's seedlings are not bearing enough this year to judge of their merits.

HOUSTON COUNTY, MINN.

The orchard of William Oxford, of Freeburg, on high bluff limestone land, is the best in the county, and shows very little scab or disease, except on Fameuse, Fall Queen (synonym *Haas*), Edgar Red Streak (synonym *Walbridge*), and Tolman Sweet. All varieties are fruiting to their fullest capacity. Hibernal and one unknown Russian of the Anissim family are the best Russians. A variety is found here that I have not met with at any other place that seems to be hardy and fruitful, and the fruit is superior in quality to most of the Russians. The fruit is medium in size and of a smooth, round form, light yellow color, with pale blush on the sunny side. The flesh is pale yellow, fine grained, and the flavor pleasant, subacid. Season this year, November; origin, unknown. There are other good orchards in the towns of Brownsville, Hokah, Union, and Caledonia. I have found a few promising seedlings in the towns of Hokah and Union. A few of them were sent on to the division, and I think T. Johnson's No. 2 will become a very valuable fruit to follow the Oldenburgh in case it proves entirely hardy. It is large to medium in size; flattish round in form; color, greenish yellow, striped with red; flesh, fine grained, yellowish white, pleasant, subacid; season, November, but said to keep till Christmas. The tree is about sixteen years old. Three-fourths of the fruit raised in the county this year was Oldenburgh. About 1,000 bushels were sold to go out of the county.

FILLMORE COUNTY, MINN.

The orchards of Fillmore County are confined largely to the orchards of Forestville, Etna, and Spring Valley. The crop of fruit in this county was very fine. The varieties grown are chiefly Oldenburgh and Wealthy. The surplus sold to go out of the county is estimated at 5,000 bushels. I find the Malinda doing well here. There are also nearly a dozen seedlings of the Oldenburgh in the county. Walker's No. 1 and Nelson's No. 6, of Spring Valley, are good and fair-looking fruit, about the same season as the Oldenburgh. Krugel's No. 5, of Forestville, will keep until midwinter; is a medium-sized, fair-looking fruit; tree, very good; the quality of fruit not the best.

MOWER COUNTY, MINN.

In Mower County less fruit is grown than in Fillmore County. Oldenburgh produced a bountiful crop wherever the trees were old enough to bear. I found very few trees of any variety doing well. There is one seedling in the town of Lyle that may prove worthy of looking after on account of its long-keeping quality. It is a conical, medium-sized, red-striped apple that is said to keep until June. It is quite acid, but may tone down as it approaches ripeness. The tree was breaking down under the load of fruit; has stood well where Malinda, Wealthy, Fall Queen, and Edgar Red Streak were killed to the ground.

FREEBORN COUNTY, MINN.

The fruit crop of Freeborn County was remarkably fine. The bulk of the crop was Oldenburgh and Wealthy. Oldenburgh apples were shipped from Albert Lea by the car load into Iowa and Missouri—States from which this country has received large supplies of apples in previous years. The surplus sold to go out of the county was 2,000 to 3,000 bushels. In this county I found a considerable number of Malinda and Utter trees doing well. A seedling sweet apple by A. C. Wannamaker, of Albert Lea, is a good fruit, and tree may prove more hardy than Tolman Sweet.

FARIBAULT COUNTY, MINN.

This county also produced a very fine crop of fruit; surplus sold to go out of the county estimated at 2,000 bushels. Here was found the largest Wealthy orchard in the State. It contains 1,500 trees which were bearing to their fullest capacity. A considerable number of seedlings producing a fair quality of fruit, were also found.

MARTIN COUNTY, MINN.

In Martin County is a seedling orchard of twenty trees, said to be about thirty years old. The trees have the appearance of being very hardy, but the fruit is too small in size to be worth retaining, unless it shall be found that better varieties will not ultimately succeed here. The fruit crop was fairly good in this county, but the orchards are generally too young to afford a surplus. I found one very fair seedling sweet apple on the farm of H. S. Livermore, of Fairmount, and on his place the Malinda and Utter are fruiting well and trees looking healthy.

WINONA COUNTY, MINN.

In Winona County the fruit crop was nearly a failure in the valleys but was fair on the bluffs and highlands. There are three seedlings of the Wealthy on the place of O. M. Lord, at Minnesota City. The trees were free from blight where all other varieties blighted badly. The quality of the fruit would range from good to very good; trees too young to determine their ultimate hardiness.

OLMSTED COUNTY, MINN.

No new seedlings of any great value were found in Olmsted County. At Rochester is situated the largest orchard in the State, owned by Mr. R. C. Keel. There have been planted in the orchard over 150 varieties, very few of which have proved of any value for this climate. The leading varieties are Oldenburgh, Wealthy, and Longfield, which are being grown in large quantities for commercial purposes. The crop harvested this year was over 3,500 bushels. A considerable number of the Russian varieties have been planted here, but as the nomenclature is badly mixed, I could not determine which were promising the best, aside from the Longfield, Ostrokoff, and Hibernal. The surplus sold to go out of the county was estimated from 5,000 to 6,000 bushels. There are a number of young orchards in the county that are promising, the largest being probably that of William Somerville, of Viola. He has over fifty varieties of new Russians, now of bearing age, and is continuing to plant largely of these. He has great faith in their value for this climate, but owing to the uncertainty as to their being correctly named, is unable to give full statistics upon their relative value. This county, owing to the elevation of the land and the texture of the soil, bids fair to be one of the best apple regions of the Northwest.

STEELE COUNTY, MINN.

There are few promising orchards in Steele County. None of the older varieties have succeeded well, except the Oldenburgh. That variety has fruited well this season. From an orchard of 2½ acres, planted out in the spring of 1885 near the city of Owatonna, 315 bushels of merchantable apples were gathered this year. Older orchards have done equally well in proportion to their age. Surplus sold to go out of the county, 2,000 bushels.

RICE COUNTY, MINN.

This county has gained some notoriety from being the home of the Peerless. J. G. Miller, the originator of that variety, is an enthusiast in the propagation of seedlings, and has now a considerable number coming forward. The varieties from which seed were taken are largely Peerless and Oldenburgh. Such of them as have commenced fruiting generally produce fruit of fine appearance and fair quality. None of them, however, will keep longer than Peerless.

HENNEPIN COUNTY, MINN.

Owing to its proximity to the cities of Minneapolis and St. Paul, which afford good markets, and the peculiar adaptation and favorable conditions existing around Lake Minnetonka, considerable attention is paid to gardening and fruit culture, and I found a great number of young and promising orchards, small fruit plantations, and vineyards. Nothing new has developed in the experiments of Peter M. Gideon, of Excelsior, since my visit there two years ago. The location is one peculiarly subject to fire and twig-blight; and the crop this season is only moderate. His experiments have been largely for the purpose of securing hardiness of tree by using the crab and Siberian crosses, crossed with the hardier apples as the foundation. The result is a race of apples considerably larger and better than the Siberians, but generally not large enough to become popular for commercial purposes. Although some of them are as hardy in tree as any of the Siberians, most of them seem predisposed to blight.

At Long Lake there are some fine orchards, chiefly of Oldenburgh and Wealthy. At Mrs. C. W. Gordon's there are a few seedlings that fruited for the first time this year. Three or four of the varieties were of average size and fair appearance, but were not sufficiently ripened to test their quality. In this vicinity it is the practice to set trees very close, usually about 16 feet apart, and train with low heads, or really give no training. Cultivation soon becomes impracticable and is abandoned. It is my opinion that the trees will soon become unfruitful, or the fruit inferior in size and quality. In the orchard of George Smith, adjoining, I think was found a valuable object lesson. His trees are set at a greater distance apart, and the ground is kept very heavily mulched with barnyard and hog manure, and the result is that the trees bear liberal crops every year. This year they are bearing to their fullest capacity, and at the same time making a healthy, vigorous growth. The fruit is larger in size than that in the adjoining orchards. Mr. Pierce, of Chowan, has out a large young orchard that looks very promising. It is chiefly double or top-worked. His trees are what he terms whole root. His method of propagating is to plant the seeds for the roots, crown-graft when two years old without taking up, using for scions the Virginia or Tonka crabs, or some variety of undoubted hardiness. These make a growth the first year of from 4 to 5 feet; in autumn they are taken up and buried for the winter, and the next spring are set in orchard, and top-worked with such varieties as are desired. The plan seems to work well, and I saw numbers of the trees only four years from the root-graft carrying considerable fruit. Hibernal is proving a great success; also the Charlamoff and Good Peasant. The Tonka crab is free from blight, a strong and vigorous grower, and one of the best of the species.

CARVER COUNTY, MINN.

In Carver County, at Waconia, is found the oldest orchard of new Russian varieties in the State. The orchard is planted on a warm, deep, rich, sandy loam soil, and has always until the present year received very thorough cultivation. The trees of many of the varieties have suffered greatly from blight. This orchard is owned by Andrew Peterson. Only about twenty varieties are doing reasonably well, and are as free from blight as Oldenburgh, or more so. The list stands as follows: Borovinka, Charlamoff, Cross, Good Peasant, Krimskoe, Blushed Calville, Christmas, Anisovka, Jungfrau, Plikanoff, Hibernal, Lieby, Kluevskoe, Royal Table, Reinette, Red Repka, and Nos. 502 and 469. Patten Greening is doing well with Mr. Peterson, and he thinks it bids fair to become a valuable variety for this region, for the reason that it is free from blight. P. D. Anderson, a neighbor of Mr. Peterson, has a very promising seedling, size medium, form round oblate, color yellow, mostly covered with bright red, and sprinkled over with fine gray dots; stem medium, short, elastic, set in a broad greenish-yellow cavity; calyx half open, in a broad, medium deep corrugated basin; flesh yellowish white, fine grained, firm; flavor subacid, sweet; core, small and closed; season, winter.

Beyond and west and north of Carver County but little success has followed the attempts at apple culture. Here and there may be found a few trees and sometimes considerable orchards of the Siberian species doing fairly well, and were it not for their predisposition to blight they would fill an important place in our pomology for the more uncertain districts. In a few instances I met with the Oldenburgh, but no American variety seems to have been found that may be planted with a certainty of living to produce fruit. The hope of this vast region of territory lies in the finding of a few of the hardiest Russians and seedlings yet to be produced from them that will prove to be adapted to these trying situations.

EXPERIMENTAL WORK.

In the test orchards under the charge of Prof. Samuel B. Green, on the State Experimental Station at St. Anthonys Park, are planted some three hundred varieties of apple trees, ranging in age from six to fourteen years. About two-thirds of them are of the newer Russian varieties. The winter after the planting of the oldest trees was a severe one, and many of them were killed back a full season's growth. To give these trees the most thorough possible test, they were planted on level ground without any surrounding protection and upon the most exposed portion of the farm. They were given fertilization and clean culture. As fast as varieties have killed out, others have been set in their places. Such varieties as blight hopelessly or produce fruit that is of no value will be discarded or noted on the record as such. Thus they will be gradually sifted down to only such varieties as produce good fruit and are undoubtedly hardy. At the present time the most promising and free from blight are Nos. 245, 187, 599, 140 M., 469, 169, 152 M., 282, 65 M., Borovinka, Glass Green, Romenskoe, Czar Thorn, Grandmother, Green Sweeting, Voronesh Reinette, Krimscoe, Breskovka, Anisovka, Cross, Zusoff Winter, Lieby, Bitter Pipka, Red Repka, Good Peasant, Hibernal. These varieties are of the oldest planting and a portion of them have fruited, but they may not all prove true to name. The trees of Glass Green and Borovinka are certainly of the

Oldenburgh family, if not the true Oldenburgh. The one marked Good Peasant is not true to name and does not answer to the description except in size, its color being a dark red instead of green, as described by Dr. Regel. The 152 Breskovka is a fine tree, free from blight, bearing young and fruit of fair quality for early, and it may take the place of Yellow and White Transparent where they can not be grown on account of blight. All new seedling varieties of apples are placed on trial as fast as they can be secured; apples and all other fruits for this latitude are being thoroughly tested. Considerable attention is being given to the originating of new varieties from seed, by selection, crossing, and hybridizing. An effort is being made to gather in some of the native wild fruits of this region, with the view of their amelioration and improvement through cultivation. The State Horticultural Society is working in harmony with the professor of horticulture and lending aid and encouragement in every possible manner.

EXPERIMENTAL TREE STATION AT OWATONNA.

This station is under the direction of E. H. S. Dartt, an old and experienced nurseryman and orchardist, and is really an auxiliary to the Central Station at St. Anthonys Park. It is considered to be in one of the most trying situations for fruit-growing in southern Minnesota, and any varieties that may prove adapted there will be safe to plant over the greater portion of the State.

It is designed to be a place for testing the Russian and other foreign varieties of hardy fruit; for gathering in and testing all seedling fruits of any promise already originated, or that may hereafter be originated, as fast as scions or trees can be secured; and for the continuous planting of seeds of hardy varieties produced in the far North, for the purpose of originating new, more hardy, and adapted varieties. In connection with the propagating ground and nursery is a trial orchard that now contains six hundred trees, of which there are seventy-five of the Russians, forty of Western seedlings and crabs, six of pears, seventeen of plums, Russian and natives, and three of Russian cherries. Some of the Russian varieties are blighting so badly that they will be removed, the names noted, and their place filled with something else; on account of the mixed condition of the nomenclature of the Russians, no doubt some of the names and numbers are duplicated. On this account the work of sifting out and getting down to the best will prove much more difficult than it would to ascertain the merits of varieties correctly named. One hundred varieties, less duplicates, of Russians are being propagated in the nursery, and nearly as many named varieties of seedling apples and hybrids, besides a great number of seedlings that have never fruited. The method pursued with the latter is, without waiting for fruiting, whenever a seedling shows more than usual vigor, large and healthy foliage, and freedom from mildew or blight, to root-graft about ten scions, recorded under a letter and number, so that if the variety prove hardy and the fruit desirable, plenty of scions can be had for distribution. Of the varieties under a name or number, originated in other places, six to twenty, according as they appear promising, are root-grafted, in order to get trees enough for a full and fair test. One hundred varieties have been started in this manner, and there remain four hundred that look too well to be discarded at present. As fast as any show that they will have no value they will be rooted out. With so many trees started from carefully selected seed we hope to get something that will endure our climate and produce an abundance of good fruit.

The experimental work in Minnesota is not confined to what can be done at these two stations. The State Horticultural Society has taken the matter in hand and has designated a number of individuals in different localities to follow up special work, the most important of which is to take on trial new seedlings and unknown varieties and give them a thorough test before the society shall indorse or recommend them for trial or general cultivation. These substations are to some extent receiving trees and plants from the Central Station, but no financial or other aid is extended from the State, and they are required to report annually to the professor of horticulture, who also is expected to render an annual report to the State Horticultural Society. In some of these stations the trial and testing of native plums is made a specialty.

REPORT OF THE MICROSCOPIST.

SIR: I have the honor to submit herewith my twenty-first annual report, covering the work of the Division of Microscopy for the year 1892.

THOMAS TAYLOR,
Microscopist.

Hon. J. M. RUSK,
Secretary.

WORK OF THE YEAR.

During the past year this division has been largely engaged in collecting specimens of the edible and poisonous mushrooms of the United States and Territories, intended for exhibition, collectively, at the World's Columbian Exposition. In this work the division has had the cordial assistance of the agricultural experiment stations of the country, and upward of six hundred molds have been made of the perishable forms, in addition to which several thousand specimens of the woody fungi have been collected for the exhibition. Models of the perishable species will be colored from nature and grouped and classed according to their edible or poisonous character. The groups as a whole will illustrate, in miniature, a forest scene and, indirectly, will show some of the permanent causes of forest decay.

In consequence of the increased demand by the public for information relating to the cultivation of edible mushrooms, this subject has received further attention, and new illustrations will be published from time to time showing the latest successful methods in this direction. Mushrooms have been received in great numbers from all parts of the United States, the result of an increased interest in them as an article of food. Many of our correspondents have commenced the cultivation of this esculent as a source of profit, a number of whom have succeeded.

Public attention is again directed to the trade in spurious butter, which seems to have been revived in this city. Quite recently a number of samples of oleomargarine, butter-like in appearance, which have been sold as butter without the brand required by the law, have been submitted to me for investigation and determination.

As the force of this division is at present restricted to two assistants, and much additional work has been undertaken by it relating to the Columbian Exposition, I have been unable to report progress in relation to the measurement and strength of textile fibers, but many valuable samples of the cotton product of the world have been received from Liverpool, Egypt, and the various cotton exchanges of the United States; that from Liverpool being selected with great care, especially for this division, and presented by Mr. Peter Brown, secretary of the Liverpool Cotton Association, embracing admirable specimens of the cottons of Europe, Asia, and Africa. The samples of Egyptian cotton were presented to the division by Mr. J. T. Callender, of New Orleans, La., and those from Liverpool, England, through the New Orleans (La.) Cotton Exchange. For valuable and well-selected samples of our own cotton staple we are indebted to Messrs. H. G. Hester and J. W. Barkdull, of the New Orleans (La.) Cotton Exchange; J. P. Merrihew, Savannah (Ga.) Cotton Exchange; R. H. Bolling, of the Mobile (Ala.) Cotton Exchange; A. G. Mills, Galveston (Tex.) Cotton Exchange; and R. A. Tavel, of the Charleston (S. C.) Cotton Exchange. Valuable flax samples of the four principal varieties which form the staple of commerce are included in the collection belonging to this division; also, samples of European and Asiatic ramie and of our domestic product. Samples of the fiber used in the manufacture of farmers' binding twine and shipping cordage constitute a part of the collection and await but the time and opportunity to carry on the work outlined in this direction and for the prosecution of which preparations have been made. A large assortment of animal fibers is also embraced in this collection for investigation and comparison.

Over seven hundred letters have been received during the past year, and upwards of four hundred written and copied; the disproportion between letters received and answered being the result of lack of clerical force and time to do more in many cases than to mail the divisional reports in reply to correspondents.

EDIBLE AND POISONOUS MUSHROOMS.

In my earlier papers upon the edible and poisonous mushrooms of the United States, it was my purpose to give simply a general and popular statement regarding some varieties desirable for food purposes. It was also my aim to point out how to detect poisonous species without special regard to scientific nomenclature. While it is not my intention to abandon this plan of instruction, it seems now necessary, owing to the deep and widespread interest manifested in my reports on the mushrooms, to enter more into scientific detail based upon microscopic observation of the spores and varied structure of these plants. I have therefore given in my present report more of the scientific nomenclature than heretofore, as to diversity of structure, form, and color of the tissues, necessary to be understood in a study of these plants as a means of discriminating between them.

In my present report, my first two illustrations represent two species of the genus *Amanita*, the first, called popularly "the orange," an edible mushroom; the second, "the false orange," a poisonous species. Some of the most beautiful species of this genus have been mistaken for the edible species, and for this reason all the nutritious esculents of this class have been considered doubtful, especially in America, and bushels—not to say tons—of valuable nitrogenous food are annually wasted that would otherwise, under proper cultivation, yield a fruitful food supply and source of revenue. Following the *Amanitas*, I have selected a species of *Lepiota*, abundant in the United States, and which forms in Italy, especially, a favorite article of food. The *Lepiotas* are all edible. My last plate of this series represents a species of *Cortinarius*, drawn and colored from the natural plant and found abundantly under mounds of pine needles in the autumnal months, in Prince George County, Md. I have fully tested this mushroom and find it very good eating.

CULINARY PREPARATION OF CERTAIN EDIBLE MUSHROOMS.

The following methods of preparing the foregoing edible mushrooms for the table will be found useful:

"*The Orange.*"—Remove peel and stems, but reserve the upper half of the stems. Rinse the mushrooms well in cold water, take them out and wipe them dry in a soft cloth. Make force meat with the upper part of the stems minced, bread crumbs, sweet herbs, garlic, pepper, salt, and a little oil. Pack this upon the gills of the mushrooms. Put them on a plate in a hot oven and continue to baste them with oil. Give them fifteen minutes and serve. They are much improved by roasting before a hot fire in a Dutch oven.

Lepiota procera.—Remove the stem and peel. Rinse the mushrooms well in cold water, take them out and wipe them carefully with a soft cloth. Then put them into a well-buttered pie dish with a little butter on them, or cream, and with toasted bread below. Sprinkle with pepper, salt, and parsley that has been rubbed with garlic and minced. Cover with oiled paper and a plate. Bake in a hot oven fifteen minutes. Serve in dish without removing the cover. The *Lepiota procera* also yields a first-rate catsup.

Cortinarius turmalis.—Take large ones. Remove the stems but not the peel nor gills. Rinse in cold water, then scald them by throwing the mushrooms into a pan of boiling water. Do not let them remain in the hot water more than a few seconds, but take them out immediately and wipe them carefully dry in a soft cloth. Then powder them slightly with flour. Put a little butter, pepper, and salt on the gills. Lay them top downwards on a gridiron over a moderate fire for five or six minutes at the most.

DETECTION OF POISONOUS MUSHROOMS BY MEANS OF A SILVER SPOON, ONIONS, ETC.

Considering that an opinion seems to prevail that the discoloration of the silver spoon or small white onions when brought into contact with mushrooms during the culinary process is an infallible test of the poisonous species, I quote from a French author on mushrooms the following in relation to this supposed test and some other popular fallacies regarding the detection of edible and non-edible species:

* * * We may not dispute the fact that a silver spoon or article of brass, or onions, may not become discolored on contact with the poisonous principle, but this discoloration is not reliable as a test for deciding the good or bad quality of mushrooms. In fact, we know that in the decomposition of albuminoids sulphureted hydrogen is liberated which of itself discolors silver, brass, and onions.

I have deemed it advisable to publish this as one of the best means of answering those correspondents who have made inquiries as to the reliability of this test.

Mushrooms that change color when cut are not always poisonous; on the contrary, we know that several of the non-edible *Amanitas* do not change color when they are cut.

Mushrooms of vivid colors and viscid caps are not always poisonous. It is by some supposed that high colors and viscidity are indications of non-edible species, but there are numerous exceptions here. *Russula alutacea*—the pileus of which is often a purplish red—*Amanita Cæsarea*, and other species of brilliant coloring are known to be edible. As to viscidity, two very viscid species, when young, are among the highly prized esculents by those who know them, viz, *Fistulina hepatica*, or the ox tongue, and *Hygrophorus eburneus*, the ivory mushroom.

The method of deciding the character of mushrooms by their odor and flavor is not to be relied upon. Edible mushrooms are usually characterized by an odor like that of fresh meal, and a flavor of hazelnuts; non-edible varieties have sometimes an unpleasant odor, and produce a biting, burning sensation on the tongue and throat, even in very small quantities, but several of the *Amanitas* have only a slight odor and taste, and certain species of mushrooms, acrid otherwise, become edible when cooked.

EXPLANATION OF PLATES.

PLATE I.—AMANITA CÆSAREA Scopoli ("The Orange")

(Edible.)

[Leucosporæ—White spores.]

Cap hemispherical as in Fig. 1, then expanded, smooth, free from warts, bright red or orange, shaded lemon yellow toward the margin, which is widely and distinctly striate. (See Fig. 2.) Stem equal or slightly tapering upwards, stuffed with cottony fibrils, or hollow; color a clean light yellow, bearing a yellowish ring near the top, and encased at the base in a large, loose, membranous, white volva. Gills free, color light lemon yellow. Spores white, and elliptical. (Fig. 4.) The plant is usually from 5 to 8 inches in height. Breadth of cap when extended, from 4 to 8 inches. Figs. 3, *3a*, and *3b* are sectional views of the plant. *A*, view of the embryonic stage of the plant.

PLATE II.—AMANITA MUSCARIA Linnæus ("False Orange").

(Poisonous.)

[Leucosporæ—White spores.]

Cap is at first ovate as in Fig. 1, then broadly convex or nearly plane as in Fig. 2. When young and moist, slightly viscid, rough, with numerous whitish or yellowish warts, rarely smooth, narrowly and slightly striate on the margin, ochraceous yellow or orange-red color. Gills white, as in Fig. 3, stem equal or slightly tapering upwards, stuffed with webby fibrils, as in sectional view 4, or hollow, bearing a white deflexed ring, ovate-bulbous at the base, white or yellowish. The volva usually breaks up into scales, which adhere to the upper part of the bulb. Spores white, elliptical (Fig. 5), from .0003 to .0004 inch long by .00025 to .0003 inch broad. The plant is found from June to October, growing from 5 to 8 inches high; cap from 3 to 6 inches broad.

PLATE III.—LEPIOTA PROCERA Scopoli ("The Parasol").

(Edible.

[Leucosporæ—White spores.]

Cap fleshy, at first ovate, then expanded and umbonate; cuticle thick, torn up into scales; stem tall, at first stuffed, then hollow, bulbous, with closely pressed scales; ring movable, gills very remote. Fig. 1 represents a young form; Fig. 2, a more advanced growth; Fig. 3, full-grown plant; Fig. 4, top view of cap; Fig. 5, sectional view of the cap and stem; *5a*, *5b*, *5c*, represent cross sections of the stem; Fig. 6, the spores. This mushroom is abundant in the United States, agreeable in odor and flavor. Its flesh does not change. Gills at first white; change finally to flesh color, bordered with brown. Breadth of cap from 5 to 8 inches; length of stem from 8 to 12 inches The original from which this fine specimen was drawn was found growing in pine woods in Prince George County, Md.

PLATE IV.—CORTINARIUS TURMALIS Fries.

(Edible.)

[Ochrosporæ—Ochraceous spores.]

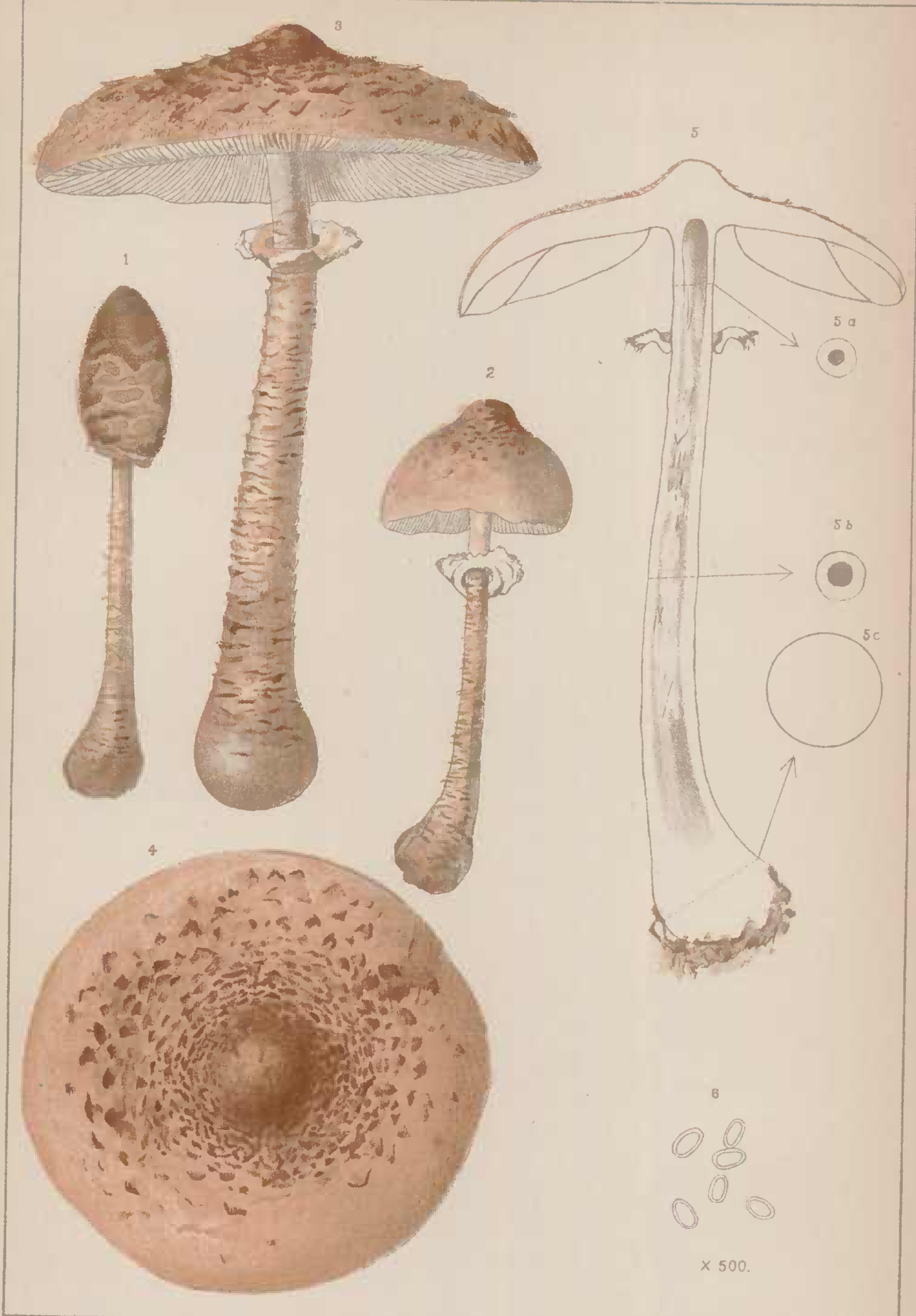
Cap fleshy, convexo-plane (Fig. 1); viscid in wet weather; from 2 to 4 inches broad; ochraceous yellow, shining. Flesh soft. Veil or cortina extending from the margin of the cap to the stem in delicate arachnoid threads, best seen generally in the young plant. The stem is cylindrical, white, 3 to 4 inches in length, rather attenuated than thickened, as in Figs. 1 and 2, but in some cases I have observed a thickening at the base The remnants of the cortina or veil appear above the middle of the stem as a zone of minute striæ, darker than the stem. (Figs. 1 and 2.) The gills are ochraceous yellow when mature, close, emarginate (see sectional view, Fig. 3), and decurrent, depending on the age of the plant. By some authors the gills are described as, at first, white. Spores fusiform, as in Fig. 4, color brownish-ochraceous yellow. Fig. 5 represents a section of the pine-needle mounds formed by this species, as they generally appear in pine woods.

AMANITA CÆSAREA, SCOPOLI.

A. Embryonic form. 1. Young plant. 2. Mature plant.
3. 3a and 3b. Sectional views. 4. Spores.

AMANITA MUSCARIA, LINNÆUS.

A. Embryonic form. 1. Young plant.
2. Mature plant. 3. Under view of cap. 4. Sectional view.
5. Spores.



Trautmann Bailey & Blampey N.Y.

LEPIOTA PROCERA SCOPOLI.

1. Young plant. 2. Cap expanding, umbonate.
3. Mature plant. 4. Top view of cap. 5. Sectional view.
5a, 5b, 5c. Cross sections of stem. 6. Spores.

CORTINARIUS TURMALIS, FRIES.

1. Mature plant, 2. Under view.
3. Sectional view. 4. Spores.
5. Manner of growth.

THREE EDIBLE MUSHROOMS.

AMANITA *Persoon*.

The genus *Amanita* holds the first place in the order *Agaricini*, and may be regarded as representing the most perfect type of the Hymenomycetes, consisting of mushrooms which have reached the highest stage of development. The mushrooms of this class are furnished in youth with a volva and ring. *Amanitas* have a cap that is usually plano-convex, the flesh thick in the center and growing thin toward the margin. The gills are ventricose, narrowing at the extremities, free, and numerous; half gills are rare. The stem is central, frequently swollen or bulbous at the base, solid, or stuffed interiorly with cottony fibrils more or less evanescent. The ring is persistent, deflexed, more or less prominent, in rare cases close against the stem, and sometimes scarcely distinguishable from it. Flesh and gills are white. There is an edible species, however, which has gills of a clear golden yellow.

The *Amanitas* are not a numerous family, and most of them are regarded as dangerous, but the *Cæsarea* (Plate I), which I have placed first in my present list, may be regarded as first of all mushrooms for food at the present time. This large, beautiful, and very showy plant, found from August to October in wet seasons in thin, open woods in Europe and North America, is not found in England* and is not very common. The American plant seems to differ from the European species in some slight respects, as represented in figures and descriptions. In Europe the pileus or cap is said to vary in color, being sometimes white, pale yellow, red, or even copper color, although it is usually orange yellow. In our own plant, according to Prof. Peck, of New York, the cap is uniform in color, being at first bright orange, or even brilliant red, fading with age to yellow, either wholly or only on the margin. The red color entirely disappears in the dried specimens. The striations of the margin are quite deep and long, and almost as distant as in *A. vaginata*, where they are said to be "pectinate-sulcate." In Europe the flesh is represented as yellowish. In our plant the flesh is white, yellow, or red under the cuticle, but next the gills—that is to say, the under surface of the cap to which the gills are attached—the flesh is generally yellow. The stem is described as subventricose in our plant. Says Prof. Peck:

> I have always found it equal or slightly tapering upwards, and generally rather long in proportion to the size of the pileus, so that the American plant must have a more graceful aspect than the European. The color of the stem is yellowish; the ring is sometimes tinged with this hue. The volva is soft and almost tomentose in texture, yet distinctly membranous, persistent, and white. The lamellæ are of a light citron-yellow color, by which it is at once distinguished from all our other species of *Amanita*. All authors agree in attributing esculent qualities to this mushroom.

In conclusion, I deem it safe to say that any mushroom having a white volva and gills of a citron-yellow color is *Amanita cæsarea*.

We are assured by some authorities that the Russians are accustomed to eat the *Amanita* indiscriminately without experiencing the least unpleasant effects. Mérat relates having seen the bodyguard eat plenti-

* Curtis says that it grows in great quantities in oak forests in the United States, and may be found by the cart-load in its season.

fully of them without ill effects. (D'Orbigny's Dict. Natural History, Vol. I, p. 177.)

An instance of eating the embryonic form of the *Amanita* without harmful results was related to us by a correspondent in Florida, who supposed he had discovered a region of truffles and was accustomed to eat freely of the egg-shaped *Amanita*, not discovering his mistake until a specimen was sent here for identification as a supposed truffle. I was unable to discover from the samples sent to what species of *Amanita* the plant belonged.

Another instance in this country is related also by one of our correspondents in Oregon, an extract from whose letter is here given:

> With this mail I send you what I shall call the poultry mushroom till you give me a better name for it. In its habits it seems a link between vegetable and animal life. It lives in fir and hazel woods, on hill or flat ground. At first it pushes itself up through the ground and sits up on end just like an egg, from size of a grouse's egg to that of a giant goose-egg. The period of the hatch depends upon the degree of humidity and heat in the atmosphere. Generally it requires about three days. One other quality it has in common with its biped relative: it sometimes dies and rots in the egg. My son first drew my attention to it about three years since. He found it on the mountain when bringing the cattle home. I then knew the meadow mushroon and the morel as edible fungi, but this looked so pure and sweet I cooked it and fed it to the dog and cat and the hens. Then I cautiously partook myself and found them fine. My method of cooking them is to peel and slice them and wash them in cold water, put them to stew in melted butter, pepper, and salt for a quarter of an hour; then thicken with flour and bread crumbs and serve with or without toast. They do not easily decay. I send you three of the egg form and one full-grown specimen.*

LEPIOTA *Fries*.

This genus is distinguished by a well-developed annulus, which soon breaks loose from its attachment to the stem and forms a movable ring upon it. The substance of the cap known as the hymenophorum is distinct from the stem, the latter reaching up into a distinct cavity or depression in the pileus, which forms the umbonated feature of the cap as illustrated in Plate III. The species of this subgenus are generally smaller than those of the preceding (*Amanita*) and most of them have the pileus rough, with tufts or scales formed by the breaking up of the cuticle. According to Prof. Peck the only representative of this subgenus in the State of New York a few years ago was the species *procerus*, but several other species, as *rachodes*, *excoriatus*, *mastoideus*, and *Morganii*, were reported from neighboring States. All the European species of this subgenus are classed by Fries as edible.

It is recommended, in preparing this mushroom for food, to gather the plant just before the veil breaks away from beneath the gills; remove the veil, but do not wash the plant. Simmered in a stew pan for half an hour, it will form its own gravy. The flavor closely resembles that of meat. *Lepiota procera* requires slow cooking to prevent toughness.

CORTINARIUS *Fries*.

The distinguishing features of the genus *Cortinarius*, to which the species *turmalis* (Plate IV) belongs, are: (1) Gills not changing to a dark brown or black as in the *Pratellas*, but assuming a cinnamon color with age, probably from the deposit of spores; (2) a cortina or veil which is an imperfect membrane, or rather web, composed of filaments or threads

* The specimen was not a full-grown *Amanita*, but a full-grown embryo of an *Amanita*, the egg form.—T. T.

interlaced loosely, resembling the delicate web of the spider. It varies in hue, is in some species persistent, in others evanescent, leaving either upon the margin of the cap or on the stem, or both, its filamentous remnants, located, as regards the stem, above, below, or midway, as hereafter described, and represented by a mere zone of darker colored fibrils (illustrated in Plate IV), sometimes scarcely perceptible. I observe that some of the French authors do not class this species as edible. Gillet in his Hymenomycetes of France enumerates fifty-three edible species of *Cortinarius*, but places *turmalis* among the suspects. Dr. Gautier describes ten edible species of this genus, but we do not find *turmalis* among them. I find this mushroom edible and of great value. It is very plentiful in the pine woods of Maryland. I have collected a bushel of them in less than an hour in fresh condition, in the early part of October. These plants are easily discovered by those familiar with their habitat, as they grow under the pine needles in groups, forming small mounds extending over great spaces, and in these hiding places, in the autumnal months, they are free from insects and dust. (See Plate IV, Fig. 5.)

THE VOLVA.

The volva is a membrane which envelops the entire plant in embryo, giving it the appearance of an egg. Its texture is so delicate that it generally disappears without leaving the least trace of its previous existence on the adult plant. Otherwise, traces of the volva are left upon the upper surface of the cap more or less prominent, numerous, and thick, sometimes regularly disposed, sometimes irregularly, in the form of plates, warts, etc. At the base of the stem of the mushroom the remains of the volva are seen in the form of a sort of wrapper, more or less ample, thick, and ascending, in other cases as a mere border, distant more or less, or as merely a few scales. As will be seen by reference to Plate I the plant emerges from the volva (Figs. 1 and 2). The volva is a feature of great importance in the study of the Agaricini, of the genera *Amanita* and *Volvaria*.

THE MUSHROOM VEIL.

The veil is not a constant feature in the Agaricini, at least it is not always visible. When present it consists of a membrane which extends from the margin of the cap to the stem, veiling or protecting the gills. This membrane, called the cortina, has given its name to a numerous and important class of mushrooms (the *Cortinarias*). It is generally white, soft, slightly spongy, cottony, at times fibrillose or even slightly fibrous, again in texture comparable to the spider's web, and may be even powdery or glutinous. It exists intact only in the youth of the plant. It is not visible in the developing mushroom, at least while the cap is closely pressed against the stem, but as the cap expands the membrane extends and finally breaks, leaving in some species its remnants upon the margin of cap and upon the stem in the usual form of a ring or a mere zone, as described and illustrated in Plate V.

EXPLANATION OF PLATE V.

Plate V illustrates, by section or otherwise, various forms and positions of the annulus or ring characteristic of certain species of mushrooms, together with the cortina or veil, of which the ring, if present, is the remnant, in some species, either as it appears entire or as a fringe on the margin of the cap, contrasting these forms with a sectional view of a species in which the veil or ring are always wanting.

Fig. 1. Ring broad, reflexed or deflexed, or both; situated high up on the stem, as in *Armillaria mellea;* edible.

Fig. 2. Ring situated about midway of the stem, deflexed and pendulous.

Fig. 3. Ring about half midway of the stem, split, and radiating outwards, as in *Agaricus arvensis;* edible.

Fig. 4. Ring low upon the stem, near its base.

Fig. 5. Ring persistent, movable, wholly detached, in age, from the tall and slender stem, upon which it easily slips up and down. A species of great beauty, *Lepiota procera;* edible.

Fig. 6. Ring narrow, scarcely perceptible above the middle of the stem; remnants of the veil adhering to the margin of the cap as a fugacious web.

Fig. 7. Ring generally wanting—*Tricholoma nudum;* edible; remnants of the veil seen on the margin of the cap.

Fig. 8. Remnants of the veil appearing on the margin of the cap as a fringe, and particularly on the stem as a mere fibrillose zone of a darker color.

Fig. 9. Plant exhibiting the cortina unbroken, the extremities of its delicate arachnoid threads attached to cap and stem, respectively.

Fig. 10. Section of a Russula in which subgenus the ring is always wanting; veil none.

MUSHROOM GILLS.

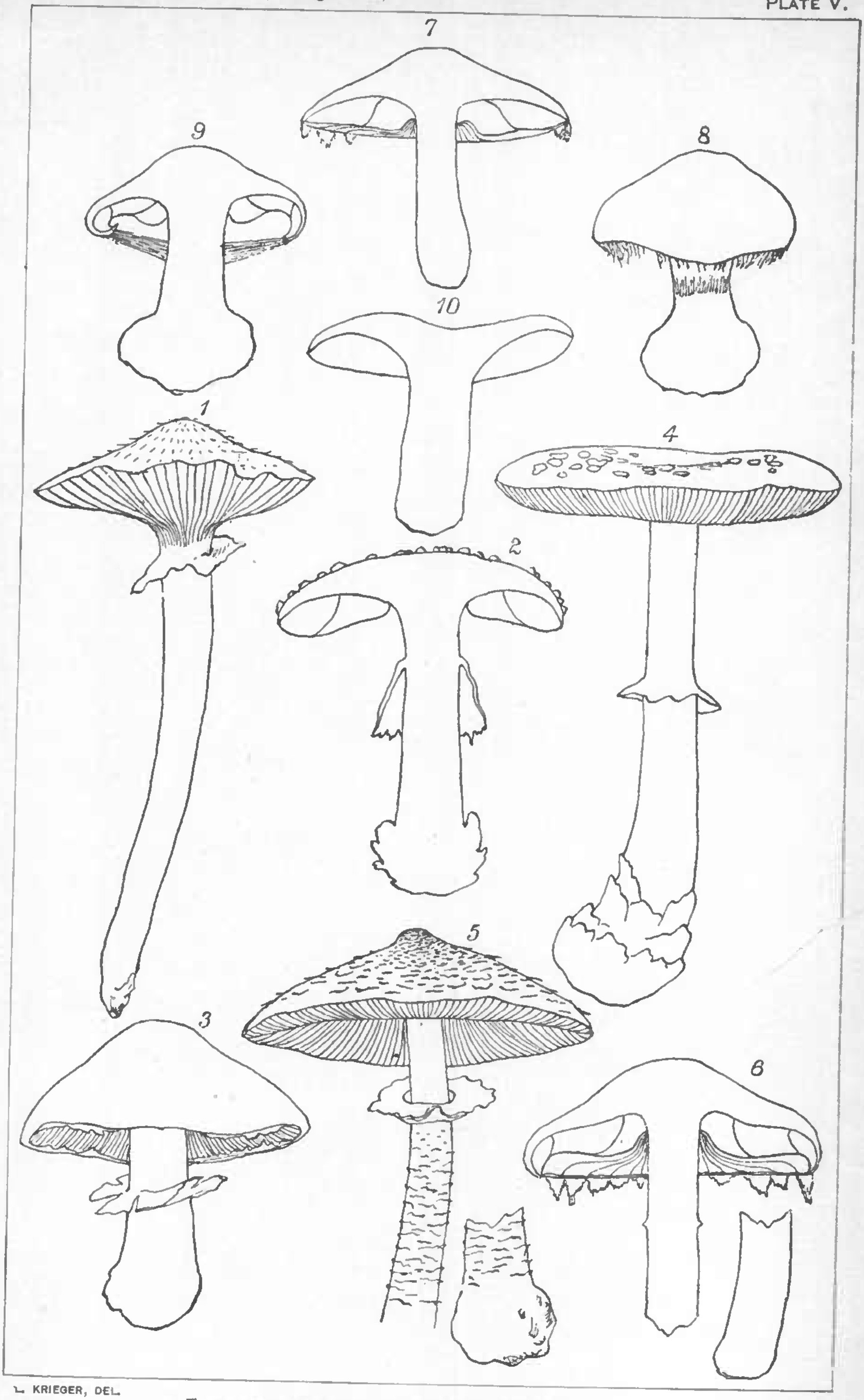
The gills of the mushroom are vertical, simple, equal, respectively, or more frequently alternating with shorter gills and entirely covered, as well as the intervening spaces by the sporiferous membrane, the hymenium. They are very often evanescent and putrescent, sometimes liquefying altogether. Their color is usually different from the upper surface of the cap, not always similar to that of the spores borne upon them, at least in youth; with age, however, they usually assume the color of the mature spore. The change of color of the gills according to the age of the plant is very important in the study of the Agaricini; it accounts for the white gills of certain species in youth, the pink in maturity, and the brown when aged. The gills, anatomically considered, are composed, first, of a central portion, a prolongation of the tissue of the hymenophore or flesh of the cap, more or less dense, scarcely perceptible sometimes; second, the hymenium covering the two surfaces of this prolonged hymenophore.

The end of the gill nearest the stalk of the plant is termed the posterior extremity; the opposite end, the anterior extremity. In most of the Agaricini the gills are unequal. Some extend from the margin to about half the space between it and the stem; others are still shorter. In Russula the gills are perfect or entire, that is to say, reach from the margin to the stem. The species *furcata,* however, is an exception, having a few forked gills.

Explanation of Plate VI.

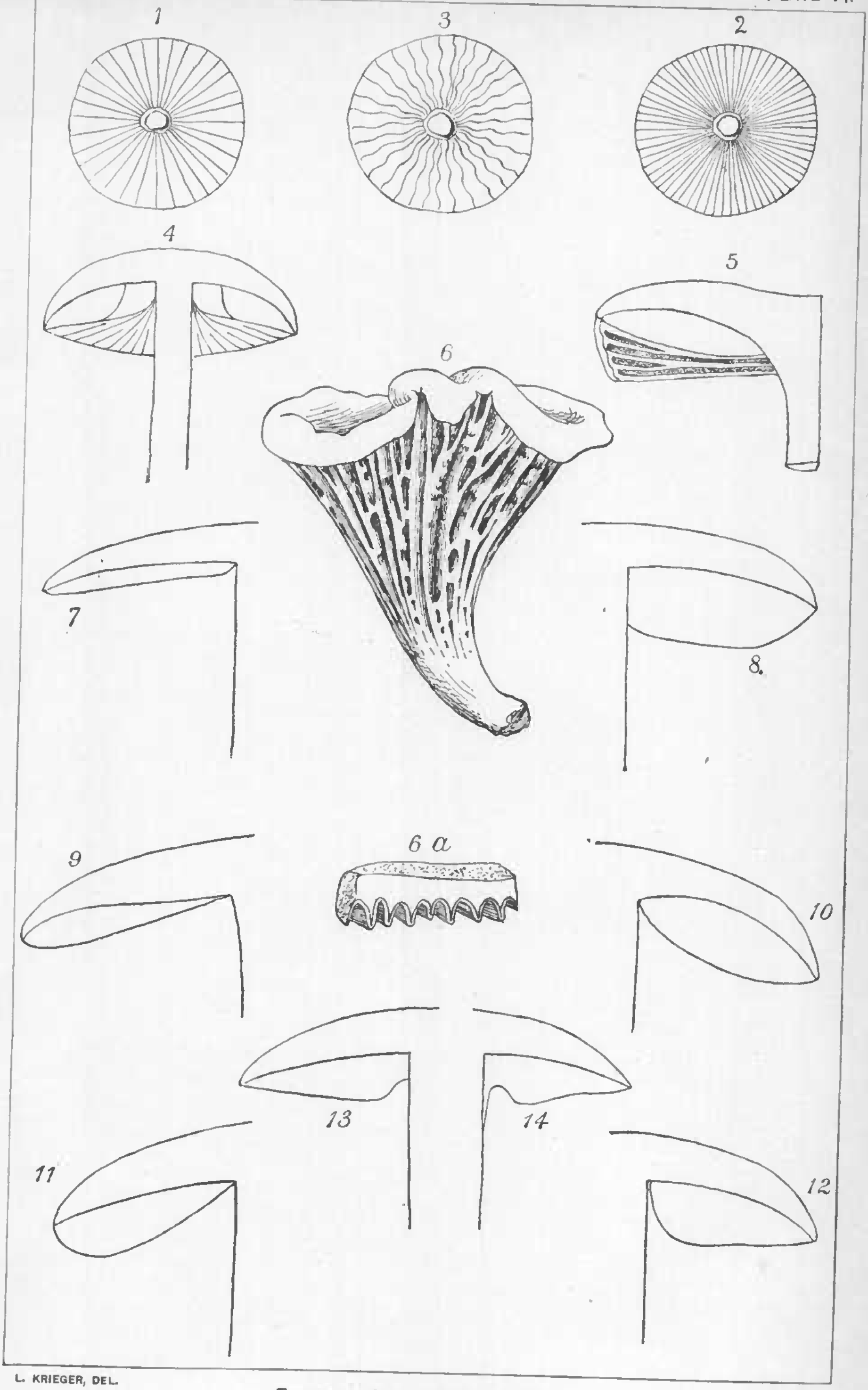
Plate VI illustrates by section or otherwise (being a continuation of my figures in Plate VI of my former report, 1891), various forms of these gill-like processes characteristic of species, considered either with regard to marginal outline or position of their posterior extremity:

Fig. 1. Gills distant.
Fig. 2. Gills crowded.
Fig. 3. Gills flexuose.
Fig. 4. Gills unequal.
Fig. 5. Bifurcated.
Fig. 6. Anastomosing veins.
Fig. 6*a*. Sectional view.
Fig. 7. Gills narrow.
Fig. 8. Gills broad.
Fig. 9. Lanceolate.
Fig. 10. Ventricose.
Fig. 11. Anteriorly rounded.
Fig. 12. Posteriorly rounded.
Fig. 13. Emarginate.
Fig. 14. Emarginate and denticulate.



L. KRIEGER, DEL.

FORMS AND POSITION OF THE ANNULUS OR RING.



L. KRIEGER, DEL.

FORMS CF GILL-LIKE PRCCESSES.

MUSHROOM SPORES.

Mushroom spores are very variable in size, shape, and color, but tolerably constant at maturity in the same species and even in different species of the same genus. This feature, varying thus with the age of the plant, should be studied in the mature plant. The size of spores varies from one-hundredth to a few thousandths of a millimeter in diameter. Their shape, almost always spherical in the young plant, becomes ovate, ellipsoidal, fusiform, reniform, smooth, stellate, sometimes tuberculate, or remains globose. The spore colors of the Agaricini are defined as follows by various authors:

According to—

Elias Fries, 5 groups: *Leucosporus*, white; *Hyporhodius*, pink; *Cortinaria*, ochraceous; *Derminus*, rust; *Pratella*, purplish black.

Rev. M. J. Berkeley, 5 groups: Very frequently pure white, but presenting also pink, various tints of brown, from yellowish and rufous to dark bister, purple-black, and finally black; *Leucospori*, white; *Hyporhodii*, salmon; *Dermini*, ferruginous; *Pratellæ*, brown; *Coprinarius*, black.

Dr. Badham, 6 groups: Pure white or a yellow tinge on drying; brown; yellow; pink; purple; purple-black; some pass successively from pink to purple and from purple to purple-black.

Mrs. Hussey, 11 shades: White; rose; pale ocher; olivaceous-ocher; reddish-ocher; ochraceous; yellowish olive-green; dull brown; scarcely ferruginous; snuff-color; very dark brown.

Hogg & Johnson, 5 groups: *Leucosporei*, white; *Hyporhodii*, salmon; *Dermini*, rusty; *Pratellæ*, purplish-brown; *Coprinarius*, black.

C. Gillet, 7 shades: White; pink; ochraceous; yellow; ferruginous; black or purplish-black; round, ovate, elongated, or fusiform, smooth, tuberculate or irregular, simple or composite, transparent or nebulous, etc.

Jules Bel, 5 groups: White; pink; red; brown; black.

Dr. Gautier, 5 shades: White; pink; brown; purplish-brown; black.

Constantin & Dufour, 5 groups: White; pink; ochraceous; brownish-purple; black.

J. P. Barla, 7 groups: *Leucosporii*, white; *Hyporhodii*, pink; *Cortinariæ*, ochraceous; *Dermini*, rust; *Pratellæ*, purplish-black; *Coprinarii*, blackish; *Coprini* and *Gomphi*, dense black.

L. Boyer, 5 groups, 11 shades: White to cream yellow; pale pink to ochraceous yellow; bay or red brown to brown or blackish bister; rust color, cinnamon or light yellow.

W. D. Hay, 5 groups: White; pink; brown; purple; black.

C. H. Peck, 5 groups: *Leucosporii*, white; *Hyporhodii*, salmon; *Dermini*, rust; *Pratellæ*, brown; *Coprinarii*, black.

Saccardo, 6 groups: *Leucosporæ*, white; *Rhodosporæ*, pink; *Hyporhodiæ*, salmon; *Ochrosporæ*, yellow; *Derminæ*, brown; *Melanosporæ*, black.

Dr. M. C. Cooke, 5 groups: *Leucospori*, white or very slightly tinted; *Hyporhodii*, rosy or salmon color; *Dermini*, brown, sometimes reddish or yellowish brown; *Pratellæ*, purple, sometimes brownish purple, dark purple, or dark brown; *Coprinarii*, black or nearly so.

These shades are somewhat different from the colors of the mushrooms' gills, so that, when it is of importance to determine exactly the color of the spore in the identification of a species, we may without recourse to the microscope cut off the stem of an adult plant on a level with the gills and place the under surface of the cap upon a leaf of white paper if a dark-spored species and upon a sheet of black paper if the spores are light. At the expiration of a few hours we will find, on lifting the cap, a bed of the shed spores which will represent their exact shade. These may be removed to a glass slide and their size determined by means of the microscope.

From my own observations of spore colors under the microscope, I consider that the diversity of colors as above quoted would probably have been less had the respective authors been professional artists or even familiar with the well-known names and chemical properties of art water colors, such as those of Windsor and Newton, which have been well known by every artist for the last sixty years, the shades of colors being always the same. The terms white and black are understood by all English-speaking people, but the term pink is indefinite, since there are many shades of pink all known by different names, because made from various plants, and each color thus named has a constant sameness of consistency and composition. The terms bister, brown pink, vermilion, cobalt blue, Prussian blue, cadmium yellow, are well-known constant colors, but some of the authors above quoted speak, for example, of yellowish spores, ochraceous, snuff color and ash color. In describing yellow it is very important to state the tone or tint. We have lemon yellow, yellow ocher, three shades of chrome yellow, King's yellow, Naples yellow, gamboge, etc., colors well known to be constant in tint. Rust of iron yields two well-known colors, the yellow a protoxide of iron and the red a peroxide of iron. These rusts are frequently combined with clay and thus constitute pigments, the one yellow ocher, the other red ocher. I am glad to see, in a recent pocket manual by Messrs. Costantin & Dufour, published in the French language, that a diagram lettered and numbered is appended representing the natural colors of the respective species of mushroons, not alone spore colors, the letters and numbers of the diagram referring to corresponding figures upon each plate of illustrations, thus assisting the student to obtain a correct idea of the usual colors of the living plant.

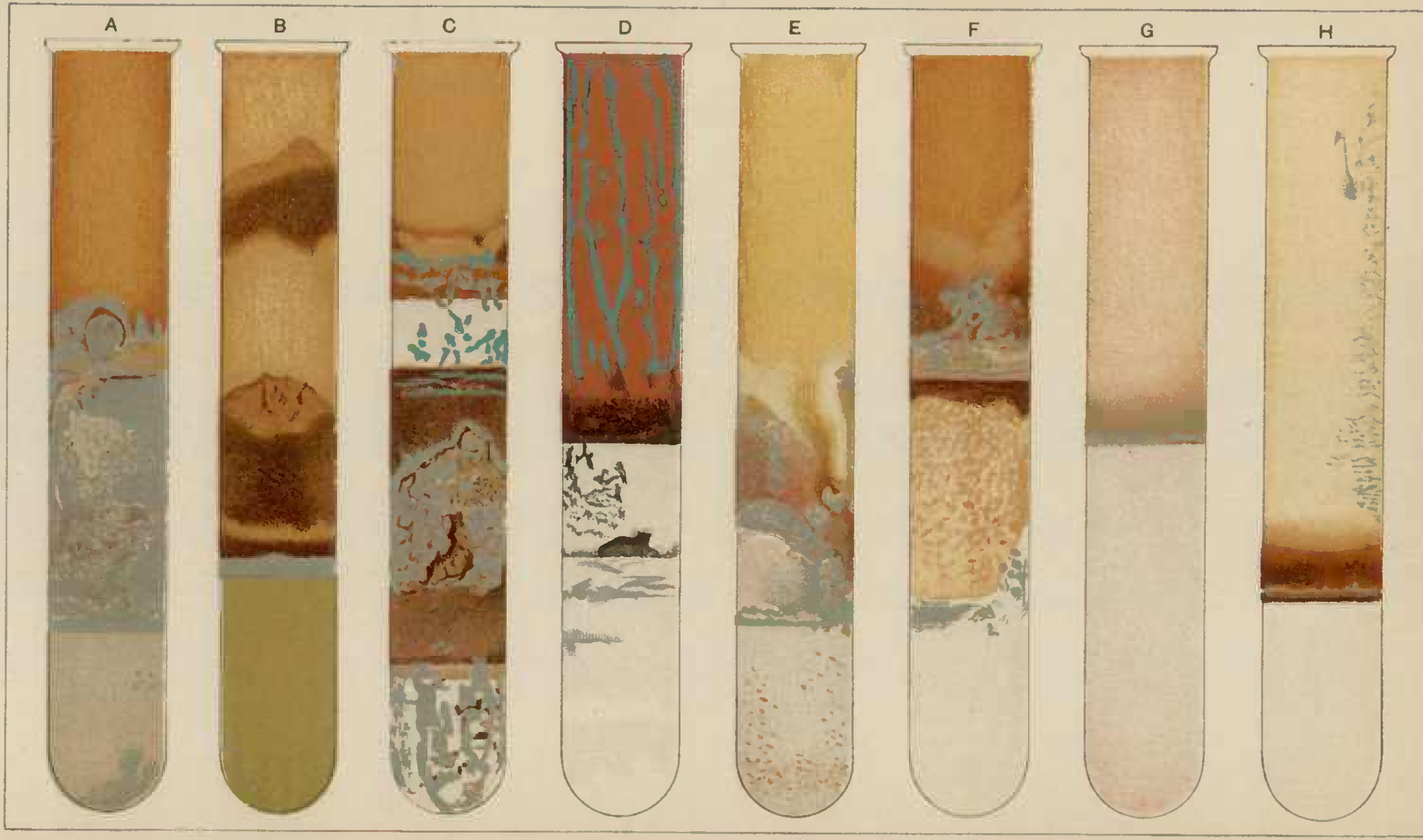
AUTHORITIES CONSULTED.

Fries.
Saccardo.
Paulet & Léveillé.
Gillet.
Boyer.
Bel.
Gautier.
Badham.
Hussey.
Hogg & Johnston.
Berkeley.
Peck.
Curtis.
Falconer.
Hay.
Robinson.
Palmer.
Costantin & Dufour.
Cooke & Berkeley.
Cooke, M. C.
Stevenson.
Schaeffer.
Barla.
Léveillé.
Worthington G. Smith.

SILVER NITRATE TEST FOR OILS.

It has been customary for several years past to use a solution of silver nitrate as a means of detecting cotton-seed oil as an adulterant of food oils and fats. In some recent experiments with the silver nitrate solution combined with an oil and subjected to a boiling temperature, I observed that opposite every point where a vapor explosion occurred a whitish deposit appeared upon the inner wall of the test-tube. When the tube containing the mixture had been exposed for several days to the indirect rays of the sun, I observed that the white deposits no longer appeared an opaque white, but as bright sparkling spots of pure silver. From several experiments of this sort I was led to suppose that an aqueous solution of the silver nitrate of the usual strength used in such experiments would yield similar results in the absence of any fatty substance. Later experiments demonstrated this to be the case. It therefore seemed somewhat dangerous to rely wholly upon hot solutions of silver nitrate as a means of determining the presence of cotton-seed oil in food compounds. Still later experiments clearly show that several oils other than cotton-seed oil not only deposit silver in various colors, but in larger amounts than is produced by cotton-seed oil; but to make

PLATE VII.



LARD OIL. COTTONSEED OIL. POPPY OIL. LINSEED OIL. PEANUT OIL. COLZA OIL. OLIVE OIL. CASTOR OIL.

Trautmann, Bailey & Blampey N.Y.

this more clear I made other experiments, using the same combination of silver and oils, but without the application of heat, with very satisfactory results, its full value only restricted by the greater length of time required to obtain such results.

EXPLANATION OF PLATE VII.

Plate VII represents eight test-tubes, each containing a solution of the silver nitrate and an oil. (The silver solution used in all these experiments was of uniform strength, prepared by diluting a saturated solution of silver nitrate one-fourth, with distilled water.) *A*, lard oil and the silver solution; *B*, cotton-seed oil and the silver solution; *C*, poppy-seed oil and the silver solution; *D*, linseed oil and the silver solution; *E*, peanut oil and the silver solution; *F*, colza oil and the silver solution; *G*, olive oil and the silver solution; *H*, castor oil and the silver solution.

The proportions of the silver solution and oil were the same in each case.

My usual method is to fill each test-tube one-third full of the silver nitrate solution and fill the remaining two-thirds of each tube with the respective oils to be tested. The tubes are then closed tightly with a stopper and each tube is well shaken and then placed in a rack exposed to indirect sunlight. The immediate results are observed, as well as the daily changes, and both are noted. The first precipitation of silver may be white or dark without the silver brilliancy.* Colors of various shades begin to appear in the condition of allotropic silver. After standing several months in a shady place the deposits of silver as well as the changes of color are greatly increased, and show several well-marked and typical conditions.

Pure lard oil *A* exhibits a large amount of the precipitate, of a silvery appearance more or less.

Cotton-seed oil *B* exhibits at the bottom of the tube the appearance of a solid deposit of burnished gold, which two months later appeared a copper color.

The precipitation of silver in tube *C* is not uniform, although considerable in amount.

Tube *D* presents a remarkable condition, exhibiting a branching deposit of silver in the upper part of the tube, and this is characteristic of linseed oil.

Tubes *E*, peanut oil, and *F*, colza oil, exhibit slightly varied forms of silver precipitate.

Tube *G*, olive oil, and *H*, castor oil, exhibit much less of the silver precipitate. It will be seen at a glance that olive oil has precipitated a smaller amount of silver than any of the other oils represented, thus demonstating that olive oil has less affinity for oxygen than either of the other oils named. For this reason, crude olive oil has been used as a lubricant for machinery.

It will also appear self-evident, from the foregoing, that oils which precipitate large quantities of silver can not be used as lubricating oils, since they will corrode iron. On the other hand, the results of these silver tests demonstrate that if olive oil is adulterated with either of the oils, especially the first named, the presence of the adulterating oils would be easily detected, because of the comparatively large amount of silver which would be precipitated, particularly in the use of the cold silver test. In my former reports I have pointed out that fresh, pure lard has little or no reaction upon the silver nitrate, while a lard containing free oleic acid, the result of exposure, would precipitate the silver. I have experimented with chemically pure oleic acid and the silver solution, using heat, and I find that by it silver is readily precipitated, and for the same reason any rancid oil may give the same results. It is therefore necessary to test first for the presence of acids. We should also test for the presence of alkalis, as they cause a precipitate of oxide of silver, and would thus frustrate the experiment.

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* The color of metals thus precipitated depends upon the size of their grains. If very fine, the color is dark, if coarse, the true color of the metal is shown, because the coarse grains reflect more light.

CRYSTALLIZATION OF OILS OR THEIR ACIDS.

The freezing-box (Plate VIII) is a new device which I have prepared for use with the microscope. It is the result of a long-experienced want of some method of crystallizing the various oils and their acids so as to obtain micro-photographic views of their respective crystalline arrangement, a knowledge of which is important in microscopic investigations relating to the adulterations of foods and other oils. Another advantage offered by this invention is, that by this method objects in natural history mounted in varnish or other media may be thrown on a screen and photographed. In the use of sunlight or Drummond light, the liquid soon reaches 212° F., and thus renders useless a valuable mount.

EXPLANATION OF PLATES.

PLATE VIII.—THE TAYLOR FREEZING CELL.

In this plate *A* represents a microscope; *B*, the freezing-box, made of brass or of German silver and attached to the substage of the microscope by means of two clamps, one on either side of the box. *B* is a separate view of the apparatus; *a* and a^1 represent tubes, one of which supplies a freezing liquid, the other carries it off; a pail to receive the waste liquid is in readiness, and is connected in the usual way by means of rubber tubing; *c*, an opening through the center of the box, which admits of the transmission of rays of light to the object under investigation.

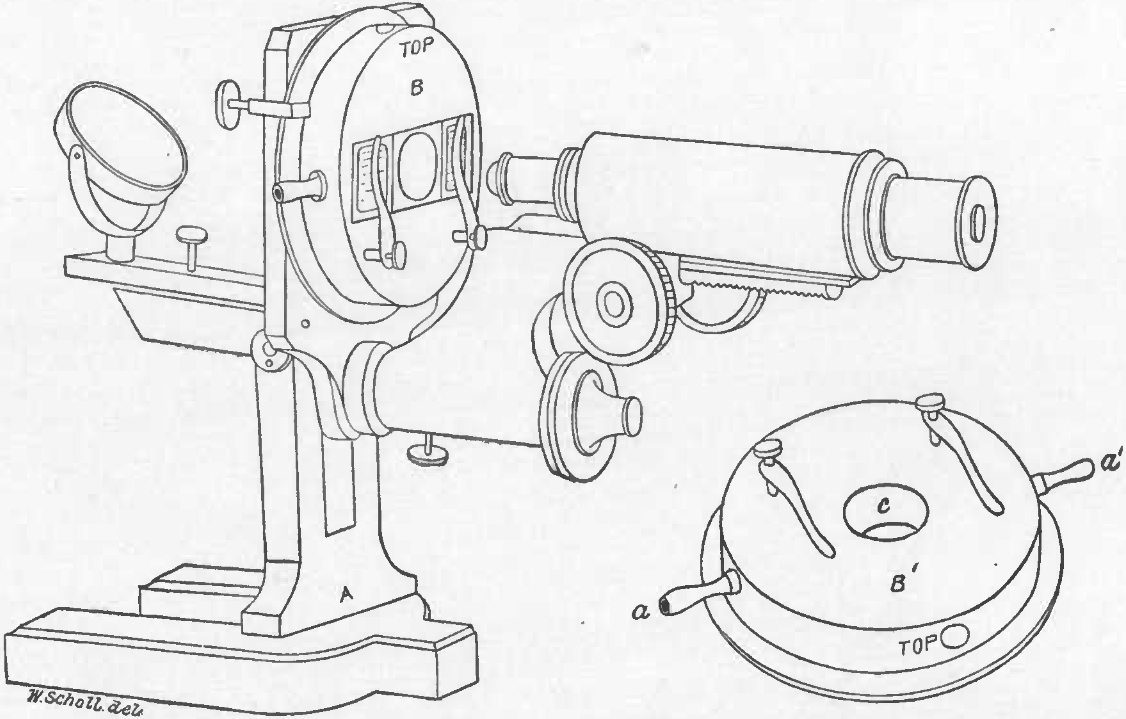
PLATE IX.—CHAULMUGRA FAT CRYSTALS.

This plate (Figs. 1 and 2) represents the crystalline forms of the solid natural fat of the oil of chaulmugra procured by the freezing process. The very peculiar forms which this fat assumes in crystallizing leads me to the belief that it is a new and undescribed fat.

The freezing liquid may be used repeatedly or until it ceases to be cold enough for the purpose. Any of the usual freezing liquids, or ammonia gas or ether may be used. The tube which carries off the liquid from the freezing-box should terminate in a small orifice to prevent unnecessary waste.

The box is provided with an air escape to facilitate the operation of filling the box with the freezing liquid. When this is accomplished, plug the opening and secure the box in position. In using ether, remove the plug to allow the ether to escape, or insert a tube to convey it into a separate vessel, where it may be condensed.

The solid fat of the chaulmugra oil is easily separated from the oil by freezing. The fat thus procured may be mounted in the usual manner. It should then be heated sufficiently to make it liquid and placed quickly under the microscope. As it cools, crystallization rapidly progresses. At first globular masses will be observed, each one showing, under polarized light, a well-defined cross. No sooner does one of these globular masses form than a second crystallization takes place, proceeding from the globular accretion in the form of an elongated, spreading fan. (See the micro-photographic illustrations, Plate IX, Figs. 1 and 2.)



ILLUSTRATING THE TAYLOR FREEZING CELL, A DEVICE FOR THE MICROSCOPE.

FIG. 1

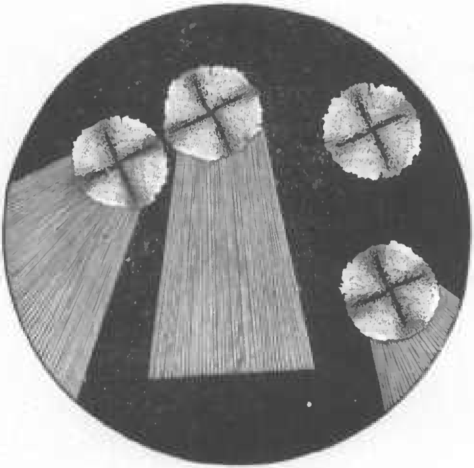
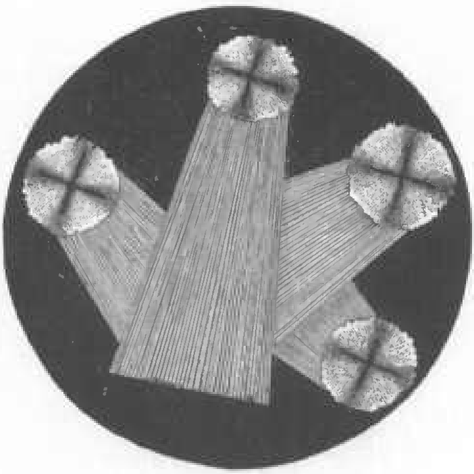


FIG. 2



CHAULMUGRA FAT CRYSTALS.

REPORT OF THE CHIEF OF THE DIVISION OF FORESTRY.

SIR: I have the honor to submit my seventh annual report upon the work of the Division of Forestry, together with separate and more extensive discussions of such subjects as have had the special attention of the division during the year 1892.

Very respectfully.

B. E. FERNOW,
Chief.

Hon. J. M. RUSK,
Secretary.

THE WORK OF THE YEAR.

During the past year the correspondence of the division in regard to general and specific subjects has grown to such an extent as to so engross the attention of the writer that the editorial work has been delayed and a large amount of accumulated material remains unprinted. While this condition of things is an acceptable exhibit of the increase of interest, as well as an appreciation of the value of information that may be derived from the Division of Forestry, it suggests at the same time the necessity of additional means to meet this kind of demand, and the need of an increased office force in the direction of experts who can give advice in technical matters. The diversity of the subjects which come before this division for consideration and reply was pointed out in my report for 1889, in which I gave a classified list of subjects, technical in many instances as well as statistical and of a general nature. The means for acquiring the information, which should be legitimately ascertained and given out, are entirely insufficient. There are but few people engaged in pursuits related to forestry matters whose experience can be made available for such use, and it becomes necessary, therefore, to train specialists in order to supply the demand. In addition to the correspondence by bona fide inquirers, there are also constant demands for newspaper articles, addresses before associations, etc., that require attention from this office, which suggest a dearth of acceptable private writers on the subjects regarding which the information is sought. It is, therefore, fair to infer that quite a number of students of forestry, who are well versed in its various aspects, now find a field for the practical application of their knowledge and remunerative employment at least by providing the public and technical press with reading matter. There are, as shown in a former report, several colleges which have introduced the subject into their courses. In addition, the Division of Forestry may claim to be sufficiently equipped with literature, collections, and expert advice to furnish a desirable place at which students can acquire the elementary knowledge needed; but while these facilities may properly be placed at the disposal of students who come here for the purpose of acquiring knowledge, it would not be proper to employ their services while they are learning, as has been suggested, nor would the funds at the disposal of the division warrant any such policy.

As during the year 1891, so during the one just passed, the funds of the division have been mainly employed in pushing the test work undertaken and described last year. Bulletin 6, on "Timber Physics," which was promised in my last annual report, has been issued during the year, and the extensive call for this publication has necessitated at once the printing of a second edition. It contains a history and description of the work in hand and also a historical review of the work that had been done by others in this direction. Since there seems still to exist misapprehension of what the main object of these timber examinations is, I may repeat my explanation from last year:

> While the testing of the timbers appears as the most conspicuous part of the work, and the more careful determination of average values expressing the strength of our wood materials is looked for with eagerness by architects, builders, engineers, and consumers of wood, these features constitute in reality the smaller part, and by no means the ultimate object of the undertaking. This object is a twofold one, namely, first, to find out in what relation the mechanical properties of timber stand to its structure and physical conditions, and thereby to find for the practice means of judging the mechanical properties from the simple microscopic or macroscopic examination; and, secondly, to find out in what relation structure, physical conditions, and mechanical properties stand to the conditions under which the tree is grown, and thereby to obtain knowledge for the forest-grower as to the kinds of timber which will yield the best results in given soil and climatic conditions.
>
> The correlation of results of these two directions of study as cause and effect is the aim of this work, and in general of the science, which I have called timber physics. Timber physics, in short, has to furnish all necessary knowledge of the rational application of wood in the arts, and, at the same time, by retrospection, such knowledge will enable us to produce in our forest growth qualities of given character.
>
> Conceived in this manner, it becomes the pivotal science of the art of forestry, around which the practice both of the consumer and producer of forest growth moves.

It is very gratifying that this first venture of original investigation by the Division of Forestry has found general favor, not only in a part of this country, but has also been highly commended by the technical press of the Old World. The calls for special investigations into the qualities of the timbers in various sections of the country have grown very numerous, and it is to be regretted that the scant appropriations made for this work will not allow an expansion, such as might furnish at least preliminary knowledge in regard to all the timbers which appear on the market. There is a special demand for the tests of such kinds as are still more or less unknown, they being now drawn upon to eke out the deficiency of supply of the better-known kinds. The Douglas spruce, the cedars, the sugar-pine of the West, the bald cypress of the South, and other conifers ought to be tested without delay. If Congress had appropriated the necessary funds which were asked for in the special bill introduced during the last session, it was the intention to establish a test laboratory at San Francisco, and another one at Washington. In this way the cost of transportation of material would be decreased, since it can not be expected that the railroad companies will in all cases be willing to furnish free transportation. Not less than $40,000 per annum should be employed in this direction for two or three years in order to secure sufficiently rapid progress at the most economical rate. The economy secured to the country at large by this work may be best comprehended from the statement that by the simple demonstration of the value of "bled" timber for building purposes an increase in the price of the product of nearly 1,000,000 acres in the Southern States has been secured, involving in the assumed appreciation at least 2,000,000,000 feet, B. M., of lumber, which, if appreciated by only $1 per 1,000 feet, represents a saving of $2,000,000 in value.

The collections for test material have now reached a total of 234 trees. The collections this year have been from Missouri, Arkansas, Texas, and Louisiana. It was aimed to complete the collections of longleaf pine, but, in addition, shortleaf pine and loblolly-pine have been collected, together with some oaks, as the opportunity of the collector permitted. I have again to record the generosity and active interest which the railroad companies, along the lines of which the collecting was done, have shown by furnishing free transportation to collectors and for the collected material. Our thanks are due especially to the management of the Iron Mountain Railroad and to the Southern Pacific Railroad Company. As soon as it is possible to complete the tests of the longleaf pine collected, it is proposed to publish the results in a preliminary bulletin, which may possibly reach the public before the issue of this report. At the present writing no less than 6,800 tests of various kinds have been made in the test laboratory, in charge of Prof. J. B. Johnson, of St. Louis, and it is expected that at an early date all the longleaf pine material will be tested and examined, and the results will be embodied in the forthcoming bulletin. The collections then will have comprised the whole western field of the geographical distribution of this one species, from five different sites. This material may be considered sufficient for an exhaustive discussion of the properties of this species, unless additional tests be made on timber collected from the eastern field of its distribution, in order to see whether any difference of development due to difference of climatic conditions is observable.

In the line of special investigations a series of tests and examinations of bled and unbled timber was carried on in order to ascertain whether the practice of taking the resin from the trees had any influence upon its quality. Some thirty trees, boxed, and cut after being abandoned a varying number of years, were so examined. The results seem to show that there is no determinable influence on the mechanical properties of the tree, and hence the prejudice of Northern engineers and architects against the use of this bled timber seems to have no foundation. A preliminary report of the results of these tests was published in Circulars 8 and 9 of this division, but the final discussion is expected to be embodied in the next bulletin on Timber Physics. The discovery of the fact that the quality of timber is not impaired by the bleeding process removes the cloud of suspicion from one of the most important articles of the Southern lumber markets. In connection with this work a study of the methods of turpentine gathering was undertaken, the results of which are embodied in this report, and embrace a description of the process of turpentine orcharding as practiced in this and in other countries to serve as basis for a change from the present wasteful methods to more rational ones. While our tests and examinations show that the removal of the resin does not directly affect the quality of the timber, it does, if not carried on with care, affect the life of the tree and invite other destructive influences, such as fire and fungus growth.

The turpentine industry, like the lumber industry, is carried on in this country on the "robbing system," simply taking off in the most crude and rapacious manner what nature has provided. It is now time to substitute a "management system," which shall utilize the remaining resources more exhaustively yet more carefully, by avoiding all unnecessary waste. If our turpentine orchardists will study the rational methods used in France, they will perhaps find it to their advantage to modify their present destructive methods.

In order to arrive at a conception of what the bleeding of timber means to the physiology of the tree, and of the manner in which the draining of the resin from the tree proceeds, a special study of the distribution of resin in bled and unbled timber has been undertaken, and the results obtained by Mr. M. Gomberg, the chemist, showing that no change in the heartwood due to bleeding can be established, will be discussed in the forthcoming bulletin.

In connection with the collecting of test material, the collector, Dr. Charles Mohr, of Mobile, Ala., has also accumulated a considerable amount of information regarding the general forest conditions of the States through which he traveled, and in regard to the biology of the tree species which he has collected, which will eventually be of special advantage. Mr. Filibert Roth, of Ann Arbor, Mich., who has most assiduously continued the investigations of physical and structural properties of the test material, was also sent into the field through the Southern forests, for the purpose of gaining knowledge of the appearance and of the methods of handling the timber of the longleaf pine, especially as to the condition of the market in reference to bled timber. Several other investigations of technological character have also been inaugurated.

In coöperation with the Division of Chemistry, an inquiry has been begun to determine the tannin contents and their distribution within the trees of the wood of such timber as will presently be used more extensively for making tan extracts. With the waning supply of tanbarks, it is to be presumed that the use of extracts made from such woods as the chestnut and the various oaks will soon assume large proportions, and such use promises to open a new and profitable field of forest exploitation and should be properly directed.

In coöperation with the Division of Vegetable Pathology, an inquiry has been instituted into the cause and possible preventives of the "bluing" of timber, which occasions much trouble and loss, especially in the Southern mills, affecting the sapwood of pines, tulip poplar, and other soft woods. A preliminary examination has shown the blue spots to be due to a fungus growth, which develops in warm, moist weather so rapidly that even careful piling to expedite rapid seasoning and, under some circumstances, kiln-drying can not entirely obviate its growth.

The life history of the fungus being still unknown, it would be premature to discuss remedies. It appears that even the dry kiln (at least some forms), the introduction of which alone made it possible to handle the shortleaf pine to advantage, is not entirely successful in destroying the fungus.

But for the mechanical impossibility, in view of the very pressing office work, of editing and preparing them for the printer, the monographs on the various conifers, which have been promised from year to year, would have been published during the past year. The delay in their publication may not be considered altogether unfortunate, as during the time which has elapsed since their first preparation additional knowledge has accumulated which will make the work much more valuable.

REVISION OF NOMENCLATURE.

The botanist of the division, Mr. George B. Sudworth, has finished the revision of the nomenclature of our arborescent flora, and the same would have been published by this time if the recent action of the botanists of the country, with reference to the laws of nomenclature, had not made it desirable to delay its publication, in order to await their decision as to what principles should guide the reviser. Some of the principles which were adopted at the meeting of the botanists at Rochester during the month of August of this year were in contradiction to those adopted by the Division of Forestry, and since an international congress had been called at Genoa, in order to establish such principles as might be adopted internationally, it was proposed to await the decision of this congress. Unfortunately, the very points of controversy were not reached by this congress, and remain unsettled. It is, therefore, now proposed to publish the revision in such a manner as readily to permit corrections when an international agreement may have been reached. In order to bring more quickly before those interested in this work the results of the revision, a list of the more important changes made, with annotations, is embodied in this report.

A NATIONAL ARBORETUM.

In my last report I suggested the desirability and excellent opportunities afforded for the establishment of a national arboretum in or near the city of Washington, D. C. I pointed out that the climate of this city is exceptionally favorable for the propagation of a very large range of species, exceeding that of even the celebrated Kew Gardens in England, and that as a means of instruction, such an arboretum would not only be superior to an herbarium, but it would also give opportunity for trials and experiments in acclimation; it would permit the study of form, rate of growth, and effect upon one another of the different species, and thus furnish additional means of instruction for forestry experts, whose education sooner or later will become a necessity. Since it can not be expected that action will soon be taken on such a proposition, I have utilized the means at hand for the purpose aforesaid. In connection with the botanist, I have made a list of the many species found in the public reservations and plats of this city, amounting to not less than from four to five hundred, endemic and exotic; their position has been indicated by numbers, on plats of the various reservations, 200 in number, so that the specimen can be found by inspecting the list and the corresponding number of the plat. This work, not entirely germane to the Division of Forestry, was undertaken with the assistance of funds from the National Museum, of which institution the writer is an honorary curator. The results will soon be published in a bulletin containing not only the enumeration, but additional notes of interest respecting the various kinds found.

With the same object in view, namely, to enlarge the facilities for the study of forest flora at the capital, the writer accepted a call from the Governing Board of the Soldiers' Home, the largest and most beautiful park of the city (excepting only the new National Rock Creek Park), to superintend the cutting and planting of trees in that park. In this connection an attempt will be made not only to call attention to the fine specimens of rare and beautiful trees now in existence and to keep them in condition, but also to extend their number so as to introduce all the varieties which will thrive in this climate.

During the summer the War Department availed itself of the information to be derived from the Division of Forestry, by inviting the writer to inspect the Chickamauga National Park, for the purpose of advising the commissioners of the park how to manage the forest growth of the reservation. Since this is a subject which may again and again, under different conditions, become a matter of inquiry, I have reproduced my remarks in regard to it in this report.

FORESTRY LECTURES.

As usual during the year many calls for addresses were made upon the writer and attended to. Among these may be mentioned a special forestry day at the Pennsylvania Chautauqua, attendance at various farmers' institutes in western New York, a forestry convention in Minneapolis, and others.

SEED AND SEEDLING DISTRIBUTION.

The usual distribution of seeds to an amount proportionate to the appropriations has been made. As heretofore, this distribution has been mainly of coniferous kinds, 5,000 packages having been distributed. From the stocks in the grounds there have also been distributed many varieties of osier willows. With the assistance of the Maryland Experiment Station it was also found possible to introduce some cork oak seedlings. Six bushels of cork-oak acorns were imported and put under ground last spring. Unfortunately quite a number spoiled on account of inattention in keeping. Nevertheless, a sufficient number came up and, but for the damage done by grubs, a larger number of seedlings could have been distributed. The actual result has been a distribution of sixteen packages, containing thirty seedlings each, mostly to the experiment stations situated in climates where promising experiments of acclimation might be made with this species. Further information regarding this species is given in a special chapter in this report.

FOREST-PLANTING EXPERIMENT.

The experiment in forest planting on the sand hills of Nebraska, described in last year's report, has been continued by supplying the deficiencies on the three plats numbered 1, 2, and 3. Plat 4, which was planted on plowed ground, plants spaced 3 by 4 feet and cultivated, showing only 5 per cent of plants living at the end of the first season, was abandoned. This poor success, under the conditions of soil, climate, and treatment, had been anticipated, yet it would be unfair to judge the method from this one experiment. A repetition of the method this year was impracticable for various reasons. We may infer, nevertheless, that on sandy soil, which is apt to blow out, dense planting without plowing or cultivating is preferable. The soil should be stirred as little as possible and the plants preferably be set with a dibble by hand. Cultivation on such soils may do harm instead of good; the percolation of the water is hardly improved by the cultivation, while the capillary condition of the sand even when packed is such as to prevent rapid evaporation from the lower strata, the upper sand strata acting as a mulch. That this is the case was indicated by the experiment of mulching one-half of each plat with hay. The report is that no difference was noticed between the mulched and unmulched plats. Hence, for improvement of water conditions plowing and cultivating are not required. The question, then, remains whether the keeping down of weed growth or preventing the sand from blowing is the more important matter. We believe that the loss of tree growth due to the choking by weeds is rather to be endured than the loss by the shifting of the sand, and that under the conditions here met the soil should be disturbed as little as possible.

For the fail places that had occurred on the first three plats there were provided 3,000 Scotch and 675 Austrian pines, received in good condition and planted on May 3 and 4; 1,880 catalpas received in very poor condition, and 900 black cherries, with a few honey locust mixed in, received in good condition; these were planted on May 5 and 7, the weather being very favorable, cool, cloudy, and moist, with occasional showers.

It might be proper to remark here that probably half the failures in tree-planting everywhere, as was the case also in this experiment, arise from the fact that the plant material was not properly cared for before the planting. A large percentage is half dead or doomed to die before the tree is put into the ground, through inattention to proper treatment of the roots. This inattention seems often to begin at the nurseries during the packing; it then continues in transit—by delays in trains and at railroad stations—and finally culminates in the hands of the planter, who treats the tender seedlings as he would potatoes or turnips. There are some trees, like fruit trees, catalpas, and black locust, that will survive such carelessness, but most forest trees, and especially conifers, succumb readily when their root system is dried out, and have poor chance for recovery.

With the additions the number of plants on the three plats was brought up from 7,036—reported living in October, 1891 (none being reported lost during the winter)—to almost 13,500, which at the end of October, 1892, showed a loss of 28 per cent, so that 9,700 remain on the three plats, or at the average of 6,470 per acre. It will be observed that all the trees living last year are reported as living after the second season, the losses being presumably entirely in the new planting, which gives countenance to the opinion that the loss occurs before and during the planting.

The following tables will exhibit the progress and condition of the planting:

Tree-planting experiments in Nebraska.

PLAT 1.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	306	139	45.4	....	139	100.0
Banksian pine	2,362	2,055	87.0	....	2,055	100.0
Scotch pine	1,350	23	1.7	2,380	916	38.1
Austrian pine	300	134	44.7	379	274	53.4
Red pine	375	54	14.4	....	54	100.0
Douglas spruce	200	53	17.7	....	53	100.0
Arbor-vitæ	225	110	48.9	....	110	100.0
	5,118	2,568	49.2	2,759	3,601	....

Tree-planting experiments in Nebraska—Continued.

PLAT 2.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	459	144	31.4	....	144	100.0
Austrian pine	450	187	41.6	253	237	53.8
Scotch pine (added 1892)	....	....	....	268	52	19.4
Black locust	1,809	1,604	88.7	....	1,604	100.0
Box-elder	1,800	109	6.1	....	109	100.0
Hackberry	450	212	47.1	....	212	100.0
Black cherry	450	34	7.6	749	596	76.1
Hardy catalpa	....	....	....	1,676	436	26.0
	5,418	2,290	42.3	2,946	3,390	....

PLAT 3.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	288	91	39.9	....	91	100.0
Austrian pine	222	99	44.6	....	99	100.0
Black locust	2,191	1,903	86.9	....	1,903	100.0
Scotch pine	228	1	.4	348	319	91.4
Douglas spruce	222	30	13.5	....	30	100.0
Oak	41	7	17.1	....	7	100.0
Box-elder	25	3	12.0	....	3	100.0
Hackberry	50	44	88.0	....	44	100.0
Hardy catalpa	....	....	....	204	52	25.9
Honey locust	....	....	....	60	48	80.0
Black cherry	....	....	....	160	120	75.0
	3,267	2,178	67.9	772	2,716	....

PLAT 4.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	1,017	111	10.9	Discontinued.		
Red pine	74	8	10.3			
Scotch pine	666	1	.2			
Box-elder	675	3	.4			
Oak	159	8	5.0			
	2,591	131	5.1			

Summary of tree-planting experiments in Nebraska.

Plat No.	How planted.	1891. No. planted.	1891. No. living.	1891. Per cent living.	1892. No. replanted.	1892. No. living.	1892. Per cent living of two years planting.
1	Pines and other conifers 2 feet apart, in sod, one-half mulched	5,118	2,568	49.2	2,759	3,601	45.7
2	Bull-pine with deciduous trees 2 feet apart, in sod, one-half mulched	5,418	2,290	42.3	2,946	3,390	40.5
3	Pines and deciduous trees, 2 by 3 feet apart, in sod, one-half mulched	3,267	2,178	67.9	772	2,716	67.2
4	Mixed planting on plowed ground, 3 by 4 feet apart, to be cultivated (the last planted, and during very dry weather)	2,591	131	5.1	Abandoned.		
		16,394	7,167	43.7	6,477	9,707	42.4

The expectations from the jack pine seem to be sustained, this species being reported in the lead with a growth of 12 to 14 inches during the summer. It must also be remembered that these plants were dug from the forest, while the others are nursery grown.

The conifers are all doing well, especially those of plat 1. The deciduous trees are reported as only living; even the black locust "seems to be losing its grip, and all have apparently made no growth this past summer."

Unless unforeseen losses occur it is believed that the planting may be considered concluded, and the plantation established, and no further attention to it will be necessary, except to keep out cattle and fire. It seems already to have proved what was intended, namely, that in the sand-hill region of Nebraska coniferous growth, especially of pines planted closely, is the proper material and method.

It is to be regretted that the Division of Forestry is not in better condition to enlarge in this direction of forest experiments. The present experiment was possible only by the voluntary donation of land and labor on the part of Mr. Hudson Brunner, of Swan, Holt County, Nebr. On account of the inaccessibility from railroads and absence of personal superintendence, many drawbacks were encountered which could be avoided if the funds and organization of the division permitted.

PUBLICATIONS.

A bulletin (Bulletin No. 7) on Forest Influences is now in the hands of the printer. As long as Government action in regard to forest resources is asked, upon the ground that the forest bears a relation to climatic and cultural conditions, it will be of interest to know how far such a relation can bé established. In this bulletin are reviewed the systematic observations at the forest-meteorological stations, specially established for the purpose of determining the forest influence in Austria, Switzerland, and Germany. There are twenty-two stations in all, equipped in such a manner that one set of instruments is placed within a forest area, and another set in the open field not far from the forest station. The observations are made daily, and have been recorded now for from eighteen to twenty years, furnishing a large amount of material for the discussion of this question. The bulletin also will contain a discussion of the influence which forests have upon waterflow and upon the sanitary conditions of the air, together with other matter pertaining to the subject.

A report on the Charcoal Industry and the use of wood in this industry has also been brought up to date by Mr. John Birkinbine, a well-known expert, and is expected to be published soon.

THE WORLD'S FAIR.

Much time has been spent in the preparation of an exhibit for the World's Fair. The exhibit of the division must of necessity, owing to lack of space and lack of means, be entirely inadequate to the interests which it represents. When it is considered that the value of products derived from our forest resources, and which it is the object of the existence of this division to have husbanded and properly managed, amount in value to more than $1,000,000,000 annually and is surpassed in the value of annual product by no other single industry, excepting agriculture itself, it will be understood that an exhibit of such a vast interest can not be properly placed within a space of 2,000 feet. It is to be hoped that in the special building devoted to the general exhibit of forestry interests, there will be brought before the public not only the rich material of our forest resources, but also some suggestions as to the manner in which they should be managed in order to yield continuous supplies.

THE SITUATION.

This division has now been in existence for more than a decade, during which time it has been engaged in an endeavor to teach the people of this country that the present methods under which our forest resources are managed are uncivilized, undesirable, and destructive not only to the resources themselves but to many other interests depending upon the material as well as upon the indirect influence of the forest. Although there seems to exist a considerable amount of public interest in the subject, we can nevertheless feel no great satisfaction at the result of the work. There must be some strong reason, which is antagonistic to a change of methods, for the fact that the slaughter of timber lands without any regard to the future, and the burning of square miles without any reference to the destruction of values, continue. Remedies have been suggested and discussed to satiety, but of practical application we have as yet had but little. It seems, therefore, proper that we should once more look over the field, investigate the situation, and find the reasons for a continued absence of more rational treatment of our woodlands; in fact, make a review in this centennial year of what we have done with and for our forest resources, state what their present condition is, and what we hope for the future.

ORIGINAL CONDITION OF FOREST AREAS.

When Columbus discovered America the territorial distribution of forest areas in the United States, and indeed on the whole continent, could be divided with more or less precision into three grand divisions:

(1) The Atlantic forest, covering mountains and valleys in the East, reaching westward to the Mississippi River and beyond to the Indian Territory and south into Texas, an area of about 1,361,330 square miles, mostly of mixed growth, hard woods and conifers; with here and there large areas of coniferous growth alone—a vast and continuous forest.

(2) The mountain forest of the West, or Pacific forest, covering the higher elevations below timber line of the Rocky Mountains, Sierra Nevada, and coast ranges, which may be estimated at 181,015 square miles, almost exclusively of coniferous growth, of enormous development on the northern Pacific coast, more or less scattered in the interior and to the south.

(3) The prairies, plains, lower elevations, and valleys of the West, with a scattered tree growth, on which, whether from climatic, geologic, or other causes, forest growth is confined mostly to the river bottoms or other favorable situations, an area of about 1,427,655 square miles, of which 276,965 square miles may be considered under forest cover of deciduous species east of the Rockies and of coniferous and deciduous species in the west of this divide.

Until the present century, and in fact until nearly the last half of it, the activity of man on this continent has practically been confined to the eastern portion, which, as stated, was originally covered with a dense or at least continuous forest. The substructure of the entire civilization of the United States was hewn out of these primeval woodlands.

Out of the vast virgin forest area of the eastern half of the country there have been cleared for farm use during this time 250,000,000 acres, or 400,000 square miles, leaving about 961,330 square miles covered actually or nominally with forest growth, or waste.

Timber being a great obstacle to the settlement of the land, and the market for it until recently being confined and limited, a large amount had to be wasted and disposed of in the log pile, where the flames made quick work of the scrub as well as of the finest walnut trees. The settlement of the western mountain country, although emigration to Oregon began in 1842, assumed proportions of practical importance only when the gold fever took many travelers over the plains and mountains to California in 1849 and the following years.

If only the legitimate need of the population of this region for cleared land and for timber had made drafts upon the forest resources, the change in forest conditions would have been insignificant, but the recklessness which the carelessness of pioneer life and seemingly inexhaustible resources engender has resulted in the absolute destruction by fire of many thousand square miles of forest growth and the deterioration in quality and future promise of as many thousands more.

The third region, the so-called "treeless area," has experienced, since the advent of the white settlers and the driving out of the Indians, changes which are almost marvelous. The prairies were reached by settlers in any considerable number only as late as the third and fourth decades of this century, but they and their successors have not only occupied a farm area of 80,000,000 productive acres, but they have also dotted the open country with groves, smaller or larger, either by planting them or, by keeping out fire and cattle, aiding the natural reforestation.

CAUSES OF REDUCTION IN FOREST AREAS.

While the requirements of the settlement of agricultural lands have necessitated the removal of forests, their principal destruction has come from two other causes—fire and wood consumption. The latter has assumed proportions which no other country of the earth can equal, for the annual consumption of wood in the United States for all purposes reaches the enormous amount of over 22,000,000,000 cubic feet,* or about 350 cubic feet per capita, as against 12 to 14 cubic feet per capita in Great Britain or about 40 cubic feet in Germany.

The present sawmill capacity (inclusive of shingle mills) of the United States is between 140,000,000 and 270,000,000 feet B. M. daily, which would indicate, at the very lowest, an annual product of about 30,000,000,000 feet B. M. (requiring 4,000,000,000 cubic feet of forest-grown material)—an increase of over 35 per cent in the last five years. Only a small proportion of this is exported either as lumber, timber, or manufactures, namely, less than 150,000,000 cubic feet, or hardly 6 per cent of the total output of lumber; and since we import about 95,000,000 cubic feet of wood material (less than 1 per cent of our consumption) outside of fine cabinet woods (of which we import about $1,500,000 worth), the consumption of sawed-wood products is over 40 cubic feet per capita. If we add the consumption of hewn timber and that used in railroad construction the requirements for sizable timber increase readily to 50 cubic feet per capita. To produce such amounts the annual growth of not less than 500,000,000 acres of well-managed forest in good condition would be necessary, while the consumption in mining, fences, and especially for firewood, for which in this country

*The largest part of this consumption is for firewood; according to the Census of 1880 the consumption of firewood must then have been 280 cubic feet per capita (figuring 100 cubic feet solid to the cord), and this amount has probably not been reduced during the last decade. This firewood is not, as in older countries, made up of inferior material, brush and small fagots, but is, to a large extent, split body wood of the best class of trees.

body wood, hardly inferior to saw timber wood, is chiefly used, would swell the necessary acreage to more than double that amount.

The following table shows the value of exports of forest products, crude, or only slightly enhanced in value by manufacture:

Value of exports of forest products, 1860-'92.

Year.	Value.	Total exports of domestic products.	Year.	Value.	Total exports of domestic products.	Year.	Value.	Total exports of domestic products.
		Per cent.			*Per cent.*			*Per cent.*
1860......	$10, 299, 959	3. 26	1880.....	17, 321, 263	2. 11	1887.....	21, 126, 273	3. 01
1870......	14, 897, 963	3. 27	1881.....	19, 486, 051	2. 20	1888.....	23, 991, 092	3. 51
1875......	19, 165, 907	3. 43	1882.....	25, 580, 264	3. 50	1889.....	26, 997, 127	3. 70
1876......	18, 076, 668	3. 04	1883.....	28, 636, 199	3. 56	1890.....	29, 473, 084	3. 49
1877......	19, 943, 290	3. 14	1884.....	26, 222, 959	3. 62	1891.....	28, 715, 713	3. 29
1878......	17, 750, 396	2. 55	1885.....	22, 014, 839	3. 03	1892.....	27, 957, 423	2. 75
1879......	16, 336, 943	2. 34	1886.....	20, 961, 708	3. 15			

We have now less than 500,000,000 acres in forest growth, but even that is neither in good condition nor well managed. We have, therefore, long ago begun to use more than the annual growth, and are cutting into the capital which we inherited at a rate which must sooner or later exhaust it unless we adopt recuperative methods.

These figures are approximate and without fine distinctions, but they will be found by those who study the subject conservative rather than extravagant.

A computation by one of the journals representing lumbermen's interests makes the amount of timber standing in the United States 1,200 billion feet B. M., and the present annual consumption 10,000,000,000 feet; or one-third of the above figures. There exists, to be sure, no reliable basis for such computation, but even with these figures the supply would be exhausted in less than one hundred years, for our consumption during the last three decades has increased at the rate of about 30 per cent, as follows:

Estimates of value of forest products used in 1860, 1870, and 1880.

[Including all raw, partially manufactured, wholly manufactured wood products, fuel, and naval stores; estimated upon the basis of census figures, and other sources of information.]

Articles.	1860.	1870.	1880.
Mill products, rough, and partly finished	$155, 000, 000	$340, 000, 000	$400, 000, 000
Cut on farms for home use	45, 000, 000	52, 000, 000	55, 000, 000
In manufactures using wood	50, 000, 000	100, 000, 000	110, 000, 000
Railroad building	6, 000, 000	14, 000, 000	30, 000, 000
Fuel	135, 000, 000	210, 000, 000	328, 000, 000
Total	*391, 000, 000	716, 000, 000	923, 000, 000

* Probably 25 per cent underestimate.

While there are still enormous quantities of virgin timber standing, the accumulations of centuries, the supply is not inexhaustible. Even were we to assume on every acre a stand of 10,000 feet B. M. of saw timber—a most extravagant average—we would, with our present consumption, have hardly one hundred years of supply in sight—the time it takes to grow a tree to satisfactory log size.

Certain kinds of supplies are beginning to give out. Even the white-pine resources, "which a few years ago seemed so great that to attempt an accurate estimate of them was deemed too difficult an undertaking, have since then become reduced to such small proportions that the end of the whole supply in both Canada and the United States is now plainly in view."

The annual product of this pine from the sawmill has reached the enormous total of over 8,000,000,000 feet B. M., which, if we assume a pine stumpage of 5,000 feet to the acre—a high average—would require the culling of 1,600,000 acres annually of their white-pine supplies. Since the three white-pine States (Michigan, Wisconsin, and Minnesota) have a total reported forest area of altogether 60,000,000 acres, it is evident that even if we allow two-thirds of that area to be in the white-pine belt, and consider this area fully stocked—which it is not—twenty-five years would suffice to practically exhaust the supplies. These figures, crude though they be, leave no doubt that the end of this staple is practically much nearer than we have supposed; all opinions to the contrary may be set down as ill-founded.

It is one of the peculiarities of the development of our country that prices of the manufactured article do not give a clue to the condition of the supplies of raw material. The opening of new territories and the improvement of machinery and methods of handling have a tendency to keep the prices of manufactures low. This is especially noticeable in the lumber trade, prices for lumber having hardly changed in the average for the last twenty years.

It is different, however, with land values and with the value of stumpage of such staples as the white pine. In this respect the table given on page 309, as compiled from the report of the Saginaw Board of Trade, is most instructive, showing a sixfold appreciation of stumpage and almost stationary prices for lumber.

The extent and distribution of the sawmill business through the States is, perhaps, best illustrated by the following statement of the number of the various classes of mills and their daily capacity as compiled from the Directory of the Northwestern Lumberman:

Number of mills, logging railroads, and daily capacity of mills.

[Compiled from data published in Northwestern Lumberman, 1892.]

United States.	Sawmills.		Shingle mills.*	Staves and heading mills.	Logging railroads.	Daily sawmill capacity.		Daily shingle-mill capacity.	
	Stationary.	Portable.				Lowest.	Highest.	Lowest.	Highest.
						Feet B.M.	*Feet B.M.*	*Number.*	*Number.*
Maine	355	6	292	61	3	4,686,000	8,730,000	3,208,000	6,275,000
New Hampshire	270	7	158	40	....	2,530,000	4,720,000	972,000	1,860,000
Massachusetts	282	20	78	16	1	1,452,000	3,095,000	390,000	775,000
Rhode Island	10	2	6	......	....	48,000	100,000	42,000	75,000
Connecticut	56	7	22	1	....	342,000	710,000	114,000	215,000
Vermont	349	20	129	10	1	2,851,000	5,525,000	716,000	1,515,000
New England States	1,322	62	685	128	5	12,909,000	22,880,000	5,442,000	10,715,000
New York	738	42	255	44	10	6,670,000	12,680,000	2,266,000	4,535,000
Pennsylvania	887	96	266	39	92	14,597,000	27,190,000	2,814,000	5,415,000
New Jersey	73	3	11	......	....	174,000	540,000	36,000	90,000
Delaware	46	4	2	5	....	252,000	535,000	....	5,000
Maryland	39	6	5	1	2	470,000	900,000	12,000	40,000
Middle Atlantic States	1,785	151	539	89	104	22,163,000	41,845,000	5,128,000	10,085,000
Virginia	100	58	31	8	29	1,602,000	3,260,000	168,000	330,000
North Carolina	140	21	26	2	34	1,932,000	3,605,000	162,000	355,000
South Carolina	70	16	9	2	21	810,000	1,580,000	369,000	475,000
Georgia	144	17	57	17	44	3,086,000	5,495,000	816,000	1,470,000
Southern Atlantic States	454	112	123	29	128	7,460,000	13,940,000	1,515,000	2,630,000
Atlantic coast	3,561	325	1,347	246	237	42,532,000	78,665,000	12,085,000	23,430,000

* Shingles may be averaged 5,000 to the 1,000 feet B. M.

Number of mills, logging railroads, and daily capacity of mills—Continued.

United States.	Sawmills. Stationary.	Sawmills. Portable.	Shingle mills.*	Staves and heading mills.	Logging railroads.	Daily sawmill capacity. Lowest.	Daily sawmill capacity. Highest.	Daily shingle-mill capacity. Lowest.	Daily shingle-mill capacity. Highest.
						Feet B.M.	*Feet B.M.*	*Number.*	*Number.*
Florida	123	13	48	4	20	2, 036, 000	3, 665, 000	890, 000	1, 575, 000
Alabama	141	13	20	6	36	2, 514, 000	4, 505, 000	812, 000	1, 655, 000
Mississippi	152	13	18	2	34	2, 740, 000	5, 015, 000	282, 000	505, 000
Louisiana	106	3	29	1	15	1, 926, 000	3, 405, 000	1, 536, 000	2, 945, 000
Gulf States	522	55	115	13	105	9, 216, 000	16, 590, 000	3, 520, 000	6, 680, 000
Texas	150	2	30	......	61	3, 602, 000	6, 370, 000	890, 000	1, 525, 000
Michigan	847	52	391	101	79	21, 630, 000	42, 045, 000	12, 356, 000	25, 680, 000
Wisconsin	477	32	265	26	20	14, 724, 000	27, 585, 000	8, 706, 000	15, 865, 000
Minnesota	103	2	67	2	2	4, 182, 000	8, 965, 000	2, 700, 000	4, 740, 000
Northern lumbering States	1, 427	86	723	129	101	40, 536, 000	78, 595, 000	23, 762, 000	46, 285, 000
Ohio	576	78	30	82	9	3, 856, 000	7, 820, 000	162, 000	310, 000
Indiana	549	68	32	51	....	4, 192, 000	8, 130, 000	300, 000	540, 000
Illinois	109	41	9	9	1	1, 158, 000	2, 770, 000	264, 000	445, 000
Northern agricultural States	1, 234	187	71	142	10	9, 206, 000	18, 720, 000	726, 000	1, 295, 000
Lake States	2, 661	273	794	271	111	49, 472, 000	94, 315, 000	24, 488, 000	47, 580, 000
West Virginia	136	93	14	33	40	1, 425, 000	2, 595. 000	770, 000	1, 490, 000
Kentucky	218	117	34	37	10	3, 146, 000	5, 970, 000	306, 000	590, 000
Tennessee	332	111	29	32	20	4, 018, 000	7, 695, 000	180, 000	360, 000
Arkansas	284	33	56	27	45	5, 030, 000	9, 615, 000	1, 074, 000	1, 920, 000
Missouri	184	41	15	9	10	2, 016, 000	3, 820, 000	214, 000	355, 000
Central States	1, 154	395	148	138	125	15, 635, 000	29, 695, 000	2, 544, 000	4, 715, 000
Iowa	42	6	19	2	....	1, 400, 000	3, 655, 000	900, 000	1, 785, 000
North Dakota	1	......	......	......	....	....	....	....	....
South Dakota	18	1	14	......	....	186, 000	360, 000	186, 000	365, 000
Nebraska	4	......	......	......	....	12, 000	25, 000	....	....
Kansas	......	......	......	......	....	....	....	....	....
Prairie States	65	7	33	2	....	1, 598, 000	4, 040, 009	1, 086, 000	2, 150, 000
Interior States	1, 219	402	181	140	125	17, 233, 000	33, 735, 000	3, 630, 000	6, 865, 000
Montana	24	3	11	......	1	438, 000	1, 000, 000	162, 000	310, 000
Wyoming	10	......	7	......	....	60, 000	110, 000	96, 000	170, 000
Colorado	34	17	29	......	....	420, 000	820, 000	318, 000	620, 000
New Mexico	15	1	8	......	3	222, 000	405, 000	108, 000	210, 000
Indian Territory	17	......	1	......	....	180, 000	350, 000	12, 000	25, 000
Eastern Rocky Mountain region	100	20	56	......	4	1, 320, 000	2, 685, 000	696, 000	1, 335, 000
Idaho	37	9	20	......	....	306, 000	580, 000	150, 000	315, 000
Nevada	6	......	2	......	1	212, 000	380, 000	24, 000	50, 000
Utah	31	5	9	......	....	102, 000	285, 000	48, 000	95, 000
Arizona	10	1	2	......	1	146, 000	310, 000	24, 000	50, 000
Western Rocky Mountain region	84	15	33	......	2	766, 000	1, 555, 000	246, 000	510, 000
Rocky Mountain region	184	35	89	......	6	2, 086, 000	4, 240, 000	942, 000	1, 845, 000
California	159	3	64	2	33	3, 446, 000	6, 105, 000	2, 202, 000	4, 010, 000
Oregon	184	7	25	......	11	2, 722, 000	5, 225, 000	380, 000	715, 000
Washington	178	16	83	......	28	2, 850, 000	5, 500, 000	2, 114, 000	3, 645, 000
Pacific coast	521	26	172	2	72	9, 018, 000	16, 830, 000	4, 696, 000	8, 370, 000
Total	8, 818	1, 118	2, 728	672	717	133, 159, 009	250, 745, 000	40, 251, 000	96, 295, 000

*Shingles may be averaged 5,000 to the 1,000 feet B. M.

Prices for lumber and stumpage of white pine.

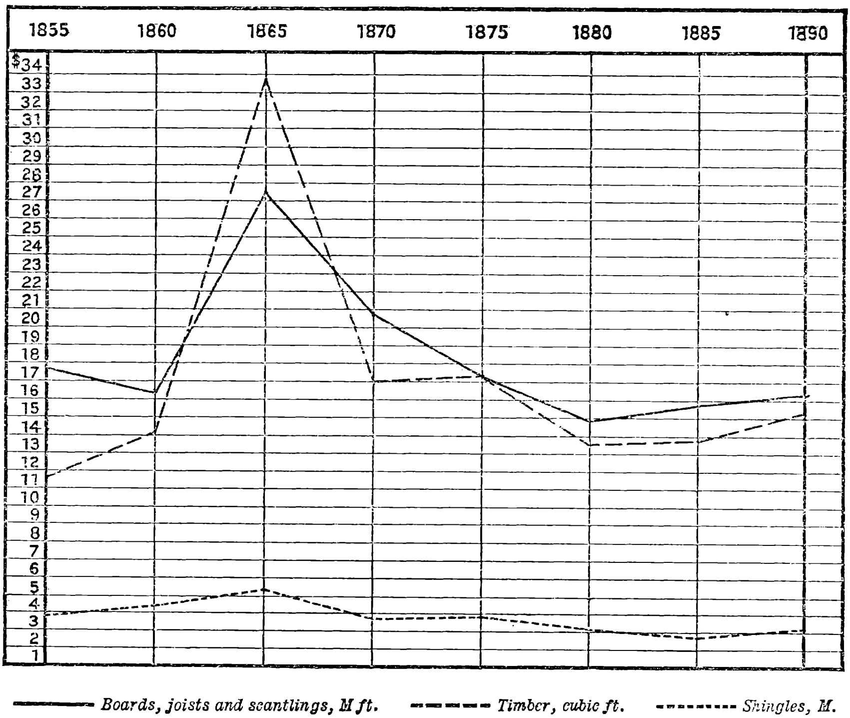
[Compiled from report of Saginaw Board of Trade.]

Year.	Lumber, per 1,000 feet B. M.		Stumpage, per 1,000 feet.		Year.	Lumber, per 1,000 feet B. M.		Stumpage, per 1,000 feet.	
1866....	$11.50 to	$12.00	$1.00 to	$1.25	1877...	$9.25 to	$9.75	$2.25 to	$2.75
1867....	12.00	12.50	1.25	1.50	1878...	9.50	10.00	2.25	2.75
1868....	12.00	12.50	1.50	1.75	1879...	10.50	11.00	2.50	2.75
1869....	12.50	13.00	2.00	2.50	1880...	11.50	12.00	2.75	3.00
1870....	12.00	12.50	2.00	2.50	1881...	12.50	13.00	3.00	4.00
1871....	12.50	13.00	2.00	2.50	1882...	14.00	14.50	3.50	4.50
1872....	13.00	12.00	2.00	2.50	1883...	13.50	14.00	4.00	5.00
1873....	11.50	11.00	2.00	2.50	1884...	12.50	13.00	4.00	5.00
1874....	10.50	10.00	2.00	2.50	1885...	12.50	13.00	4.50	6.50
1875....	9.50	10.00	2.25	2.75	1886...	12.50	13.00	4.50	6.50
1876....	9.00	9.50	2.25	2.75	1887...	12.50	13.00	4.50	6.50

The following diagram of export prices for lumber shows also comparative stability, with the exception of war time:

DIAGRAM 1.—*Export prices of lumber from 1855 to 1890.*

[The prices given represent market value at time of exportation in the ports whence the lumber was exported, averaged for all ports.]



FIRES.

Regarding the loss by fire no adequate conception can be formed. Fires are of such general occurrence that only the larger conflagrations are noticed and it is difficult to obtain reports as to their extent and destructiveness.

In the South the foolish custom of annually burning off the old grass in order to gain a fortnight's earlier pasturage still prevails and gives rise to widespread destruction, which is increased by the coniferous composition of the larger part of these areas and the additional danger occasioned by turpentine orchards. In the West carelessness of campers seems to be the principal cause of fires, which, owing to the dryness of the climate and absence of population interested in stopping the conflagrations, assume frightful dimensions and often not only destroy square miles of timber, but endanger the lives and property of settlers.

From locomotives, without spark-arresters or carelessly handled at the ash-pit, comes the greatest danger in the East. To estimate even the direct loss or damage from this source is well-nigh impossible, much less the indirect loss, which consists in the destruction of the forest floor, the handing over of the ground to worthless brush, brambles, and inferior tree growth, or, as happens in some regions, the burning of the soil down to the rock, leaving an irredeemable waste. Thus the accumulation of centuries—it takes from three to five centuries to make a humus soil 1 foot in depth—is destroyed in one brief season by carelessness.

In the Census of 1880 an attempt was made to ascertain the extent of the fires and the consequent loss in money value. Upon unsatisfactory and partial returns a total of over 10,000,000 acres was reported burned with a loss of over $25,000,000 in value.

A canvass made by the Division of Foresty for the last year, which was highly unsatisfactory in its returns, these being vague and reporting only very partially, shows that in the districts reporting more than 12,000,000 acres of woodland were burned over during 1891. The report showed log timber killed 473,387,000 feet, B. M., and damage from forest fires to other than forest property to the extent of $503,590, besides injury to valuable forest growth difficult to estimate. What proportion of the actual destruction these reports represent it is impossible to tell. They show, however, that in spite of the growing sentiment against such useless waste the nuisance has hardly abated in the last ten years. The loss from prairie fires to crops, tree growth, buildings, and other property was reported by the same correspondents at $1,633,525.

In comparison with our figures of bona fide consumption the direct loss in material is but a small matter, perhaps 2 to 3 per cent of the total value of forest products, but the indirect loss can hardly be overestimated. This lies, not only in the destruction of the fertility of the soil, but in discouraging more conservative forest management on the part of forest owners, while the constant risk from fire is an incentive to turn into cash as quickly as possible what is valuable in the forest growth, leaving the balance to its fate.

There is a crying need in the United States for economic reform in this matter of playing with fire. If the fire nuisance could be reduced to the unavoidable proportion, half the forestry problem would be solved.

FIRES SET BY RAILROADS.

The railroads are probably responsible for as much loss of forest growth by fire escaping from their locomotives as results from any other cause of fire. Yet, if we expect to carry on profitable forest management, we can not dispense with these instruments of transportation, and the development of the country can not be retarded, even at this expense in devastated forest growth. Strange as it may appear to the average railroad man and to the public accustomed to conflagrations from locomotive sparks, it is possible to use locomotives without any special risks from fires. That this is a fact is shown by the following statistics: In the Prussian Government forests during the years 1882 to 1891, there have been 156 larger conflagrations. Of these 96 originated from negligence, 53 from ill-will, 3 from lightning, and only 4 from locomotives. Seven years out of the ten are without any record of fire due to this last cause. When we consider that the larger part of the Prussian forest property, namely, 56 per cent, is stocked with pine mostly on dry, sandy soils, this fact increases in significance.

How is this danger so reduced? In the first place, by ordinances which are enforced regarding the use of spark-arresters and regulations for the cleaning of ash-pits, as well as by frequent patrols of the guards. But with all these precautions the object could hardly be attained effectively if other preventive measures were not adopted. These are fire-safety strips. These safety strips, running along the right of way of railroads, are variously constructed and utilized. An ideal form is described and illustrated on Plate VI.

Wherever this system has been adopted, the clearing having been attended to in spring with reasonable watching during the dangerous season, fires from locomotives have been of no significance. The wooded safety strip acts as a screen, preventing the sparks from being thrown into the growth beyond the ditch.

Such a system would be applicable in many cases in our own country, and while it would not be necessary for the railroad company to acquire title to the right of way for a breadth of 200 feet the company should at least be under obligation to keep the safety strip in order. It would be perfectly feasible and in the end profitable in many cases for the company to grow their tie timber on the safety strips, using for this purpose such thin-foliaged rapid growers as the locust, catalpa, etc. Should it be found impossible to compel the railroad company to provide such protection, owners of valuable timber land may at least find a hint in this system for protecting themselves and reducing the danger from fire by cleaning out and keeping free from inflammable material the ground near the tracks.

FOREST-FIRE LEGISLATION.

Against other causes of fire, watchfulness alone will protect. This, in more densely settled communities, is best secured by the methods of the Pennsylvania or Maine laws. Special fire wardens are appointed for districts not too large, who have sheriff's power, whenever a fire is started, to call out a posse and put out the fire, charging the cost to the county treasury. They are also to find out the originator and bring him to trial, he to pay damages and suffer criminal punishment as provided by law. In this way carelessness at least will soon be more or less eradicated.

In less settled communities, and on large territories, where lumbermen are interested, the Canadian system, which has worked satisfactorily for nearly ten years, is to be recommended. It consists in having fire patrols appointed by the government on recommendation by the limit holders, who contribute one-half the expenses of this service.

There exist some legislative provisions regarding forest fires in almost every State, but they are rarely if ever carried into execution for lack of proper machinery. The most comprehensive fire legislation is that enacted in Maine in 1891, which creates a forest commissioner and organizes a protective service. The first report of the forest commissioner, Mr. Cyrus A. Packard, of Augusta, Me., containing a copy of the law and other valuable matter, is recommended for the perusal of all interested in this most important matter of fighting forest fires. With this legislation as a basis, the following suggestions for the drafting of forest-fire legislation are made, which, with appropriate modifications to suit the special conditions in each State, should be enacted.

The principles most needful to keep in view when formulating legislation for protection against forest fires are—

(1) No legislation is effective unless well-organized machinery for its enforcement is provided. The damage done by forest fires being in many cases far-reaching beyond the immediate private personal loss, the State must be prominently represented in such organization.

(2) Responsibility for the execution of the law must be clearly defined and ultimately rest upon one person, and every facility for ready prosecution of offenders must be at the command of the responsible officer.

(3) None but paid officials can be expected to do efficient service, and financial responsibility in all directions must be recognized as alone productive of care in the performance of duties as well as in the obedience to regulations. In the case of corporations the officer most directly responsible for any damage must be amenable to law in addition to the corporation itself.

(4) Recognition of common interest in the protection of property can also be established only by the creation of financial liability on the part of the community and all its members.

The following is the draft of a bill which embodies the principal features of the desired legislation:

AN ACT FOR THE PROTECTION OF FOREST PROPERTY.

FOREST COMMISSIONER.

Section 1 creates a forest commissioner, whose office may be either an enlargement of some existing office or, much better, a separate one, with adequate compensation in either case, to be appointed by and reporting directly to the governor.

Section 2 prescribes the duties of the forest commissioner, namely, to organize, supervise, and be responsible, under the provisions of this act, for the protection of forest property in the State against fire. In addition he is to collect statistics and other information regarding the forest areas in the State, and the commerce of wood and allied interests, especially such information as will explain the distribution, condition, value, and ownership of the woodland; this information and the results of the operation of this act, together with suggestions for further legislative action, to be embodied in annual reports.

Section 3 provides for the giving of a bond by the forest commissioner for the faithful performance of his duties, and fixes fines for such neglect in performing the duties of the office as may be proven, and explains the manner of imposing and collecting such fines.

ORGANIZATION OF FIRE SERVICE.

Section 4 constitutes the selectmen of towns, or the sheriffs, deputies, constables, supervisors, or similar officers as fire wardens. If preferred, special fire commissioners may be appointed by the forest commissioner, with the advice of county commissioners, or both methods of providing firewardens may be employed together. The towns are to be divided into fire districts, the number and boundaries to be governed by the exigencies in each case, and each district to be under the charge and oversight of one district firewarden. One of these should be designated as town firewarden, to take command in case of large conflagrations. The town firewarden and at least 50 per cent of the district firewardens should be property owners in the county, unless a sufficient number of such can not be found or residents refuse to serve. A description of each district and the name of its firewarden are to be recorded with the forest commissioner and the town clerk or similar officer.

Section 5 provides for employment of special fire patrols in unorganized places in any county and during the dangerous season, especially in lumbering districts, and for coöperation of forest-owners. Wherever unorganized places exist in a county or so far distant from settlements as to make discovery of fires and speedy arrival of regular firewardens impossible, or wherever forest-owners whose property is specially endangered require, the forest commissioner may annually appoint special fire patrols, to be paid at daily rates, the owner paying one-half the expense and the State the other half; such patrols to be under the regulations of this law and to report to the nearest firewardens. The manner of appointment and the matter of compensation and duties are to be formulated by the forest commissioner.

Section 6 defines the power and duties of firewardens: To take measures necessary for the control and extinction of fires; to post notices of regulations provided in this law and furnished by the forest commissioner; to ascertain the cause of fires and prepare evidence in case of suits; to report each fire at once to the forest commissioner on blanks furnished, giving area burned over, damage, owner, probable origin, measures adopted, and cost of extinguishing; to have authority to call upon any persons in their district for assistance, such persons to receive compensation as determined by the selectmen or county commissioners at the rate of not to exceed 15 cents per hour and to be paid by the town or county upon certification by the forest commissioner.

Persons refusing, when not excused, to assist or to comply with orders, shall forfeit the sum of $10, the same to be recovered in an action for debt in the name and to the use of the town or county, or for the fire protection fund.

Firewardens shall be paid $10 a year as a retainer besides day's wages at the same rates as sheriffs or similar officers for as many days as they are actually on duty, and shall be responsible for prompt extinction of fires and be amenable to law for neglect of duty. The district firewarden shall call on the town firewarden in case of inability to control fires, and the town firewarden shall have sheriff's power to enlist assistance, as is provided in case of a mob.

FIRE-INDEMNITY FUND.

Section 7 provides for the creation of a fire-indemnity fund, each county to pay into the State treasury $1 for each acre burnt over each year, the special fund so constituted to be applied in the maintenance of the system provided by this act and for the payment of damages to those whose forest property has been burned without neglect on their part or on that of their agents.

The burned areas shall be ascertained by the county surveyor and shall be checked from the reports of firewardens by the forest commissioner. All fines collected under the provisions of this law shall also accrue to the fire fund.

JURISDICTION AND LEGAL REMEDIES.

Section 8 establishes jurisdiction and legal proceedings in each case of prosecution of incendiaries and adjustment of damages, and imposes upon every district judge the duty in charging the grand juries of his district to call special attention to the penal provisions of this act and of any similar acts providing for offenses against forest property.

Section 9 charges the forest commissioner to issue and publish, by posters and otherwise, reasonable regulations regarding the use of fires; such regulations to contain special consideration of campers, hunters, lumbermen, settlers, colliers, turpentine men, railroads, etc., and to be approved by the governor.

Section 10 makes it a misdemeanor to disobey the posted regulations of the forest commissioner, or to destroy posters, or to originate fires by neglect of the same; provides that the prosecution shall be prepared by the forest commissioner, and imposes fines and imprisonment in addition to damages. Fines should be double the actual damages, one-half to go to the fire fund, one-half to the damaged person.

Section 11 makes it a criminal act, subject to indictment, to willfully set fires, and imposes fine and imprisonment.

Section 12 provides that any person whose forest property is damaged by fire, not originated by his own neglect, and who is able to prove neglect on the part of the firewarden, may call on the forest commissioner for award of damage, whereupon the forest commissioner, in conjunction with the county authorities, shall investigate the case and refer his findings to the judicial officer of the district, who shall charge the grand jury to indict any offender against this act and adjudge any neglectful firewarden or other officer, or any person refusing to act upon orders of the firewarden.

Any neglect on the part of the forest commissioner to investigate and find in each case within one year from the appeal of the owner shall be followed by dismissal unless reasonable cause for failure be shown.

LIABILITY OF RAILROADS.

Section 13 charges railroad companies to keep their right of way free from inflammable material by burning under proper care before certain dates to be established by the forest commissioner. Failure to do so, upon notification by the commissioner, to be followed by the arrest of the superintendent of the section, who shall be liable prima facie to procedure under section 10.

Section 14 provides for the use of spark-arresters—failure to comply with this provision to be followed by arrest of the superintendent or other officer in charge of the motive power and by procedure under section 10.

Section 15 declares that fires originating from the tracks of a railroad company shall be prima facie evidence of neglect on the part of the company—the engineer and fireman to be liable to arrest and procedure under section 10.

Section 16 declares that in all cases where a fire originates through neglect of a railroad company or its agents, both the company and its officers shall be liable for damages under the provisions of section 12.

Section 17 establishes special liabilities for damage by fires in case of railroads under construction.

FIRE INSURANCE AND STOCK LAWS.

Section 18 provides for incorporation of forest fire insurance companies. In States where cattle are allowed to roam, provisions to stop this practice should be enacted.

FURTHER DUTIES OF FOREST COMMISSIONER.

Section 19 defines minor duties of the forest commissioner, namely, to coöperate with superintendents of schools and other educational institutions in awakening an interest in behalf of forestry and rational forest use.

Section 20 provides for salary and other expenses of the office of forest commissioner, which should be liberal in proportion to the responsibility of the office.

Section 21 repeals all acts and parts of acts inconsistent with provisions of this act.

EXTENT OF FOREST AREA.

In consequence of the various destructive agencies described, not only has the forest area dwindled down to less than 480,000,000 acres, but a large part of this area believed to be under forest is in a more or less devastated condition. If, therefore, the map of the State of Massachusetts, by the U. S. Geological Survey, for instance, exhibits over 50 per cent of the area of the State in forest, this has but little meaning for the question of future supplies, for fully one-third or more of this so-called forest is useless brush and waste land, which will not be productive in this or the next generation.

An exact census of the forest area in existence has never been made. The figures given have been approximations from various sources of information, more or less reliable, and hence much larger areas have been claimed to be in existence by those who deny the necessity of a conservative forest policy. It will, however, be found that, deducting the so-called treeless area—which does not contain forests of extent or value—the farm area not in forest, and as large a per cent of waste land as is reported in farms from the total area of the United States, the area that could possibly be in forest will not exceed 850,000,000 acres. Anyone familiar with the condition of the culled-over and burnt-over forest areas, and at the same time cognizant of what the lumber-producing capacity of a growing woodland may be, will readily admit that 50 per cent of this area may, to all intents and purposes of lumber production, for the next generation at least, be considered unavailable. It may then be safely assumed that we have hardly 25 per cent of our area in producing forest—a proportion that is reported for Germany; but our drafts on it for material exceed the consumption of Germany at least eightfold.

OWNERSHIP.

The ownership of the forest area is for the most part in the hands of private individuals. The policy for the single States or the United States to own lands, except for building, etc., and for eventual disposal, has not been germane to the spirit of the institutions of this country.

School lands, indemnity lands, swamp lands, and other lands which the General Government has given to the States, or which they have owned otherwise, have never been held for an income, except by their sale. The State of New York seems to be the first to make an exception, having set aside an area of nearly 1,000,000 acres in the Adirondack and Catskill mountains as a forest reserve; and a movement to extend this reserve over a larger area—3,000,000 acres, more or less—is strongly advocated. The administration of this reserve is, however, confined to protection without utilization, and forest management in any sense does not as yet exist, although the staff of the three forest commissioners includes, besides a secretary with assistants, a superintendent with assistant, inspectors, and surveyor, eleven foresters, who constitute, in fact, however, only a police force.

The General Government has also within the last two years been committed to a change of policy by the enactment of a law permitting the reservation of forest areas for permanent ownership by the Government. This policy will be discussed further on. Before this enactment several areas of public lands besides the Indian reservations had been reserved as military, timber, and water reservations, and as national parks; the former for temporary occupancy by troops to supply them with fuel, the latter for permanent ownership on account of natural wonders and scenery for the benefit of pleasure-seekers, or for health resorts, but not with the express purpose of preserving and improving forest conditions. These parks are at present—

	Acres.
Yellowstone National Park, Wyoming	2,288,000
Yosemite National Park, California	960,000
Sequoia National Park, about	100,000
General U. S. Grant National Park, about	3,000
Hot Springs Reservation, Arkansas	2,529

The area of the permanent forest reservations, proclaimed by the President of the United States will, before the close of the present administration, amount to nearly 13,000,000 acres, while the total area of public lands, classed as timber lands, may be in the neighborhood of 50,000,000 acres, the last estimate made in 1883 making the area 73,000,000 acres.

There are three classes of private forest owners: The farmers who have wood lots connected with their farms; the speculators, among whom may be included all those who hold forest property temporarily for the purpose of selling it to obtain the "unearned increment" from the third class, namely those who develop and utilize the forest resources—lumbermen and manufacturers.

The first class should be considered a safe and conservative one, holding forest property to the extent of from 35 to 40 per cent, and we might feel safe regarding the fate of this part of the forest area. Whatever attempt at rational forest management exists in the United States is found among the farmers. It is probable, however, that a large part of their forest property is held only for speculative purposes, and the opportunity of paying off indebtedness by sacrificing the wood lot is not unfrequently embraced. The forest land is not treated in a conservative manner, which arises from lack of conception of the true value of this part of the farm.

The speculators are harmless as far as forest conservancy goes—perhaps even an advantage to the country in keeping their holdings from utilization until a change in market conditions may make a more rational exploitation of the forest practicable. It is, then, the lumbermen, or those who make it a business to exploit the forest resources, to whom we must look for a forest policy. Here, again, we must distinguish between those who supply the raw material to others, engaged only in logging, and those who supply themselves, their mills, manufactures, charcoal kilns, etc. The latter might be expected to have conservative tendencies, and to some extent they do exhibit them in the care of their forest property; but their foresight usually does not reach beyond a few years, certainly not to the length of a "rotation"—the length of time it takes to mature trees; and, as to application of real forest management, the writer is not aware of any attempts worthy of notice.

Altogether, the general speculative spirit prevailing in all classes of society and business breeds instability, and is detrimental to anything that depends on decades and centuries for results, as does a forest growth. Those engaged in the logging business, purchasing only stumpage from others, are the ones that have the least regard for the future—the most wasteful and reckless methods of exploitation are theirs; after them, fire or the deluge.

To induce any forest owner to adopt rational and conservative forest management we should have to show him that it is directly profitable—profit, we must never forget, is the only incentive for private enterprise. Now, from the foregoing statements regarding market conditions and fire risks, it will have appeared that this is difficult, almost impossible, to do in a general way, and it is questionable whether in many, perhaps in most, localities forest management for the present can be shown to be profitable. The wanton waste and destruction, to be sure, is not profitable—certainly not to the nation at large—but forest management means more than abstaining from wantonness. It is not only a negative but a positive business. It means application of knowledge; it means expenditure for a manager and other requisites of an organized management; expenditures for protection; curtailment of present profits for the sake of a continued revenue; expenditure in the present for the sake of gain in the future.

There are two main objections on the part of forest owners to such expenditures; the first is, the hazard to which their property is exposed under our poorly administered laws, especially against damage from fire; the second is, that as long as forest supplies from virgin growth compete in the market with only the cost of harvesting and transportation placed upon them, there seems no money in the business, at least for the present, if there is an additional cost of production in the shape of expenditure for management to be placed upon it.

The lumberman, accustomed to carry on his business like the butcher, slaughtering his herd and finding his profit in the difference of the price he paid for the cattle and the price he got for the meat, is not readily turned into a forester, who like the breeder finds his profit in the sale of the young increase, treating his herd as the capital. Additional difficulty results from the absence of educated foresters, competent to advise and carry on a management under such difficult economic conditions. So that, even if the forest owner were willing to try the experiment, he would not be able readily to secure the manager.

The result of all these considerations is, that profitable exploitation of our forest resources and forest conservation or conservative forest management are at present more or less incompatible. At best, any scheme of introducing forest management would be an experiment, which few private forest owners would be willing to risk. Hence, where the preservation of forest conditions is of importance to the community, the community alone will be able to insure their preservation, for the community alone can afford to forego the immediate profits arising from conservative exploitation for the sake of an indirect object, that of favorable soil and water conditions. The community, or rather government, State or Federal, can alone afford to establish such an experiment, and after it has shown the methods to be employed, after it has offered the opportunity for the education in theory and practice of forest managers, there will be more inclination for private enterprise to follow suit.

THE FORESTRY MOVEMENT.

Having thus briefly sketched the conditions of the forest areas and the difficulties in the way of their rational use and management, it behooves us to inquire what methods have been pursued to bring about a more rational policy in regard to the same, and to interest people and governments in the art of forestry.

Although from early colonial times voices were heard, and occasionally enactments were made by legislatures, in behalf of a more conservative forest policy, and with a recognition of a special value in timber lands, it is only within the last twenty years that this recognition has become more general, as when the law of March 3, 1873, the so-called timber-culture act was passed by Congress, by which the planting to timber of 40 acres of land in the treeless territories conferred the title to 160 acres of the public domain. This law was not in existence ten years when its repeal was demanded, and finally secured in 1891, the reason being that, partly owing to the crude provisions of the law and partly to the lack of proper supervision, it had been abused and given rise to much fraud in obtaining title to lands under false pretenses. It is difficult to say how much impetus the law gave to bona fide forest-planting and how much timber growth has resulted from it. Unfavorable climate, lack of satisfactory plant material, and lack of knowledge as to proper methods, led to many failures; so that while the entries made during the years 1873 to 1878 comprised 3,821,843 acres, ten years from the last date (in 1888) the final acreage proved up was not more than 779,582 acres, or about 20 per cent, representing perhaps 175,000 acres planted; and if the same proportion had prevailed since, the acreage of groves originated under the timber-culture law might now be estimated at about 2,000,000 acres.

The encouragement given to timber-planting in the prairie States by legislative means (Minnesota, 1871; Illinois, 1874, offering bounty; Iowa, 1872, exemption from tax; Dakota, 1877, bounty and exemption from tax) has been of only indifferent success. Private interest of homesteaders and settlers, without State aid, has probably been as effective. In this direction the establishment of Arbor days through the States has perhaps been as stimulating as any other measure. From its inception by Governor J. Sterling Morton, and first inauguration by the State Board of Agriculture of Nebraska, in 1872, it has become a day of observance in nearly every State, until its adoption as a national holiday may be shortly expected. While, with the exception of the so-called treeless States, perhaps not much planting of economic value is done, the observance of the day has been everywhere productive of increased interest in tree growth and forest preservation.

The following table exhibits the condition of the Arbor-day movement at the present time:

Arbor-day observance in the United States.

States and Territories.	First observed. Date.	First observed. By whose appointment.	When legally established.	Legal holiday.	Date of annual observance.	By whom fixed.
Alabama	1887	Supt. of Education.			Feb. 22	
Arizona	1890-'91	Legislature	1891	Yes	1st Fri. after Feb. 1.	Legislature.
Arkansas						
California	1886	Gen. Howard and others.			Variable	
Colorado	1885	Governor	1889	For schools.	3d Fri. in Apr	Do.
Connecticut	1887	....do	1886		In spring	Governor.
Florida	1886	Governor			Jan. 8	Do.
Georgia	1891	Legislature	1890	For schools.	1st Fri. in Dec	Legislature.
Idaho	1887	....do	1887	Yes	Last Mond. in Apr.	Do.
Illinois	1888	....do	1887			Governor.
Indiana	1884	Supt. of Pub. Instruction.			Oct., usually	Supt. of Pub. Instruction.
Indian Ter						
Iowa	1887	Supt. of Pub. Instruction.			Variable	Do.
Kansas	1875	Mayor of Topeka.			Apr., usually	Governor.
Kentucky	1886	Legislature	1886			Do.
Louisiana	1888-'89	State Supt. of Schools.			Option of parish boards.	
Maine	1887	Legislature	1887			Do.
Maryland	1889	....do	1884		Apr	Do.
Massachusetts	1886	Village Imp. Soc.	1886		Last Sat. in Apr.	Legislature.
Michigan	1876	Governor	1885			Governor.
Minnesota	1876	State Forestry Assoc.				Do.
Mississippi	1892	State Board of Education.	1892			State Board of Education.
Missouri	1886	Supt. of Schools.	1889	For schools.	1st Fri. after 1st Tues. Apr.	Legislature.
Montana	1887	Legislature	1887		3d Tues. Apr	Do.
Nebraska	1872	Board of Agric	1885	Yes	Apr. 22	Do.
Nevada	1887	Legislature	1887	For schools.		Governor.
New Hampshire	1886	....do	1885			Do.
New Jersey	1884	....do	1884		Apr	Do.
New Mexico	1890	....do	1891	For schools.	2d Fri. in Mar	Legislature.
New York	1889	....do	1888		1st Fri. after May 1.	Do.
North Carolina	1893	....do	1893			Do.
North Dakota	1884	Governor			May	Governor.
Ohio	1882	....do	1882		Apr	Do.
Oklahoma	1892	Supt. of Pub. Instruction.			Feb. 22	Supt. of Pub. Instruction.
Oregon	1889	Legislature	1889		2d Fri. in Apr	Legislature.
Pennsylvania	1887	....do	1887			Governor.
Rhode Island	1887	....do	1886		Variable	Do.
South Carolina	(*)	Individual action.				
South Dakota	1884	Governor				Do.
Tennessee	1875	Normal College.	1887		Nov	County Supt.
Texas	1890	Legislature	1889	Yes	Feb. 22	Legislature.
Utah	1892	....do	1892	Yes	1st Sat. in Apr	Do.
Vermont	1885	Governor				Governor.
Virginia	1892	Village Imp. Soc.				
Washington	1892	Agric. College				
West Virginia	1883	Supt. Pub. Instruction.			Fall and spring.	Supt. of Schools.
Wisconsin	1889	Legislature	1889			Governor.
Wyoming	1888	....do	1888	Yes		Do.

* Uncertain.

Private efforts in the East in the way of fostering and carrying on economic timber-planting should not be forgotten, such as the prizes offered by the Society for the Promotion of Agriculture, the planting done by the private landholders at Cape Cod, in Rhode Island, Virginia, and elsewhere. Altogether, however, these efforts have been sporadic and unsystematic and not on any scale commensurate with the destruction of virgin-forest resources.

Interest in the preservation and conservative use of our natural forest areas may be said to have been first systematically aroused when Mr. George B. Emerson and Dr. Franklin B. Hough, in 1873, engaged the attention of the American Association for the Advancement of Science to the subject, and a memorial from that association to Congress led to the appointment, in the centennial year of our existence, of Dr. Hough to make a detailed report on forestry, which was published in 1877, followed by three other reports, and finally by the establishment of a permanent Division of Forestry in the U. S. Department of Agriculture, for the purpose of investigating, experimenting, and reporting upon forestry. While this was the first official recognition of the importance of the subject, private interest associated itself in the American Forestry Congress, which was convened at Cincinnati in 1882, called together by patriotic citizens, incited thereto by the representations of Baron von Steuben, a Prussian forest official, when visiting this country on the occasion of the centennial celebration of the surrender of Yorktown.

The association then formed has labored to arouse public interest in forestry matters and to influence Government action, and during the decade of its existence has given impetus to many other private efforts in behalf of better forest management.

Thus State forestry associations were formed under its direct or indirect influence. The most thriving of these, the Pennsylvania Forestry Association, founded in 1886, maintains a useful periodical in the interest of forestry. State forestry associations exist also in Minnesota (established as early as 1876), Colorado, Ohio, Kentucky, and New York, and associations less comprehensive as to title, but not less active, exist in California, Dakota, South Carolina, and Maine, while several of the State horticultural societies make forestry a subject of discussion in their meetings and reports. Several of the State agricultural colleges have introduced the subject in their curriculum and have professors of forestry, usually in connection with botany. In the absence of employment for forestry experts, the instruction in forestry proper, to be sure, can be only of very general nature.

Official recognition has been given to the subject in several States not only by sending official delegates to the meetings of the American Forestry Association, but also by the appointment of forest commissions. These have been mostly commissions of inquiry, of temporary nature, to make reports on desirable legislation. Such commissions were appointed in New York in 1884, in New Hampshire in 1881 and again in 1889, now endeavoring to commit the State to a purchase of the forest cover of the White Mountains; in Vermont in 1884, in Michigan in 1887, and in Pennsylvania in 1888.

The Forestry Bureau of Ohio, which has been continued since 1885, is also of an advisory and educational nature, and publishes biennial reports. So is the office of superintendent of irrigation and forestry of North Dakota (1890), while the forest commissioner of Colorado (1885) and the State Board of Forestry of California (1885) were charged with executive duties. The former was only poorly provided with the means of executing his official duties, which were mainly to organize a service for the protection of forests against fire and to keep alive an interest in forestry matters; while the latter, with ample means, should have been able to do much for the forestry interests of the State.

The forest commissioner of Maine is charged principally with the execution of the forest-fire laws enacted in 1891, which may be considered the best effort in that direction.

The State of New York alone since 1885 has, as stated before, an administrative forest commission with forests to manage, having charge of the Adirondack and Catskill Forest Reserves. There is, however, so far but little application of the art of forestry within the power of this commission. The reports of these various commissions have done much to stimulate interest in forestry matters.

Finally, I should mention two attempts known to me of private enterprise having in view the introduction of forest management. The one in the Adirondacks, contemplated by the Adirondack League Club, in which over 100,000 acres of excellent virgin timber land are to be brought under systematic management, has not yet progressed far enough to speak of it as a fact; the other, begun in the mountains of North Carolina by a rich private owner, lacks, unfortunately, the opportunities of serving the contemplated purpose, namely, to be an object-lesson of the profitableness of forestry. Being applied to a forest area severely culled and away from markets, that might take inferior material, such demonstration can hardly be expected in the near future.

Altogether, as I have pointed out elsewhere, profitableness in forest management is rarely immediate, but lies in the future rather than in the present. Where, therefore, the maintenance of forest cover for its influence on water and soil conditions is of importance, the community alone which can forego or wait for profits can be successful. It is for this reason that I consider as the most important step toward a proper forest policy the plan inaugurated March 3, 1891, and followed up by the present Administration in a statesmanlike manner, establishing forest reservations in the public timber lands. Under this policy fourteen reservations, aggregating 13,000,000 acres, have been established, while a number of other locations have been temporarily withdrawn from the market and subjected to examination prior to their final permanent reservation.

The year 1892, the quadro-centennial year of the discovery of this continent, during which most of these reservations were at least prepared, will, therefore, in the forestry annals of the future, mark a new era for this country.

The reservations so far established by proclamation of the President are as follows:

In Arizona.—Grand Cañon Forest Reserve, in Coconino County, containing about 1,851,520 acres.

In California.—San Gabriel Timber Land Reserve, in Los Angeles and San Bernardino counties, containing 555,520 acres; Sierra Forest Reserve, in Mono, Mariposa, Fresno, Tulare, Inyo, and Kern counties, containing about 4,096,000 acres; San Bernardino Forest Reserve, in San Bernardino County, containing 737,280 acres; Trabuco Cañon Forest Reserve, in Orange County, containing 49,920 acres.

In Colorado.—White River Plateau Timber Land Reserve, in Routt, Rio Blanco, Garfield, and Eagle counties, containing 1,198,080 acres; Pike's Peak Timber Land Reserve, in El Paso County, containing 184,320 acres; Plum Creek Timber Land Reserve, in Douglas County, containing 179,200 acres; The South Platte Forest Reserve, in Park, Jefferson, Summit, and Chaffee counties, containing about 683,520 acres; Battlement Mesa Forest Reserve, in Garfield, Mesa, Pitkin, Delta, and Gunnison counties, containing 858,240 acres.

In New Mexico.—Pecos River Reserve, in Santa Fe, San Miguel, Rio Arriba, and Taos counties, containing 311,040 acres.

In Oregon.—Bull Run Timber Land Reserve, in Multnomah, Wasco, and Clackamas counties, containing 142,080 acres.

In Washington.—The Pacific Forest Reserve, in Pierce, Kittitas, Lewis, and Yakima counties, containing 967,680 acres.

In Wyoming.—Yellowstone National Park Timber Land Reserve, lying on the south and east of the Yellowstone National Park, containing 1,239,040 acres.

NOTE.—The areas given are the estimated aggregate areas lying within the exterior boundaries of the reservations. The lands actually reserved are only the vacant, unappropriated public lands within said bounderies.

While the primary object of these reservations is to insure favorable water conditions in the regions which depend for their fertility upon irrigation, ultimately it will not be practicable to exclude such areas and their resources from use.

When, therefore, the immediate necessity of providing for the special protection of these permanent Government reservations against fire and depredation has been satisfied, there will have to be developed methods for the rational use and management in perpetuity of their timber resources and other useful material, which must ultimately lead to the well-regulated forest administration contemplated in the bill now before Congress (S. 3235), which the American Forestry Association has advocated.

We may, then, before the end of the century expect to see the first phase of the history of forestry development in the United States ended by having the Government fully committed to a sound forest policy. Such a policy will induce imitation on the part of smaller communities, and finally of private landholders, especially as with the settlement of the country greater stability will lead to permanent investments and induce conservative management, when also with the rapid destruction of virgin supplies the profitableness of forest management will have become more apparent.

Imports of wood and certain wood products for home consumption during the years ending June 30, 1891 and 1892.

Articles.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
Free of duty.				
Firewood....cords..	171, 762	$360, 090	198, 850	$411, 482
Logs and round timber	....	1, 272, 427	....	1, 188, 797
Railroad ties....number..	2, 287, 411	399, 207	748, 520	131, 295
Shingle and stave bolts	....	89, 198	....	44, 387
Handle and head bolts	....	72, 530	....	59, 573
Ship timber	....	81, 159	....	31, 721
Ship planking	....	30, 761	....	79, 622
Hop poles	....	11, 562	....	18, 412
Wood for pulp-making	....	130, 747	....	230, 959
Charcoal	....	56, 669	....	48, 395
Cabinet woods; cedar, ebony, mahogany, etc	....	1, 802, 703	....	2, 234, 003
Corkwood or bark	....	1, 249, 008	....	1, 368, 244
Hemlock bark....cords..	57, 254	274, 426	53, 018	256, 346
Bamboos, rattans, canes, etc	....	1, 080, 859	....	1, 198, 813
Briar root or briar wood, and the like, only partially manufactured	....	15, 141	....	39, 185
Ashes	....	42, 624	....	54, 855
Fence posts	....	30, 779	....	31, 351
Tar and pitch of wood....barrels..	2, 981	12, 597	768	3, 352
Turpentine, spirits of....gallons..	2, 889	1, 219	9, 337	3, 470
Turpentine, Venice....pounds..	70, 185	8, 138	36, 642	3, 992
Pitch, Burgundy....do....	212, 627	3, 520	281, 430	4, 386
Total free	....	7, 025, 364	....	7, 442, 640
Dutiable.				
Wood, unmanufactured, not specially provided for..	....	13, 616	....	32, 655
Timber—				
Used for spars, wharves, etc....cubic feet..	1, 207	153	12, 295	2, 301
Hewn and sawed....do....	556, 969	34, 852	445, 804	54, 570
Squared or sided, not specially provided for.do....	117, 782	35, 947	14, 036	1, 392
Lumber—				
Boards, planks, deals, and other sawed lumber....M feet..	373, 373	4, 240, 145	482, 339	5, 588, 948
Sawed lumber, not otherwise specified....do....	325, 967	3, 576, 638	150, 184	1, 416, 331
Sawed boards, planks, deals—cedar, ebony, etc..	176	6, 602	222	5, 117
Clapboards....M..	5, 558	88, 254	6, 259	99, 187
Hubs, posts, laths, and other rough blocks	....	50, 828	....	29, 823
Laths....M..	293, 142	345, 602	259, 157	328, 359
Pickets and palings....M..	15, 856	66, 597	3, 157	22, 679
Cedar poles, posts, and railroad ties	450, 216	72, 535	2, 115, 986	259, 583
Shingles....M..	259, 897	553, 274	362, 551	731, 299
Shooks	....	107, 586	....	62, 981
Staves	....	438, 063	....	551, 575

Imports of wood and certain wood products for home consumption, etc.—Continued.

Articles.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
Dutiable—Continued.				
Manufactures, all other—				
Barrels or boxes containing oranges, lemons, etc., apart from contents	....	522,364	....	467,514
Casks and barrels, empty	....	1,545	....	919
Chair cane or reeds, manufactured	....	235,773	....	181,337
Cabinetware and household furniturd	....	453,041	....	411,712
Osier or willow, prepared for manufacture	....	93,207	....	82,633
Osier or willow, manufactures of	....	223,335	....	123,820
Wood pulp .... pounds	94,786,416	1,895,677	92,155,840	1,831,231
Veneers of wood	....	884	....	8,264
Bark extract, for tanning .... pounds	772,020	15,187	12,973	408
Sumac .... do	13,811,325	312,611	12,721,703	294,744
Corks and cork bark, manufactured	....	432,055	....	321,480
Matches	....	88,066	....	83,157
Frames and sticks for umbrellas	....	91,758	....	92,437
All other manufactures of wood or of which wood is the component of chief value	....	901,501	....	1,277,644
Total dutiable	....	14,897,696	....	14,364,100
Total imports	....	21,923,060	....	21,806,740

Exports of wood and certain wood products during the year ending June 30, 1892, by districts of country whence exported.

	Districts.*				
	I.	II.	III.	IV.	Total.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Raw materials:					
Boards, deals, planks, etc	3,089,115	2,220,327	2,962,732	1,400,319	9,672,493
Joists and scantling	16,953	157,136	43,739	10,685	228,513
Hoops and hoop poles	74,626	13,465	....	131	88,222
Laths	2,337	75	620	14,685	17,717
Palings and pickets	76	1,183	293	4,707	6,259
Shingles	5,841	39,671	13,171	29,309	87,992
Shooks	691,867	46,052	1,899	41,719	781,537
Staves	946,210	709,952	551,578	3,976	2,211,716
All other lumber	657,304	29,651	250,687	113,755	1,051,397
Timber (sawed)	37,235	259,653	1,844,333	531,933	2,673,154
Timber (hewn)	242,770	57,986	682,818	....	983,574
Logs and other round timber	875,371	740,502	268,985	38,746	1,923,604
Firewood	1,604	....	....	....	1,604
Rosin	652,777	2,755,811	8,123	1,748	3,418,459
Tar	38,534	12,078	226	1,679	52,417
Turpentine and pitch	15,965	2,217	38	116	18,336
Spirits of turpentine	445,249	4,050,533	429	4,510	4,500,721
Bark and bark extract	84,268	155,440	....	....	239,708
Total raw materials	7,878,102	11,251,732	6,621,671	2,198,018	27,957,423
Manufactures:					
Agricultural implements	3,682,784	19,042	65,753	27,404	3,794,983
Carriages and horse cars	1,799,344	550	73,954	70,322	1,944,170
Cars, passenger and freight	1,145,473	95,419	56,565	22,808	1,320,265
Matches	48,657	76	3,395	21,537	73,666
Organs	748,938	19,970	1,573	2,101	772,582
Doors, sash, and blinds	191,045	633	12,124	92,116	295,918
Moldings, trimmings, etc	169,623	14,592	1,423	16,951	202,589
Hogsheads and barrels, empty	281,533	326	5,162	3,092	290,113
Household furniture	2,751,111	48,114	112,261	178,660	3,090,146
Wooden ware	326,991	27,197	2,289	76	356,553
All other wood manufactures	1,551,013	134,626	54,647	87,182	1,827,470
Total manufactures	12,696,514	360,545	389,146	522,249	13,968,455
Total exports	20,569,217	11,612,277	7,010,817	2,720,267	41,925,878

* District No. 1 includes all of the United States north of Baltimore and east of the Rocky Mountains. District No. 2 includes the territory having its outlet by the South Atlantic ports. District No. 3 includes the territory adjacent to the Gulf ports. District No. 4 embraces that portion of the United States bordering on the Pacific Ocean.

Exports of wood and wood products from the United States for the twelve months ending June 30, 1891 and 1892.

Articles.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
Agricultural implements:				
Mowers and reapers		$1,579,976		$2,372,938
Plows and cultivators		596,728		397,735
All other, and parts of		1,042,426		1,024,310
Bark and extract of, for tanning		241,382		239,708
Carriages and horse cars, and parts of		2,015,870		1,944,170
Cars, passenger and freight, for steam railroads ....number..	3,902	2,885,250	1,680	1,320,265
Ginseng ....pounds..	283,000	959,992	228,916	803,529
Matches		73,220		73,666
Organs ....number..	14,498	954,507	11,856	772,582
Rosin ....barrels..	1,790,251	3,467,199	1,950,214	3,418,459
Tar ....barrels..	17,265	39,094	22,377	52,417
Turpentine and pitch ....barrels..	8,541	17,180	8,739	18,336
Turpentine, spirits of ....gallons..	12,243,621	4,668,140	13,176,470	4,500,721
Firewood ....cords..	2,061	7,026	423	1,604
Boards, deals, and planks ....M feet..	613,406	9,916,945	592,596	9,672,493
Joists and scantling ....M feet..	11,324	155,114	16,131	228,513
Hoops and hoop poles		60,502		88,222
Laths ....M..	7,976	20,799	7,893	17,717
Palings, pickets, and bed slats ....M..	1,352	13,479	640	6,259
Shingles ....M..	42,463	116,868	31,198	87,992
Shooks:				
Box		199,674		195,618
Other ....number..	316,242	450,492	412,308	585,919
Staves and headings		2,404,213		2,211,716
All other lumber		886,133		1,051,397
Timber:				
Sawed ....M feet..	214,612	2,549,411	235,550	2,673,154
Hewn ....cubic feet..	6,900,073	1,227,960	6,736,446	983,574
Logs and other timber		2,274,102		1,923,604
Doors, sash, and blinds		338,263		295,918
Moldings, trimmings, and other house finishings		140,670		202,589
Hogsheads and barrels, empty		240,430		290,113
Household furniture		2,956,114		3,090,146
Wooden ware		387,823		356,553
All other wood manufactures		1,924,022		1,827,470
Total		44,811,004		42,729,407

REPORT ON CHICKAMAUGA NATIONAL PARK.

During the year the chief of this division made an inspection of the Chickamauga National Park, and the following is the text of his report:

GENTLEMEN: Pursuant to your invitation, through the Hon. the Secretary of War, and under instructions of the Hon. the Secretary of Agriculture, I have made a cursory inspection of the woodlands which form the Chickamauga National Park, with a view to advising in regard to the most suitable manner of treating the same, and herewith submit to you in brief the result of my inspection and conclusions.

THE CONDITIONS.

The Chickamauga National Park lies on two geologic formations, which predicate a difference of soil. For the larger part it is situated on a limestone base known as the Chickamauga Limestone, the stratification of which is almost horizontal; a smaller part to the west lies on a dolomitic limestone, known as the Knox Dolomite, with a more inclined stratification. The residual soils resulting from these two formations differ in composition and physical conditions. The dolomite furnishes a more fertile and usually deeper soil of red clays mixed with cherty gravel, while the limestone proper disintegrates into a stiff blue clay, which usually does not reach great depth, and hence is less fertile, although here and there capable of a fine tilth and good crop results. Due to the varying depths of the soil on such formations and its physical conditions is a noticeable variation in the character and development of the timber growth.

A further difference may also be noted in the species composing the forest as well as their growth along the few water courses and gulches, where, in addition to greater depth and finer soil, water conditions are also more favorable.

The present condition of the timber growth in general—no attempt has been made to go into details—is not what it was at the time of the battle thirty years ago, and can only be understood by reference to the conditions then prevailing. Before the war these grounds were mostly pasture lands for large herds of cattle and horses; the timber growth was thinned out and the underbrush kept down, only some old timber giving the shade under which the grass thrives in the sunny South. The tramping and browsing of the stock, probably assisted by occasional burning over, kept the woodland in a park-like condition like the so-called oak openings.

The consequence of such treatment is a destruction of the natural vegetable mold, a compacting of the soil, a consequent more rapid dessication and final deterioration of the land, which shows itself in top dryness of the old timber and slow growth of any young timber that may spring up, until the mold has been reëstablished and the evaporation checked by a denser cover.

After the war, the stock-breeding industry being destroyed, an undergrowth started, making more or less rapid growth according to soil and light conditions regulated by the denser or thinner stand of the old timber. The old growth consists mainly of oaks, the black jack and post oak prevailing, with Spanish oak and red oak—the natives confound the two—in spots old loblolly and occasionally shortleaf pines are found scattered through the woods, and the former especially form a large proportion in the young growth which has sprung up in the oak openings. Along the water courses, ravines, and bottoms may be found; in addition, elms, water oaks, willow oaks, sweet gum, beech, maple, etc. While only here and there a few old hickories are found, in the young growth this timber represents quite a fair proportion, together with the oaks and pines.

The old timber for the most part is not of much value, except in a few localities. Much of it is top dry, or with tops broken off, the trunks diseased.

The blackjack, as is well known, is not useful, except for firewood and charcoal; the post oak would furnish at least good railroad timber and fence posts, and the few old pines would furnish fair lumber. Altogether, however, not much of value exists in the old timber, except for home consumption as needed.

The young growth is as thrifty as can be expected under the conditions—absence of a good humus cover and shade from the old timber—only on the thinner and drier portions is it stunted and of little promise. A growing prevalence of pine is noticeable in the young growth and abandoned fields are entirely occupied by this kind.

THE PROBLEM.

The objects of the park being primarily to restore and preserve as much as possible the conditions existing during the time of battle and to facilitate the study of topography and military operations, the consideration of the requirements of proper forest management becomes only secondary and subservient to the first object.

To be sure, the maintenance of natural conditions for a length of time can be only partially accomplished, nor would it be rational to attempt it beyond certain limits. Those who remember the field as it was exactly and to whom the exactitude of conditions is a natural matter of sentiment to be gratified, will have ceased to visit the ground within the next twenty-five or thirty years. After that, if only the relation of pasture, field, and forest can be maintained, it will suffice, albeit the character of the forest growth be changed and a better young growth shall have taken the place of the old and worthless, in character and condition worthy of the civilization we expect will then have been attained even in our woodlands.

The problem, then, may be formulated as follows: To gradually improve and regenerate the wood growth making the period of conversion not less than thirty years, preserving the most important strategic points of interest longest in original conditions as regards old growth and opening up the young growth, for the purpose of establishing vistas, as far as absolutely necessary and with a view of its ultimately taking the place of the original growth.

THE SOLUTION.

With the exception of a few places, where replanting is proposed in order to restore forest growth which has been cleared away since war times, the manipulations of the forester will have to be restricted to what may be called improvement cuttings. These should be made in the young growth with the following general principles in view:

(1) It is much easier to cut and destroy than to replace and restore; therefore all cutting should be done with caution and in a conservative manner. It is better to go twice and three times over the same ground with the ax than to thin severely at once, by which operation the soil is deteriorated and the tree growth further stunted, besides undesirable undergrowth is invited. Every consideration urges that the soil should be kept constantly and densely shaded.

(2) It is desirable to restrict and reduce the less valuable and encourage the more valuable kinds, especially the hickories and post oaks and to some extent the pines, which are soil improvers and will form a desirable mixture with the other two. The black jack, on the contrary, should be gradually eradicated; the red and Spanish oak only tolerated where the crown cover necessitates them.

(3) In determining which trees to cut and which to leave, besides the consideration of the species, it is necessary to observe the condition of the crown cover; the endeavor should be not to interrupt this to any great extent, for it is the shade which the interlocking dense leaf canopy exerts that insures improvement of soil conditions and at the same time tends to keep down undergrowth; this is desirable in order to keep the vistas open.

The workmen should therefore be trained to look up to the top and see whether the tree they are about to cut takes any prominent part in making shade. This is quite readily learned, and soon the axmen will themselves classify those trees that are already out of the race with their competing neighbors, being shaded out and of no value in maintaining shade, which may be removed without hesitation; those that form with their tops a part of the general leaf canopy, but not an important one, and which, if of an inferior kind, may also be removed, but if of the favored species and of promising growth may be left, and should be favored by the removal of their overcrowding neighbors, judgment being required in the selection; lastly, those trees which form the principal shade, which should be disturbed only for good reasons, such as misshapen growth, diseased condition, or conditions other than the forest management.

To regulate the cutting by either number of individuals or diameters fails of accomplishing its objects, and is hardly any more readily obtained from the unskilled workman than the judgment in making proper selection.

(4) Vistas are obstructed mainly by the number of stems; they may, therefore, in most cases be opened without disturbing the crown cover by the simple removal of the overgrown individuals. It should also be borne in mind that the near objects obstruct the view to a greater extent than those farther removed, hence along roads and paths the thinning out of the undergrowth may have to be done more severely than is desirable from forestry considerations, while farther in the operation may be more conservative.

(5) Where it is desired to keep the undergrowth down, the cutting is best done in June and July, when the stumps will be killed and sprouting prevented.

The old growth is for the most part an obstruction to the young growth, and would, if forest management were the only consideration, have to be removed wherever sufficient young growth is established to insure regeneration. As it is, its conservation being of historic import, at least for a time, the removal should be restricted to those trees that are positively unsightly and misshapen, and such leaning and spreading trees as are an undue hindrance to the young growth, especially if they are of the inferior kinds. On the portions of the field more remote from the centers of interest, the operations in the old growth might be carried on with greater consideration of improving forest conditions. A regular cutting for regeneration in such places as, for instance, Snodgrass Hill, is a matter of consideration for future years.

Wherever replanting of fields is contemplated, the simplest plan would be to gather hickory nuts and post-oak acorns and sow them in the fall in trenches; loblolly-pines will find their way into such a plantation naturally. Other plans may be suggested if desired.

I need not say anything regarding the necessity of keeping out fire and restricting the running of cattle, which latter compacts the soil undesirably. On the other hand, pigs in moderate numbers are not unwelcome cultivators, being frequently employed as such to open the ground and plant acorns and nuts in the oak and beech forests of Europe.

CONCLUSION.

In conclusion, I would suggest that the policy here outlined, although of a simple nature, can only be properly and successfully carried out by the employment of stable and skillful laborers, who would take an interest in the park and its twofold objects as here conceived and gradually develop into a corps of expert foresters. There is no better opportunity than on the park property to establish such a class from among the tenants of the various farms which constitute part of its area. Since the park is not intended primarily to be managed for revenue, it would be wise to select the tenants with such an object in view, and by low rents induce a desirable class of woodmen to settle on these farms and to devote themselves to the interests of the park and ultimately of rational forest management.

In this way a much-needed object lesson for our people of the manner in which our maltreated woodlands may be recuperated and put into better and more profitable condition could be inaugurated. This would be of even more value to our people than the preservation of war memories, however valuable their influence in educating proper patriotic spirit.

Respectfully submitted.

B. E. FERNOW,
Chief of Division of Forestry.

The COMMISSIONERS OF THE CHICKAMAUGA NATIONAL PARK.

ADDITIONS TO THE FOREST FLORA OF NORTH AMERICA AND NECESSARY CHANGES IN NOMENCLATURE OF IMPORTANT TIMBER SPECIES, WITH NOTES.

By GEORGE B. SUDWORTH, *Botanist of the Division.*

Magnolia fœtida (L.) Sargent, Gard. & For. ii. 615 (1889). MAGNOLIA (BULL BAY).
Syn. *M. Virginiana,* var. *fœtida,* Linn. Spec. Pl. 536 (1753).
M. grandiflora, Linn. op. cit. ed. 2, 755 (1762–'63).

Since *M. fœtida* has been taken up as the oldest specific name for this magnolia, there has been considerable protest against its maintenance. The greatest objection raised thus far, however, is that *fœtida* is inapplicable as a specific name to a sweet-scented species. But the practice of changing regularly published, although unfortunately misapplied, names to those thought to be more suitable in accordance with present knowledge of the species, is dangerous, and threatens stability by sanctioning changes too often dependent upon personal likes or dislikes rather than upon the strict law of priority. *M. fœtida,* founded on Linnæus' *M. Virginiana* var. *fœtida,* is sufficiently characterized to prevent confusion with any other known magnolia, and, as the oldest designation, should be maintained. The subsequent renaming, by Linnæus, to *M. grandiflora* was without authority, and an arbitrary right usurped by Linnæus, at the present time neither in accordance with existing law nor just usage. Once published, a name is common property and inviolable, even by its author.

Magnolia acuminata var. *cordata* (Michx.) Sargent, Am. Jour. Sc. 3d ser. xxxii. 473 (1886).
Syn. *M. cordata* Michx. Fl. Bor. Am. i. 328 (1803).

YELLOW-FLOWERED CUCUMBER TREE.

As existing in cultivation this form is comparatively distinct from *M. acuminata,* notably in the size and form of leaves, color and size of flowers; but as found growing wild it is far less distinct, only occasional variable forms being found differing from *M. acuminata,* and chiefly in its smaller and yellower flowers.

Magnolia tripetala Linn. Spec. Pl. ed. 2, 756 (1762–'63).
Syn. *M. Virginiana,* var. *tripetala* Linn. Spec. Pl. ed. 1, 536 (1753).
M. Umbrella Lam. Encyc. Meth. Bot. iii. 673 (1789).

UMBRELLA TREE.

The long-maintained *M. Umbrella* gives place to Linnæus' older name, *M. tripetala,* which is perfectly recognizable.

TILIACEÆ.

Tilia pubescens Ait. Hort. Kew. ii. 229 (1789).
Syn. *T. Americana,* var. *pubescens,* Loudon, Arb. 374 (1838).

DOWNY LINDEN.

The characters possessed by this plant are found to be sufficiently constant and distinct from those of *T. Americana* to warrant raising it to specific rank.

SAPINDACEÆ.

Æsculus octandra Marshall, Arbustum Am. 4 (1785).
Syn. *Æ. flava* Aiton Hort. Kew. i. 494 (1789).

YELLOW BUCKEYE.

Marshall's *Æ. octandra* belongs clearly to this plant, and, as the oldest, is now maintained in place of the better-known *Æ. flava*.

Var. *hybrida* (*DC.*) Sargent, Silva N. A. ii. 60 (1891).
Syn. *Æs. hybrida* DC. Hort. Monsp. 75 (1813).
Æs. flava, var. *purpurascens* Gray, Man. ed. 5, 118 (1867).

PURPLE-FLOWERED BUCKEYE.

The original specific name for this form is now maintained in varietal rank, in place of Dr. Gray's *purpurascens*, which seems to have been created without necessity.

Acer Saccharum Marshall, Arbustum Am. 4 (1785).
Syn. *A. saccharinum*, Wang., Nordam. Holz. 26, t. 11, f. 26 (1787), not Linn.
A. barbatum Mx., Fl. Bor. Am. ii. 253 (1803).

SUGAR MAPLE.

We concur with Dr. Britton, who has already taken up, in his Catalogue Plants New Jersey, Marshall's *A. Saccharum*, the oldest name for our sugar maple. Prof. Sargent considers it unsafe, but, aside from Marshall's unscientific description, we can see no reasonable doubt as to the identity of this name.

Var. *nigrum* (Michx. f.) Britton Trans. N. Y. Acad. Sci. ix. 9 (1889).

BLACK MAPLE.

Syn. *Acer nigrum* Mx. f. Hist. Arb. Am. ii. 238, t. 16 (1810).
A. saccharinum Wang., var. *nigrum* T. & G., Fl. N. Am. i, 248 (1838).
A. barbatum Michx., var. *nigrum* Sarg. Gard. & For. iv. 148 (1891).

Var. *Floridanum* (Chapm). FLORIDA MAPLE.
Syn. *Acer saccharinum* Wang., var. *Floridanum* Chapm., Fl. So. States, 81 (1865).
Var. *grandidentatum* (Nutt. MSS. in T. & G.). LARGE-TOOTHED MAPLE.

Syn. *Acer grandidentatum* Nutt. MSS. in T. & Gr., Fl. N. A. i. 247 (1838).
A. barbatum Mx., var. *grandidentatum* Sarg. Gard. & For. iv. 148 (1891.)

Prof. Sargent is followed in reducing *A. grandidentatum* to a variety of the sugar maple, as a careful study of the variable forms to be here referred thoroughly supports this decision.

Acer saccharinum Linn. Spec. Pl. ed. 1, 1055 (1753). SILVER MAPLE.
A. dasycarpum Ehrhart, Beitung. iv. 24 (1789).

There is no doubt as to the identity of the Linnæan name for this maple, and as the oldest, it is maintained in the place of the later *A. dasycarpum*.

Negundo Negundo (Linn.) Sudworth, Gard. & For. iv. 166 (1891). BOX-ELDER.
Syn. *Acer Negundo* Linn., Spec. Pl. ed. 1, 1056 (1753).
Negundo aceroides, Moench, Meth. 334 (1771).

Strict adherence to the law of priority makes it necessary to maintain this duplicate name, a usage already adopted by the zoölogists and by Prof. Sargent in the Silva. The latter author prefers, however, in the case of the box-elder to follow Linnæus in maintaining it in the genus Acer; it is thought, however, that the diœcious habit and compound leaves of these plants furnish abundant ground for keeping up the well-known genus Negundo.

Cladrastis lutea (Mx. f.) Koch, Dend. i. 6 (1869). YELLOW WOOD.
Syn. *Virgilia lutea* Mx. f., Hist. Arb. Am. iii. 266, t. 3 (1813).
C. tinctoria Raf., Neogen. 1. (1825).

There is no question as to the identity of Michaux's *V. lutea*, and Koch is here followed in maintaining the oldest specific name *lutea* under Cladrastis which was neglected by Rafinesque when he applied *C. tinctoria*.

Gymnocladus dioicus (Linn.) Koch, Dend. i. 5 (1869). KENTUCKY COFFEE TREE.
Syn. *Guilandina dioica* Linn. Spec Pl. ed. 1, 381 (1753).
Gymnocladus Canadensis Lam. Encyc. Meth. Bot. i. 773 (1783).

Linnæus' original specific name *dioica*, the oldest applied to this plant, is here maintained as proposed by Koch, who first combined it under Gymnocladus.

Galeditsia aquatica* Marshall, Arbust. Am. 54 (1785). WATER LOCUST.
Syn. *G. monosperma* Walter, Fl. Car. 254 (1788).

Marshall's name for this locust has been shown to be the oldest, and being well founded, should be maintained, as already taken up in Gray's New Manual and by Prof. Sargent in his Silva.

CORNACEAE.

Nyssa aquatica Linn. Spec. Pl. ed. 2, 1058 (1753). BLACK GUM.
Syn. *N. sylvatica* Marsh, Arb. Am. 97 (1785).

The establishment of Linnæus' original *N. aquatica*, the earliest name applied to the black gum, is somewhat difficult, in that it includes, by citation of Catesby's t. 60 (Nat. Hist. Carolina, 1731—), another distinct species, *N. uniflora*. But the first two characterizations, in order on the page, upon which Linnæus founds his *N. aquatica* (1st "*Nyssa folliis integerrimis*;" and 2nd "*Nyssa pedunculis multifloris*") may well apply to the black gum, and are sufficient to establish the name, since the first is cited from his own work (Hort. Cliff.). The convenient designation under this name, in varietal rank, of the tree commonly found growing in water at the South is scarcely to be recommended, since there are no good characters to separate the aquatic plant from the upland form, when the numerous connecting forms are carefully studied.

OLEACEÆ.

Fraxinus velutina Torr., Emory's Rep. 149 (1848). LEATHER-LEAVED ASH.
Syn. *F. pistaciæfolia* Torr. Pac. R. R. Rep. iv. 128 (1856).
F. coriaceæ Watson, Am. Nat. vii. 302, in part (1873).
F. pistaciæfolia, var. *coriacea*, Gr., Syn. Fl. N. A. ed. 1, ii. Pt. 1, 74 (1878).

The oldest name applied to a form of this ash is the *F. velutina* of Torrey. Dr. Gray (loc. cit.) considered this particular form a variety of the type of Torrey's *F. pistaciæfolia*, taking up Watson's *coriacea* for it, and citing Torrey's *F. velutina* as a synonym of the variety. But there seems to be no good reason why the older name (*velutina*) should not have been taken up as a name for the variety, which, if this relationship should be tenable, would give *F. pistaciæfolia*, var. *velutina* (Torr.). But from what is at present known of this plant, it seems advisable to maintain it as a species and to unite all the forms under Torrey's older name, *F. velutina*.

Fraxinus Pennsylvanica Marshall, Arb. Am. 51 (1785). RED ASH.
Syn. *F. pubescens* Lam. Encyc. Meth. Bot. ii. 548 (1786).

Koch (Dendrologie ii. 253) has taken up Marshall's name, the oldest applied to the species; and Dr. Gray (Syn. Fl. ii. 1, 75) cites it as a synonym of Lamarck's later *F. pubescens*, so that it appears to have been well acknowledged as an equivalent. Marshall's description of the fruit of this ash, one of the most important characters, is sufficiently definite to indicate that he had in hand our red ash, and it seems therefore advisable to restore his name.

Fraxinus expansa Willdenow, Berl. Baumz. 150 (1796). GREEN ASH.
Syn. *F. viridis* Michx. f. Hist. Arb. iii. 115, t. 10 (1813).

There appears to be no reason for not taking up Willdenow's *F. expansa* for this species, antedating, as it does, Michaux's *F. viridis* by seventeen years.

Fraxinus nigra Marshall, Arb. Am. 51 (1785). BLACK ASH.
Syn. *F. sambucifolia* Lamarck, Encyc. Meth. Bot. ii. 549 (1786).

Marshall's description of the black ash is unmistakable, and as his *F. nigra* was published one year earlier than Lamarck's *F. sambucifolia*, it should replace the latter.

BIGNONIACEÆ.

Catalpa Catalpa (Linn.) Sudworth, Gard. & For. iv. 166 (1891). COMMON CATALPA.
Syn. *Bignonia catalpa* Linn. Spec. Pl. ed. 1. 622 (1753).
C. bignonioides Walter, Fl. Car. 64 (1788).

Strict adherence to the law of priority demands that Linnæus' original specific name *Catalpa* be taken up under the genus Catalpa.

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*Linnæus' uniform spelling of this genus is adopted in preference to the later modification by authors to *Gleditschia* (in honor of Dr. Gleditsch), which is without warrant.

URTICACEÆ.

Ulmus pubescens Walter, Fl. Car. 111 (1788). SLIPPERY ELM.
Syn. *U. fulva* Michx., Fl. Bor. Am. i. 172 (1803).

There is no doubt that Walter's *U. pubescens* refers to our slippery elm, and as the oldest name applied to it should replace the much later *U. fulva* of Michaux.

Ioxylon Rafinesque (1817) = *Maclura* Nuttall (1818).

Ioxylon pomiferum Raf., Am. Month. Mag. ii. 118 (1817). OSAGE ORANGE.
Syn. *Maclura aurantiaca* Nutt., Gen. ii. 234 (1818).

Prof. Greene (Pittonia ii. 120, 1890) has pointed out that Rafinesque's genus Ioxylon is one year older than Nuttall's Maclura and proposes that Rafinesque's name, *I. pomiferum*, should replace the better known *M. aurantiaca* of later date.

Hicoria Rafinesque (1817) = *Carya* Nuttall (1818).

Dr. Britton (Bull. Torr. Bot. Cl. xv. 277, 1888) calls attention to the fact that Rafinesque's Hicoria (his "Scoria," 1808, being supposed to be a misprint for Hicoria) should replace Nuttall's later genus Carya, and has transferred, under their oldest specific names, all the known species to this genus. Dr. Otto Kuntze, ignoring or overlooking Dr. Britton's elaboration, has likewise proposed (Rev. Gen. Pl. ii. 637, 1891) Rafinesque's original spelling, Scoria. There is abundant evidence to show, however, that Rafinesque by later references to his genus did not intend to write Scoria, but Hicoria.

Hicoria Pecan (Marsh.) Britton, op. cit. 282 (1888). PECAN.
Syn. *Juglans Pecan* Marshall, Arb. Am. 69 (1785).
Carya olivæformis Nutt., Gen. ii, 221 (1818).

Hicoria ovata (Miller) Britton, op. cit., 283 (1888). SHAG-BARK HICKORY.
Syn. *Juglans ovata* Mill. Gard. Dic. ed. 8, No. 6 (1768).
C. alba Nutt., Gen. loc. cit. (1818).

Hicoria sulcata (Willd.) Britton, loc. cit. (1888). SHELL-BARK HICKORY.
Syn. *Juglans sulcata* Willdenow, Berl. Baumz., 154, t. 7 (1796).
C. sulcata Nutt., loc. cit. (1818).

Hicoria alba (Linn.) Britton, loc. cit. (1888). MOCKER NUT.
Syn. *Juglans alba* Linn., Spec. Pl. 997 (1753).
C. tomentosa Nutt., loc. cit. (1818).

Hicoria glabra (Mill.) Britton, op. cit., 284 (1888). PIG NUT.
Syn. *Juglans glabra* Miller, Gard. Dic. ed. 8, No. 5 (1768).
C. porcina Nutt., op. cit., 222 (1818).
Scoria glabra O. Kuntze, Rev. Gen. Pl. ii, 638 (1891.)

Hicoria minima (Marsh.) Britton, loc. cit. (1888). BITTER NUT.
Syn. *Juglans alba minima* Marshall, Arb. Am., 68 (1785).
C. amara Nutt., loc. cit. (1818).

Hicoria myristicæformis (Michx. f.) Britton, loc. cit. (1888). NUTMEG HICKORY.
Syn. *Juglans myristicæformis* Mchx. f. Hist. Arb. Am. i, 211, t. 10 (1810).
C. myristicæformis Nutt., loc. cit. (1818).

Hicoria aquatica (Michx. f.) Britton, loc. cit. (1888). WATER HICKORY.
Syn. *Juglans aquatica* Michx. f., op. cit. 182, t. 5 (1810).
C. aquatica Nutt. loc. cit. (1818).

CUPULIFERÆ.

Quercus minor (Marsh.) Sargent, Gard. & For. ii, 471 (1889). POST OAK.
Syn. *Quercus alba minor* Marshall, Arb. Am. 120 (1785).
Quercus obtusiloba Michx., Hist. Ch. Am. No. 1, t. 1 (1801).

There is no doubt as to the identity of Marshall's *Q. alba minor*, and Prof. Sargent has taken up (loc. cit.) this varietal term *minor*, the oldest name for this oak, in place of the later *Q. stellata* and *obtusiloba*.

Quercus platanoides (Lam.). SWAMP WHITE OAK.
Syn. *Q. Prinus platanoides* Lamarck, Encyc. Meth. Bot. i, 720 (1783).
Q. bicolor Willd. in Neue Schrift. Gesell. Nat. Fr. Berl. iii, 396 (1801).

There seems to be little reason for longer neglecting Lamarck's name for this species, as his description (loc. cit.) points unmistakably to it, and being much older than Willdenow's *Q. bicolor*, it should replace the latter. Lamarck's name has reference to the supposed similarity in the exfoliation of the bark of this oak to that of the plane tree.

Quercus Virginiana Miller, Gard. Dic. ed. 8, No. 17 (1768). LIVE OAK.
Syn. *Q. virens* Aiton, Hort. Kew. iii. 356 (1789).

Prof. Sargent has already proposed to take up Miller's name as the oldest for the live oak, and being perfectly identifiable with that species, it should properly replace Aiton's later *Q. virens*.

Quercus velutina Lamarck, Encyc. Meth. Bot. i. 721 (1783). YELLOW OAK.
Syn. *Q. discolor* Aiton, Hort. Kew. iii. 358 (1789).
Q. tinctoria Bartram, Travels, 37 (1791).

It has been shown (Gard. & For. v. 98) that Bartram's *Q. tinctoria* is doubtfully tenable as it is not founded on a description, and no distinctive characters of the species are to be found in Bartram's remarks. The *Q. discolor* of Aiton is, moreover, an older name, and should have had precedence over *Q. tinctoria*; but as there can be no reasonable doubt of the identity of Lamarck's *Q. velutina*, the oldest name applied to the black oak, it has been taken up.

Quercus digitata (Marshall) Sudworth, Gard. & For. v. 98 (1892). SPANISH OAK.
Syn. *Q. nigra digitata* Marsh. Arb. Am. 121 (1785).
Q. cuneata Wang., Am. 78, t. 5. f. 14 (1787).
Q. falcata Michx. Hist. Chen. Am. No. 16, t. 28 (1801).

Marshall (loc. cit.) without doubt describes, under his *Q. nigra digitata*, our "Spanish oak," and being the oldest name for the species, it has been taken up in place of the later *Q. cuneata* and *Q. falcata*.

Castanea dentata (Marshall) Sudworth, Bull. Torr. Bot. Club xix. 152 (1892).
Syn. *Fagus Castanea dentata* Marsh., Arb. Am. 46 (1785).
C. vesca, var. *Americana* Michx. Fl. Bor. Am. ii. 193 (1810).

CHESTNUT.

It has been shown that Marshall's name for this species is the first applied to the American chestnut, and being perfectly identifiable, should be maintained.

Fagus atropunicea (Marsh.) Sudworth, Bull. Torr. Bot. Club. xx, 43 (1893). BEECH.
Syn. *F. sylvatica atropunicea* Marsh. Arb. Am. 46 (1785).
F. ferruginea Aiton, Hort. Kew. iii. 362 (1789.)

It has also been pointed out that Marshall's name for the American beech is the oldest one recorded, and should, therefore, be maintained in place of Aiton's much later *F. ferruginea*.

CONIFERÆ.

Thuya plicata Lambert, Pinus ed. 1, ii. 19 (1824). PACIFIC ARBOR-VITÆ.
Syn. *T. gigantea* Nuttall, Journ. Phil. Acad. vii. 52 (1834).

Lambert's name for this species is ten years older than Nuttall's, and should, therefore, replace the latter's *T. gigantea*.

Chamæcyparis thyoides (Linn.) B. S. P., in Britton Cat. Pl. N. J. 299 (1889).

Syn. *Cupressus thyoides* Linn., Spec. Pl. ed. 1, 1003 (1753).
Chamæcyparis sphæroidea Spach, Hist. Veg. xi. 331 (1842).

WHITE CEDAR.

Dr. Britton (loc. cit.) has very properly restored to this plant its oldest specific name, which was applied by Linnæus in 1753, and should be maintained in place of the later *Ch. sphæroidea*.

Pinus radiata Don, in Trans. Linn. Soc. xvii. 442 (1837). MONTEREY PINE.
? *P. Californiana* Loiseleur, in Nouv. Duham. v. 243 (1812).
? *P. adunca* Bosc, in Poiret suppl. Lam. Enc. Meth. Bot. iv. 418 (1816).
P. tuberculata Don, loc. cit. post *P. radiata* (1837), not Gordon (1849).
P insignis Loudon, Arboretum iv. 2265, f. 2170–2172 (1838).

Prof. J. G. Lemmon has called attention (Gard. & For. v. 64, 1892) to the fact that the Monterey pine does not bear its oldest name, and proposes to take up for it Loiseleur's *P. Californiana* (1812); but as Prof. Sargent remarks, in a note to Prof. Lemmon's revision (loc. cit.), there is much uncertainty as to the actual identity of this name. He therefore advises that this, and *P. adunca*, the next oldest name suspected to be long here, should be passed over, and that the *P. tuberculata* of Don (1837) be taken up. There appears, however, to be no good reason for passing over Don's *P. radiata*, which certainly applies to no other than the Monterey pine, and occurs before *P. tuberculata* on the same page with it.

Pinus attenuata Lemmon, Mining & Scientif. Press, Jan. 16; Gard. & For. v. 65 (1892).
Syn. *P. Californica* Hartweg, in Journ. Hort. Soc. Lond. ii. 189 (1847), not *P. Californiana* Loisel. (1812).
P. tuberculata Gordon, Journ. Hort. Soc. Lond. iv. 218, f. (1849), not Don (1837).

KNOB-CONE PINE.

Prof. Lemmon points out (loc. cit.) that the preoccupation of *P. tuberculata* for the Monterey pine leaves the Knob-cone pine without a name. He proposes to call it *P. attenuata*, in allusion to the tapering cones.

Pinus Virginiana Miller, Gard. Dic. ed. 8, No. 9 (1768). SCRUB PINE.
Syn. *P. inops* Aiton Hort. Kew. iii. 367 (1789).

Dr. Britton (Cat. Pl. N. J. 300, 1889) has already taken up Miller's name for this pine, and being the oldest on record, it properly replaces Aiton's later *P. inops*.

Pinus echinata Miller, Gard. Dic. ed. 8, No. 12 (1768). SHORT-LEAF PINE.
Syn. *P. mitis* Michx. Fl. Bor. Am. ii. 204 (1803).

Dr. Britton (loc. cit.) has also restored to this pine its oldest specific name *Pinus echinata*.

Pinus latifolia Sargent, Gard. & For. ii. 496, f. 135 (1889). BROAD-LEAVED PINE.

Prof. Henry Mayr, of the University of Japan, detected this new species first in 1887, on the southern slopes of the San Rita Mountains, southern Arizona. It is somewhat similar to *P. ponderosa*, but differs in having longer and broader leaves, and by the long, round umbo of the cone scales. Since Dr. Mayr's discovery of this species, it has also been collected (July, 1892) at Fort Huachuca, at an altitude of 6,000 feet, and sent to the National Herbarium for identification, by Mr. J. E. Wilcox. It is said to be a tree of about 60 feet in height.

Pinus divaricata (Aiton) Sudworth, Bull. Torr. Bot. Club xx. 44 (1893). JACK PINE.
Syn. *P. sylvestris*, var. *divaricata* Aiton, Hort. Kew. iii. 366 (1789).
P. Banksiana Lambert, Pinus ed. 1, 7, t. 3 (1803).

It has been pointed out that Aiton's "var. *divaricata*" is the oldest designation for this pine, and being perfectly identifiable with the jack pine, it has been proposed as a specific name, in place of Lambert's later *Banksiana*.

Since the publication (1884) of the Census Catalogue of Forest Trees, the geographical distribution of the jack pine has been found to extend farther southward in Maine, to Frenchmans Bay, on the eastern side, Lat. 44° 20′ (E. L. Rand, in Bull. Torr. Bot. Club xvi. 294, 1889).

Pinus heterophylla (Elliott) Sudworth, in Bull. Torr. Bot. Club xx. 45 (1893)
Syn. *P. Tæda*, var. *heterophylla* Ell., Sk. ii, 636 (1824).
P. Cubensis Griseb., Mem. Am. Acad. viii. Pt. 2, 530 (1863).
P. Elliottii Engelm., Trans. St. Louis Acad. iv. 186, t. 1, 2, 3 (1879).

CUBAN PINE.

Elliott's variety *heterophylla* is the oldest name applied to this southern lumber pine, and now that the insular (*P. Cubensis*) and mainland forms are known to belong to one species, it is proposed to unite them under the oldest name, *P. heterophylla*.

Picea Mariana (Miller) B. S. P., in Britton Cat. Pl. N. J. 310 (1889). BLACK SPRUCE.
Syn. *Abies Mariana* Miller, Gard. Dict. ed. 8, No. 2 (1768).
Picea nigra Link, Linnæa xv. 520 (1841).

We follow Dr. Britton in maintaining Miller's specific name *Mariana*, the oldest for this species, in place of Aiton's later *nigra*.

Picea Canadensis (Miller) Britton, Prelim. Cat. Pl. N. Y. 71 (1888). WHITE SPRUCE.
Syn. *Abies Canadensis* Miller, Gard, Dic. ed. 8, No. 8 (1768).
Pinus alba Aiton, Hort. Kew. iii. 371 (1789).
Picea alba Link, Linnæa xv. 519 (1841).

The oldest specific name for this spruce is Miller's *Canadensis*, taken up by Dr. Britton in 1888, in place of the later *alba* of Aiton.

Picea Breweriana Watson, Proc. Am. Acad. Sci. xx. 378 (1885). BREWER'S SPRUCE.

This spruce was discovered by Mr. Thomas Howell in June, 1884, on the Siskiyou Mountains, northern California. Lately (Gard. & For. v. 592) Mr. T. S. Douglas reports it from the summit of the coast range in Oregon, on the divide between Canyon Creek and Fiddler's Gulch. It is a very distinct species, and readily distinguished from other spruces by its long drooping branches.

Pseudotsuga taxifolia (Lamb.) Britton, Trans. N. Y. Acad. Sci. viii. 74 (1889).
Syn. *Pinus taxifolia* Lambert, Pinus ed. 1, i. 51, t. 33 (1803).
Abies Douglasii Lindley, Penny Cycl. i. 32 (1833).
Pseud. Douglasii Carrière, Trait. Conif. ed. 2, 256 (1867).

DOUGLAS SPRUCE.

Lambert's specific name for the Douglas fir is here maintained as already taken up by Dr. Britton (loc. cit.).

Pseudotsuga macrocarpa (Torrey) Lemmon, in 3d Bienn. Rep. Cal. B'd For. 134 (1890).
Syn. *Abies Douglasii*, var. *macrocarpa* Torr., in Ives's Rep. 28 (1861).
Abies macrocarpa Vasey, in Gard. Month. 22 (1876).
Pseudotsuga Douglasii, var. *macrocarpa* Engelm., in Bot. Cal. ii. 120 (1880).

BIG-CONE DOUGLAS SPRUCE.

There appears to be good reason, as pointed out by Prof. Lemmon (loc. cit.), for maintaining this as a distinct species, although considered by Dr. Engelmann to be only a variety of the Douglas fir. It differs from the Douglas fir in minor points, but chiefly, it seems, in the constant, larger-sized cones and seeds, and is usually a smaller tree.

Larix larcina (Du Roi) Koch, Dendrologie ii. Pt. 2, 263 (1873). TAMARACK.
Syn. *Pinus larcina* Du Roi, Obs. Bot. 49 (1771).
Larix Americana Michx.. Fl. Bor. Am. ii. 203 (1803).

Koch's restoration of Du Roi's original specific name *larcina* for this species is here followed, as there is no doubt as to the identity of Du Roi's *Pinus larcina* with our Larch. Dr. Britton (Cat. N. J. Pl. 302, 1889) took up *larcina*, but seems to have overlooked the fact that it had already been restored by Koch, as the combination is accredited to "Britton Sterns & Poggenburg."

THE NAVAL STORE INDUSTRY.

The most important economic result of the work of the Division of Forestry during the year is the establishment, beyond doubt, that the bleeding of the Southern pines for the purpose of gathering naval stores does not, as has been generally maintained, affect the quality of their timber. Even the claim that tapped or bled trees lose their durability does not find any support in the chemical analyses made, which seem to prove that there is no change in the condition or chemical constitution of the heartwood due to bleeding; that the turpentine collected must come from the sap, where alone it is found in a condition permitting it to flow. Nor is there any physiological reason for assuming any change.

Hence it can be stated with absolute assurance that the prejudice entertained by architects and builders against bled timber is without basis, as determined by tests and analysis, and, as may be gathered from the report of Mr. Roth, cited further on, not even warranted by practical experience. We may, then, consign to the rubbish heap of baseless theory this belief, which has caused much annoyance to the Southern lumber trade and considerable loss in money and valuable material.

But while there is no deterioration of the timber due to the process of bleeding, it can be said with truth that there is no more destructive agency at work in the longleaf pineries of the South than the turpentine industry, and that without necessity. The damage and destruction do not result directly, although by the boxing of immature trees a considerable loss to the future is involved, and by the crude boxing much of the most valuable part of the tree is needlessly wasted; but often indirectly from fires, which annually sweep the turpentine orchards and destroy millions of feet of valuable timber, the resin collected on the scars of the trees rendering them highly inflammable. The trees which are not killed by the fire are soon destroyed by bark-beetles and pine-borers, which find a breeding place in the trees, which, after the injury by fire, are blown down by the wind. "Hence," says Dr. Mohr, "the forests invaded by the turpentine industry present in five or six years after they are abandoned a picture of ruin and desolation painful to behold, and in view of the destruction of the seedlings and younger growth season after season all hope for the restoration of the forest is excluded."

It appears from the report of Dr. Mohr, agent of this division, that over 2,000,000 acres of pine forest which were in orchard in 1890 must have been exposed to this danger, and that every year adds between 500,000 and 600,000 acres of new orchard.

It seemed, therefore, desirable to study the turpentine industry in its conditions and methods with a view of suggesting improvements. The results of this study, based upon reports of special agents and the literature on the subject, follow.

TURPENTINE ORCHARDING.

The most important industry in the United States concerned in the utilization of by-products from the forest is the tanbark industry, and next to it the turpentine or naval store industry, which is practically confined to the pineries of the Southern States within a belt of about 100 miles in width along the Atlantic and Gulf coasts from North Carolina to Louisiana.

The importance of this latter industry is found not only in the value of its products, namely, nearly $10,000,000 worth per year, furnishing the bulk of the naval stores used in all the world, but also in the indirect influence which this industry exerts on the condition and future of one of our richest forest resources.

Owing to the wasteful and careless manner in which this industry is carried on and the disastrous conflagrations that follow in its train, which destroy thousands of acres of the most valuable timber every year, while the margin of profit to the turpentine gatherer is comparatively small, this industry may be considered the most unprofitable to the nation at large in spite of the large aggregate value of its products. This is not so by necessity, but due to faulty methods. The object of this discussion is to create a more general interest in the industry, give information regarding its methods, show its defects, and pave the way toward improvement and more rational procedure.

PRODUCTS OF THE TURPENTINE INDUSTRY.

Naval stores.—Under the name of naval stores are comprised all the resinous products and their derivatives that are gathered from coniferous trees. The name comes probably from the fact that the bulk of these products is or was used in the economy of ship construction and ship management, although now, with iron as a substitute for wood in shipbuilding, other industries may consume perhaps a larger portion. These products are:

(1) *Resin or crude turpentine.*—This is the crude material obtained by "tapping" or "bleeding" the trees, a mixture of resinous material and oil of turpentine, in

which the resins are partly dissolved, partly suspended. According to the species from which it is obtained, the consistency of the resin varies, depending upon the relative proportion of hard resin particles and oil: the more oil, the more liquid is the resin.

The "fine" turpentine or resin, which comes from larch and fir or balsam trees, is semiliquid, more or less transparent and clear, and remains clear on exposure to the air. The "common" turpentine, which is furnished by the other trees tapped for it, is usually not at all transparent or clear, but is semiliquid or hard, the fluidity being lost by evaporation of the oil on exposure.

Most resins are yellow or brown in color, darkening on exposure; most of them possess a characteristic odor and taste; they have a specific weight of nearly 1, and when hard melt readily at low temperatures. They are not soluble in water, but readily so in alcohol, ether, or oil of turpentine; they are free from nitrogen, poor in oxygen, and rich in carbon, and of somewhat acid reaction. With alkalies the so-called resin soap is formed.

The best grades of turpentine are usually obtained (not necessarily so) in the product of the first year, known as "virgin dip" or "soft white gum;" in the following years it becomes "yellow dip," being darker colored and less liquid every year, while "scrape" or "hard turpentine" is the product hardened on the tree and scraped off. By distillation of the cruded resin are obtained the important resinous products of trade.

(2) *Spirits of turpentine or oil of turpentine.*—This is the liquid distillate from the crude resin. When pure it is a mixture of hydro-carbons of the formula $C_{10}H_{16}$; but the impure product from the still contains also other hydro-carbons and acids. To rectify it, it is mixed with limewater and again distilled; yet, according to the source from which derived, the oil of turpentine possesses different qualities. Freshly prepared oil of turpentine, especially that from virgin trees worked for the first time, is colorless, tasteless, a thin fluid, of peculiar smell, of low specific weight (0.855–0.875), and its boiling point at 300–340° F. Most of the oils of turpentine of the trade polarize light to the left, but the American oil polarizes it to the right, and may thereby be recognized.

The oil evaporates very readily in ordinary temperature, and by oxidation thickens until hard, becomes yellow, and shows sour reaction. It burns with a strongly sooty flame; it is insoluble in water, but soluble in alcohol. It is a good solvent for many resins, wax, fats, caoutchouc, sulphur, and phosphorus. In the arts it is used mainly for the preparation of varnishes, in paints, and in the rubber industry. It is also used for illuminating purposes as pine oil, or mixed with alcohol as camphene, and under other names. It has a wide use in medicine internally and externally. It is often used in the adulteration or imitation of various essential oils.

(3) *Rosin or colophony.*—This is the residue remaining from the distillation of the crude turpentine or resin. According to the nature of the crude turpentine, which depends on the number of seasons the tree has been worked, it shows different properties. It is either perfectly transparent, translucent, or almost opaque; in color, from pale yellow, golden or reddish yellow, through all shades to deep dark brown, almost black; and of different degrees of hardness; some soft enough to take the impression of a finger nail, and some so hard that only iron will make an impression.

The hard colophony or rosin is almost without smell or taste, of glassy gloss, very brittle, easily powdered. It becomes soft at about 176° F. and melts between 194° and 212° F. It is soluble in the same solvents as the crude resin; its specific weight is 1.07. Rosin is used in the manufacture of varnish, sealing-wax, putty, soap, paper, etc.

In the American market the following grades are distinguished: W G—window glass; WW—water white, the lightest colored grade, obtained from virgin dippings and under special care at the distillery; N—extra pale; M—pale; K—low pale; I—good No. 1; H—No. 1; F—good No. 2; E—No. 2; D—good strain; C—strain; B—common strain; A—black.

By dry distillation of the rosin are obtained the following three products:

(*a*) Light rosin oil, which is used in the fabrication of varnishes.

(*b*) Heavy rosin oil, which is used in the manufacture of printers' ink, machine oil, axle grease, etc.

These oils, known in commerce as pale oil, pine oil, ink oil, etc., are of a light reddish or brown color, more or less fluorescent, with a specific gravity of 0.98 to 1; of slight odor but characteristic taste. The distillation is carried on at a dull, red heat, yielding about 85 per cent of rosin oil. They are composed of a mixture of several hydrocarbons of indefinite nature (colophene, heptin, etc.), and contain from 0 to over 15 per cent of resinous acids. They are insoluble in water, slightly so in alcohol, can not be saponified, but form unstable compounds with slaked lime and other bases. The rosin grease made by stirring slaked lime finely suspended in water is an excellent lubricant, adapted especially for metal bearings in machinery and wagons. Mixed with sweet oil, rape oil, or the denser mineral oils, it is used for the preparation of lubricating oils. These oils are also used in the manufacture of varnish, in the preparation of cheap paints used to cover metal, roofs, etc.

(c) *Common pitch.*—This is the residue from the dry distillation of rosin; a glossy, black, brittle body, which is used in the manufacture of the common ship-chandlers' pitch, used for calking of vessels, shoemakers' pitch, and black pigments. Pitch is also obtained by boiling tar down until it has lost about one-third or more of its weight. The navy pitch of commerce has more or less rosin of lowest grades added to it. It commands a price of about $1.50 per barrel.

(4) *Brewers' pitch.*—This is used for pitching beer kegs and barrels, and is obtained when the distillation of the crude turpentine is stopped, before all the oil has been distilled. It therefore contains a certain quantity of oil of turpentine; if too much, the pitch foams when melted and imparts a disagreeable, sharp taste to the beer, while with too little oil the pitch becomes brittle and does not adhere to the barrel. The best quality of this product is obtained from the larch, and is produced mostly in Tyrol, but there is quite an amount of brewers' pitch made in the Southern pineries.

(5) *Tar.*—This is not exactly a by-product of the turpentine orchard, but is mostly a product of destructive distillation of the wood itself. Most of the tar in the United States is made in North Carolina, where the industry has been largely carried on from earliest colonial times. In other parts of the Southern coast pine-belt it is only produced for home consumption. Perfectly dry wood of the longleaf pine—dead limbs and trunks perfectly seasoned on the stump, from which the sapwood has rotted—are cut into suitable billets, piled into a conical stack in a circular pit lined with clay, the center communicating by a depressed channel with a receptacle—a hole in the ground—at a distance of 3 or 4 feet from the pile. The pile is covered with sod and earth, and otherwise treated and managed like a charcoal pit, being fired from apertures at the base, giving only enough draft to maintain slow smoldering combustion. After the ninth or tenth day the flow of tar begins, and continues for several weeks. It is dipped from the pit into barrels of 320 pounds net, standard weight, mostly made by the tar-burner himself from the same pine. From one cord of dry "fat" wood or "lightwood" from 40 to 50 gallons of tar are obtained.

There is but little profit in the business, except that it employs labor in remote districts at a season (winter) when there is but little else to do. The price of tar, at present quoted as low as $1.05 per barrel at Wilmington, N. C., has been depressed, especially since considerable quantities of tar are produced incidentally in the destructive distillation of wood in iron retorts for charcoal purposes.

(6) *Oil of tar.*—This is obtained by distillation of the tar. It is a complex mixture of hydrocarbons with some wood alcohol and a small quantity of creosote, often more or less covered by empyreumatic substances, with a density of .841 to .877. It is used as an insecticide and for various external applications in domestic and veterinary practice.

SOURCES OF SUPPLY.

Naval stores are being produced on a commercial scale mainly in Austria, France, on the island of Corsica, in Spain, Portugal, Galicia, Russia, and the United States. The largest amount of European turpentine comes from the black pine (*Pinus laricio*) and the maritime pine (*Pinus maritima*). The first of the two, which yields the largest amount, is tapped especially in Lower Austria, France, and Corsica. The latter, which does not furnish much resin, is tapped especially in France, between Bayonne and Bordeaux, where about one and a half million acres are covered with it; also in Spain, Portugal, and on the North African coast. In Germany, especially in the Black Forest, the Norway spruce is tapped, but not to any great extent. In Southern Italy and the Italian Alps the larch furnishes resin of excellent quality, although small quantities per tree and year, which is known in trade as Venetian turpentine. Occasionally, and especially in Galicia, Russia, the Scotch pine and fir are tapped; the turpentine from the latter species which is bled in Alsace is known as "Strasburg" turpentine. The Hungarian turpentine, so called, comes from the Carpathian Mountains and is derived from the pine known as *Pinus pumilia.*

In the United States a considerable amount of naval stores used to be collected in colonial times from the pitch pine of the North Atlantic States (*Pinus rigida*); but this species has been so far exhausted and forest conditions so changed that this industry is now practically extinct in the North and the business of turpentine gathering is confined entirely to the South. There are three pines in the South which yield resinous products abundantly, the longleaf pine (*Pinus palustris*), the loblolly (*Pinus tæda*), and the Cuban pine (*Pinus cubensis*). The botanical features, their distribution, value as timber trees, etc., may be found in the report from the Division of Forestry for the year 1891.

The loblolly and Cuban pine yield a more fluid resin, rich in volatile oil, which when distilled leaves a smaller proportion of the solid rosin. The resin of these trees runs so rapidly that it is exhausted during the first season, and hence it is not considered profitable to work them, although they are always tapped where they are found intermixed with the longleaf pine. It is, however, possible, nay probable, that with more careful methods, differing from those now employed, these two species may be made more productive and that the compact forests of the loblolly in Arkansas, Louisiana, and Texas may still become valuable sources of naval stores as well as the Cuban pine forests of Florida.

At present the longleaf pine furnishes the bulk of naval stores, not only for the United States, but for the whole world, the production of France and Austria, the only other producers of naval stores, furnishing hardly one-tenth of the total production.

HISTORICAL NOTES AND STATISTICS.

The first production of naval stores from longleaf pine took place in North Carolina. The tapping of the trees for their resin and the production of pitch and tar was resorted to by the earliest settlers as a source of income, and during the later colonial times it had risen to a profitable industry, which furnished the largest part of the exports of the colony. In the three years—1768 to 1770—88,111 barrels of crude turpentine, 20,646 barrels of pitch, and 88,366 barrels of tar were on the average annually exported to the mother country, representing a value of $215,000 in our present currency. In its infancy the manufacture of naval stores was confined to the district between Tar and Cape Fear rivers, with Wilmington and Newberne for shipping ports. Most of the turpentine or crude resin was shipped to England. Later the distillation of spirits of turpentine was carried on to a small extent in Northern cities as well as in North Carolina. Up to the year 1844 fully one-half of the crude product was subjected to distillation in the latter State, the process being effected in clumsy iron retorts; the introduction of the copper still in 1834 led to a largely increased yield of volatile oil, and this industry received a strong impetus. The number of stills at the ports was increased, and the production grew yet further shortly afterward, caused by the new demand for spirits of turpentine in the manufacture of India-rubber goods, and turpentine orcharding was rapidly extended to the south and west of its original limit. As early as 1832 rectified spirits of turpentine was used for an illuminator, and for that purpose came into general use in 1842, either alone in the rectified state or mixed with a certain quantity of strong alcohol, under the names of camphene and burning fluid, furnishing the cheapest light until replaced by the products of petroleum. The large consumption of spirits of turpentine in this way caused such an increase in its production that the residuary product, rosin, was largely in excess of the demand, leading to a great depreciation of this article. The consequent reduction of the profits of the business caused the transfer of the still from the place of shipment to the source of the raw material—the forest. From that time (1844) dates the great progress made in the expansion of this industry to the virgin forests farther south, and the turpentine stills increased rapidly in number in South Carolina, Georgia, Florida, and the eastern Gulf States.

During the war of secession, when the production in the South was stopped, the turpentine industry of France received an impetus and that country supplied as best she could the deficiency. Prices went up to five or six times their former range, namely, $25 to $30 per 100 pounds for spirits, and $9 to $10 for pale yellow grades of rosin, $4 to $5 for inferior grades. These prices instigated improvement of methods, such as the Hugues system, described further on, and more careful treatment of the crop.

With the close of the war the industry revived in the United States, though the demand for turpentine was not as great as formerly, petroleum products of various kinds having been found to take the place of the product of the pine for many purposes. With the general extension of arts and manufactures, however, both in this country and abroad, and new application of the products, there has been an increasing demand both for spirits of turpentine and resin, the exports of these alone in the year 1891 being $8,135,339 in value.

The following table of exports of naval stores has been compiled with great care by Charles Mohr from the reports of the boards of trade, the press reports published in the several ports of export, and partly from private information. The amounts given are not claimed to comprise the total annual production, but will fairly represent the bulk of production in each year for the ten or twelve years included.

Table of exports of naval stores from the markets of principal centers of production during the period 1880 to 1890.

Year.	North Carolina (Wilmington).		South Carolina (Charleston).		Georgia (Savannah).		Alabama (Mobile).	
	Spirits turpentine.	Resin.	Spirits turpentine.	Resin.	Spirits turpentine.	Resin.	Spirits turpentine.	Resin.
	Casks.	*Barrels.*	*Casks.*	*Barrels.*	*Casks.*	*Barrels.*	*Casks.*	*Barrels.*
1879-'80	125, 585	663, 967	60, 000	259, 940	46, 321	221, 421	25, 209	158, 482
1880-'81	90, 000	450, 000	51, 386	231, 417	54, 703	282, 386	25, 224	170, 616
1881-'82	88, 376	425, 925	69, 027	258, 446	77, 059	309, 834	30, 937	172, 438
1882-'83	87, 050	483, 432	65, 914	285, 446	116, 127	430, 548	43, 870	200, 125
1883-'84	78, 978	434, 367	64, 207	264, 049	129, 835	559, 625	41, 804	210, 512
1884-'85	71, 145	310, 808	44, 126	218, 979	121, 028	401, 998	41, 713	200, 688
1885-'86	63, 580	324, 942	40, 375	170, 066	106, 925	424, 490	38, 733	175, 817
1886-'87	71, 912	381, 335	52, 549	171, 145	146, 925	566, 932	40, 149	182, 955
1887-'88	63, 473	246, 516	40, 253	181, 886	168, 834	654, 286	28, 725	132, 055
1888-'89	61, 628	351, 827	43, 127	149, 348	159, 931	577, 990	23, 927	106, 129
1889-'90	70, 289	385, 523	49, 232	217, 865	181, 542	716, 658	21, 029	93, 906

Exports of tar and crude turpentine from Wilmington, N. C.

Year.	Tar.	Crude turpentine.	Year.	Tar.	Crude turpentine.
	Barrels.	*Barrels.*		*Barrels.*	*Barrels.*
1881-'82	56, 113	2, 323	1886-'87	68, 143	24, 662
1882-'83	75, 544	3, 188	1887-'88	63, 163	21, 572
1883-'84	85, 230	31, 966	1888-'89	68, 856	18, 171
1884-'85	70, 530	45, 966	1889-'90	71, 949	19, 082
1885-'86	69, 195	35, 290			

Adding to the above records the production reported from Mississippi and Louisiana, which is said to have averaged, for the last two years, 75,000 barrels of resin and 15,000 casks of spirits, being marketed in New Orleans, we may estimate the total production at present as round:

340,000 casks spirits of turpentine, or 17,000,000 gallons, at 35 cents	$6, 000, 000
1,490,000 barrels (240 pounds net)* resin of grades W W to C, or 357,600,000 pounds, at $1.80 average price per barrel or per 280 pounds gross	2, 682, 000
	8, 682, 000

From the same report we quote the following data regarding the development of the industry in the different States (no regular returns from any district are obtainable regarding the annual production of naval stores derived from the longleaf pine previous to 1870):

GROWTH OF THE TURPENTINE INDUSTRY IN THE STATES.

North Carolina.—This State, the oldest site of production, took the lead in this industry up to the census year 1880. In the census of 1850 the value of these products of that year is stated at $2,476,225, and in the census of 1860 at $996,902. The production in 1870 of 75,990 casks of spirits of turpentine (equal to 37,995,000 gallons) and 456,131,388 barrels of resin valued at $2,337,300, increased in the business year ending 1880 to 125,585 casks of spirits of turpentine and 663,967 barrels of resin of a value of $3,146,388, showing an increase of 65 per cent in spirits of turpentine and of 45 per cent in resin. From that year to the present a gradual decline has taken place, which, in the year 1888–'89, amounted to 50 per cent in spirits and 48 per cent in the resin. The exports in that year reached a value of only $1,170,932. This decline is clearly due to the exhaustion of the natural resources. During the period of ten years, from 1879–'80–'89–'90, $2,114,483 worth of spirits of turpentine and resin, on the average, were each year exported. From the returns available it appears that nearly all the tar and crude turpentine shipped to domestic and foreign ports is produced in North Carolina. The export of these stores from Wilmington in 1889–'90 amounted to 71,949 barrels of tar and 19,082 of crude turpentine, at a value of not less than $253,000.

South Carolina.—By the census of 1850, the naval stores produced in that year were valued at $235,836, and in the census of 1860 their value is stated at $205,249.† According to the returns made to the census in 1870, 31,647 casks of spirits of turpentine and 115,945 barrels of resin were produced at a value of $779,077, rising in 1880 to 60,000 casks of spirits and 259,940 barrels of resin, at a value of $1,491,853—an increase of nearly 100 per cent in spirits of turpentine and 124 per cent in resin. After a slight check in the succeeding year, the production shows for the next four years an increase of 10 per cent on the average annually over the production in 1880. With the year 1885 a decline took place; the production between that year and the end of 1890 varied between 39,651 casks of spirits of turpentine and 218,962 barrels of resin and 49,430 casks and 217,865 barrels. The value of the products in 1888–'89 amounted to $968,761. The average price of resin reached in that year the lowest figure of $1 a barrel. The production of the same year shows a decline of 28 per cent in spirits of turpentine and 40 per cent in resin compared with the production of 1880.

Georgia.—In 1850 the naval stores produced reached a value of $55,086, and by the statements of the census of 1870, 3,208 casks of spirits of turpentine, and 13,840 barrels of resin, valued at $95,970, have been produced in Georgia during that year. In the course of the following ten years the naval store industry made great progress, resulting in 1880 in the export from Savannah of 46,321 casks spirits of turpentine and 221,421 barrels resin, at a value of $1,202,555, followed by a steady increase which, in 1884, exceeded the production of North Carolina during its palmiest days, and has been constantly progressing to the present day. In the year closing, 1889, the exports from Savannah reached 159,931 casks spirits of turpentine and 577,990 barrels of resin, valued at $3,616,680, an increase of 227 per cent in spirits turpentine and 161 per cent in resin over the production of 1880. To-day this port is the greatest market for these stores in the world.

* Lately the weight per barrel has been greatly increased, so that it now varies from 350 to 450 pounds net.

† F. B. Hough's Report on Forestry to the Department of Agriculture, 1878, IXth, Vol. II, 333.

Alabama.—According to the statements in the census of 1850, the naval stores produced in Alabama represented a value of $17,800, which in 1860 declined to $13,575, and in 1870, by the production of 8,200 casks spirits of turpentine and 53,175 barrels resin, reached a value of $280,203. In 1873 the receipts in the market of Mobile had increased fully 50 per cent over those of the previous year, amounting to from 15,000 to 20,000 casks spirits turpentine and from 75,000 to 100,000 barrels resin, besides 1,000 barrels tar and pitch, of a value estimated at $750,000. In 1875 the receipts reached a value of $1,200,000, which in the year 1879-'80 was reduced to $739,000. In the year 1883 the production had increased again to 43,870 casks spirits turpentine and 200,125 barrels resin, with but slight fluctuations to the end of 1887, indicating an increase of 59 per cent in spirits turpentine and 21 per cent in resin over the production in 1880.

With the beginning of 1888 a decline set in; during that year the receipts at Mobile were reduced to 28,725 casks and 132,055 barrels, valued at $635,643, and still further, in 1888-'89, to 23,927 casks and 106,129 barrels, of a value of $556,399. The receipts that year of spirits turpentine fell 47 per cent and of resin nearly 49 per cent below those of 1883, the year of greatest production, and the returns of the following years show still greater reductions. This decline is to be ascribed to the exhaustion of the forests along the lines of communication by water and by rail, and the consequent reduction in profits caused by the increased expense of transportation of the products from the still to the shipping points, ports, or inland markets. The receipts at Mobile include all of these stores produced in eastern Mississippi.

Other States.—In Mississippi and Louisiana this industry has not as yet reached large dimensions, while it is not known that turpentine orcharding is carried on in the magnificent pineries of Texas. The production along the New Orleans and Northeastern Railroad is reported to have averaged for the last two years 15,000 casks of spirits of turpentine and 75,000 barrels of resin.

PHYSIOLOGY OF RESINS.

All coniferous trees, with the exception of those of the genus *Taxus*, contain in their woody structure passages or pockets, filled with resin, known as resin ducts or resin vesicles. How and under what conditions exactly these ducts and vesicles arise, and how and why the resin forms, are matters still imperfectly understood. Resin passages begin to develop in the young seedling, and even during germination; resin forms in the growing bud, however, only during normal respiration and growth. It is, then, a product of the living plant, formed by and during its life functions in the living parts of the plant; yet as far as we know it is a product of decomposition, which, while perhaps not useless in the economy of the plant, seems to find no further use in the nutrition or growth of its organs.

Resin passages arise from the shrinking away from each other of the walls of neighboring rows of cells; an intercellular space is thus formed and gradually filled up with products of decomposition and secretion, which we call resin. The source of these secretions is also still more or less unexplained. In the first place it comes, no doubt, from a decomposition of the cellulose of the surrounding cell wall; then the starchy contents of the cells themselves may change into resin, and by oxidation of terpenes, essential oils, the surrounding cells with their contents are liquefied and resorbed, and in this way the resin duct becomes filled and enlarged from a mere intercellular passage to an irregular, smaller, or larger pocket or canal. The number, size, and arrangement of the resin ducts and vesicles differ with different species.

The Cupressus genus all have isolated cells containing resin; some have also ducts, the contents of which give the wood its peculiar odor, but these do not contain sufficient quantities to permit extraction except by distillation of the wood itself. One of the Thuya tribe (*Callitris quadrivalvis*) of Algiers, furnishes the white resin, known as sandarac; and the fruit of the juniper, rich in essential oil, is used in the preparation of gin, the flavor of which is due to the oil.

The wood of the firs (*Abies*) does not contain any resin ducts, only isolated resin cells and vesicles, which are found most amply in the bark, containing an oleoresin very rich in volatile oil, and hence very liquid. The wood of the spruces (*Picea*) contains few, rather narrow, longitudinal ducts, and wider lateral ducts strongly developed. The larch (*Larix*) contains resin ducts of very large diameter. The largest development of resin passages, however, occurs in the pines (*Pinus*), admitting extraction on a large commercial scale.

In these we find longitudinal resin ducts in greater or less abundance, according to the species, in all parts of the annual rings, more frequently, however, in the summer wood than in the spring wood; hence, in part, the darker coloration of the former. Those of the ducts which pass near a medullary ray form lateral extensions along the cells of the rays, by means of which the longitudinal ducts are more or less frequently connected. These lateral ducts extend into the bark, where sometimes considerable pockets of resin are formed; the longitudinal ducts are, however, the most important source of resin supply in the pine.

As we have seen, the production of resin takes place under the life functions of the tree in the living parts. Whether, and if so how, the resin wanders in the tree is not well known. Small amounts, no doubt, remain at the place where they were formed. Larger masses may change their place, following the law of gravity, although the observation that leaning trees are richest in resin on the under side does not necessarily predicate a wandering. The collection of resin in the hollows of trees (frost pits) of the larch may not be due to a wandering of the resin, but an emptying of broken ducts into the open spaces, in which the counterpressures otherwise existing are relieved.

The special investigations undertaken in the Division of Forestry, and recorded in Bulletin 8, have shown that the quantitative distribution of resin throughout the tree, from top to bottom, follows no law, the larger amounts being as often found in the top or middle portions as in the butt-logs. If the claim that the roots and base parts are richest in resin be a fact, this need not be due to a wandering of the resin, but to more abundant production in those parts. The belief that in trees bled for turpentine a change takes place in the distribution of resin was not sustained in the investigations. It was, however, found that the heartwood of old trees contains invariably more oleoresin than the sapwood, the largest amount relatively being found at the line where heart or sap wood join. This would indicate an infiltration of the heartwood with resin from the sapwood. Before, however, accepting such a conclusion, in which we would find it hard to explain mechanical difficulties in the wandering of the resin, it would be desirable to examine trees of different age and note the progress of resinification and also to make further analyses on absolutely fresh wood in which the sapwood is guarded against loss of resinous contents by evaporation and otherwise.

Of practical importance is the demonstration, furnished in these investigations, that the resin of the heartwood has lost its fluidity, being probably infiltrated into the cell-wall, and therefore the tapping for turpentine does not involve the resin of the heartwood or produce any change in the same.

Concerning the conditions which encourage abundant resin production we are also in the dark. Trees standing side by side and apparently under the same conditions show widely different amounts of resin. In general it may be said that light and warmth are prime requisites for abundant resinification, hence this proceeds more rapidly in open groves than close plantations; abundant nourishment and energetic activity of life seem also advantageous to resin production, hence a strong, fresh, warm soil furnishes more resin than a thin and cold soil, trees with full crown and branches more than thin foliaged and densely crowded trees with small crowns; warm and dry summers produce a richer flow than wet and cold ones.

METHODS OF WORKING TREES.

The methods of working trees for turpentine differ with the different species, as also in different countries. According as the resinous contents are found mainly in the bark or in the sapwood or in the heartwood, we may discern various methods.

(1) Chipping; this method consists in making a scar or chip on the tree, which is annually enlarged, and gathering the liquid turpentine at the lower end of the chip or scar in recess (box) cut into the tree; or else, as in France, in vessels; or else by allowing the resin to dry and be scraped, as is done with the Norway spruce.

(2) Bore-holes are applied in the tapping of larch where the turpentine is formed or collected in the heart.

(3) Opening the resin vesicles of the bark and gathering by hand is applied in the case of the balsam.

The yield of resin and turpentine depends upon various circumstances besides the species from which it is gathered, namely: (1) The dimensions of the tree; the larger the tree, of course, *ceteris paribus*, the larger the yield; the yield of trees of small diameter, 7 to 10 inches, may be from one-half to one-third of those of larger diameter. (2) The conditions of site; all elements which further large development of the crown, mainly open and sunny position, south or east exposure, will increase the yield. (3) The weather, and especially the temperature, during the time of gathering; the most favorable weather is changing temperature and humidity; long-continued heat and long-continued cold rains depress the yield, especially a cold spring predicts a poor crop; the flow of turpentine increases from spring to fall. (4) The duration of the bleeding process; in the first two or three years the yield is or ought to be smaller than in the following years. With the Austrian (black) pine the maximum yield seems to be reached in the trees of smaller diameter between the fourth and sixth years; in the trees with larger diameter, over 10 inches, between the seventh and ninth. Trees of these species on proper sites can be utilized for thirty years, but working becomes less profitable after six or eight years for the smaller and ten or twelve years for the larger sizes; the expense of working growing too costly, the foliage becoming thinner, and the yield smaller. (5) The aptitude and care of the workmen, which tells in the manner of making and enlarging the chips and of dipping and scraping.

PRINCIPLES TO BE OBSERVED IN TURPENTINE ORCHARDS.

The principles which should be observed in the chipping process, the one practiced on the largest scale, especially on pines, will now be mentioned.

SIZE OR AGE OF TREES TO BE TAPPED.

There is not sufficient experimental knowledge at hand to determine the most advantageous size of trees for tapping, either as far as greatest annual production of turpentine or safety to the life of the tree is concerned. The experiments on Austrian pine, recited further on, seem to show that trees above 10 inches in diameter yield much more than smaller trees, almost double the amount of resin, with a higher percentage of spirits of turpentine. It also stands to reason that the safety of the tree, where this is of moment, is better assured the larger the tree. Generally speaking, the best time for plentiful production is neither near the beginning nor near the end of the life of the tree, but when it is in its most vigorous growth, and probably after it has attained its maximum annual height growth, for then its activity is concentrated upon the development of its interior and diameter development.

If the analyses referred to before exhibit the true amounts of resin formed at the part of the tree from which they are taken, and if our proposition be true that ordinarily resins do not wander in the tree, but remain where they are formed, then we could, by analyses of cross sections, dividing them into periods and ascertaining the resin contents of each division, approximately determine the period of greatest production. In view of the great variation in resin contents, a very large number of analyses would be required to allow generalization. From those at hand it would appear that the time of greatest production falls for the longleaf pine between the seventieth and ninetieth years. Since, however, resin production appears to be a result of vigorous life functions, and since wood production depends upon the same conditions, we should rather seek a criterion for resin production in the relation of diameter to age $\frac{d}{a}$; that is to say, whenever the largest amount of wood is formed in a given time—whenever $\frac{d}{a}$ reaches its greatest value—then the largest amount of resin is presumably also formed. Investigations in this direction are still wanting.

Another consideration is that of the value of the tree after it has been bled. Since the wood which is formed after the bleeding either on or between the scars is of little value for sawmilling, no trees should be bled—unless they are otherwise unfit for lumber—that will not make good sawlogs from the heartwood; that is to say, they should be at least 14 inches in diameter, so as to furnish a log of at least 8 inches at the small end. If the diameter were allowed to increase to at least 18 or 20 inches, probably the largest value both in resin and lumber might be attained.

In practice, various rules have found acceptance. In France 14 inches, which may be attained in thirty years, is considered a necessary diameter in order to endure continued tapping without injury to life; the lumber value of the maritime pine, being small, enters hardly into consideration. In Austria the tapping is begun with trees as low as 8 inches in diameter, but a diameter of at least 10 inches is preferred. With the spruce, 12 inches is considered a minimum size. In the United States, where no regard to consequences for the tree or lumber is had, the diameter at which a tree might be tapped is gauged by the amount of resin obtained in proportion to the labor expended. Until lately small diameters were avoided, but now any tree capable of carrying a bore is tapped and the ruin of the future of the industry prepared by this malpractice.

SIZE AND NUMBER OF SCARS AND PROGRESS OF CHIPS.

Regard to the life of the tree and the length of time for which it is expected to produce, on one hand, and the rapidity with which the largest amount of resin can be extracted in the shortest time, on the other hand, determine the size and number of scars inflicted simultaneously. Although the resin itself is or seems to be of no particular use to the tree in its vital functions, by laying bare a part of the cambium and young wood, a diminution of the flow of water to the crown, and of nutritive material downwards, must be induced. As a result the foliage must suffer in proportion, and with it not only the life of the tree, but also the production of additional resin, which is produced in quantity only in vigorously growing trees with a luxuriant foliage. Hence both the life of the tree and the total yield of resin may be curtailed by too many and too large scarifications.

Since there is a relation between the amount of active foliage on each side of the tree and the activity in the cambium on the same side (one-sided crowns produce one-sided annulation), it stands to reason that a larger product can be obtained for a longer time by inflicting a number of smaller scars than by making a large scar on one side of the tree, which is bound to reduce the activity of the foliage on that side, and thereby the production of additional resin; not that the dripping itself increases the production of new resin, as has been sometimes thought, but new resin is formed every year in proportion to the activity of the foliage, and hence by impairing this activity the amount of new resin in the new wood is reduced.

As we have shown, the resin which the orchardist takes from the tree, in the longleaf pine, at least, comes alone from the sapwood, the heartwood being impregnated with nonfluid oleoresin and not contributing toward the flow. The resin tapped is not only that which was deposited in the sapwood in former years, but also that which is formed during the years of tapping by the growth of the tree; hence sufficient amount of active cambium and young wood should be left untouched to permit a plentiful supply of water from the ground and vigorous function of the foliage, and the size of the one scar, or the sum total of all the scars, if several, should stand in a certain relation to the circumference or diameter of the tree.

For the size of the scar three dimensions are to be determined—breadth, depth, and height. Breadth and depth should be determined by the considerations just stated. As far as product is concerned there is nothing gained—at least in our pine—by cutting deeper than the sapwood, since the heart is inoperative. The breadth may be larger or smaller according to whether the tree is expected to yield resin for a long time or is to be depleted as fast as possible. In the former case the scar should not be wider than can conveniently callous over in a few years' rest, so as to permit new scars to be opened after the rest without any diminution, so to say, of conducting cell tissue. In the latter case, *i. e.*, when the largest amount of resin is to be obtained in the quickest time without reference to the life of the tree, only enough cambium need be spared to sustain the tree alive during the period which it takes to carry the chip advantageously to the greatest practical height. In this case, to be sure, only the resin already formed in the sapwood is being drained, no new additions coming from the growth during the years of tapping. The greater the breadth of the chip the greater, no doubt, the momentary discharge. The height of the chip, in the pines at least, should be determined by the following considerations: The resin drains from the longitudinal resin ducts which are cut through, by the law of gravity, until by the volatilization of the solvent oil of turpentine the hardened resin stops the flow, hence regard to plentiful production dictates as low a chip to begin with as is possible to collect from. A high chip at first and rapid chipping afterwards is a useless waste of good material, without any benefit, since the flow depends only upon the number of resin ducts cut through radially.

In practice the French have come nearest a rational size of the scar, not allowing it to be more than 4 to 5 inches wide and scarcely one-half an inch deep, beginning with a height of not more than 4 inches and progressing afterwards with the greatest care very gradually. With such chips it is possible to bleed the trees without detriment for their whole natural life. In Austria the size is extravagant, namely, widening to two-thirds of the circumference, although the height is at first started with only 2 inches. In the United States a waste of 10 inches is at once incurred by "cornering" the box, and the chip is made 12 to 14 inches wide without much reference to the life or size of the tree, and several chips are opened on larger trees.

METHOD OF COLLECTING THE RESIN.

The pocket interest of the orchardist makes it desirable to have the largest amount of "dip," that is, liquid resin, and the smallest amount of "scrape," or hardened resin scraped from the surface of the scar, for the former contains larger amounts of the more valuable oil which has been evaporated from the latter by exposure to the air, as the resin, in a thin layer, runs to the receptacle. It is, therefore, advantageous to reduce as much as possible the distance between the place at which the resin exudes and the receptacle and also to concentrate as much as possible into one channel the flow of resin.

The American practice, it will be seen, is entirely faulty in this respect, and the Austrian not much better, the French alone being rational.

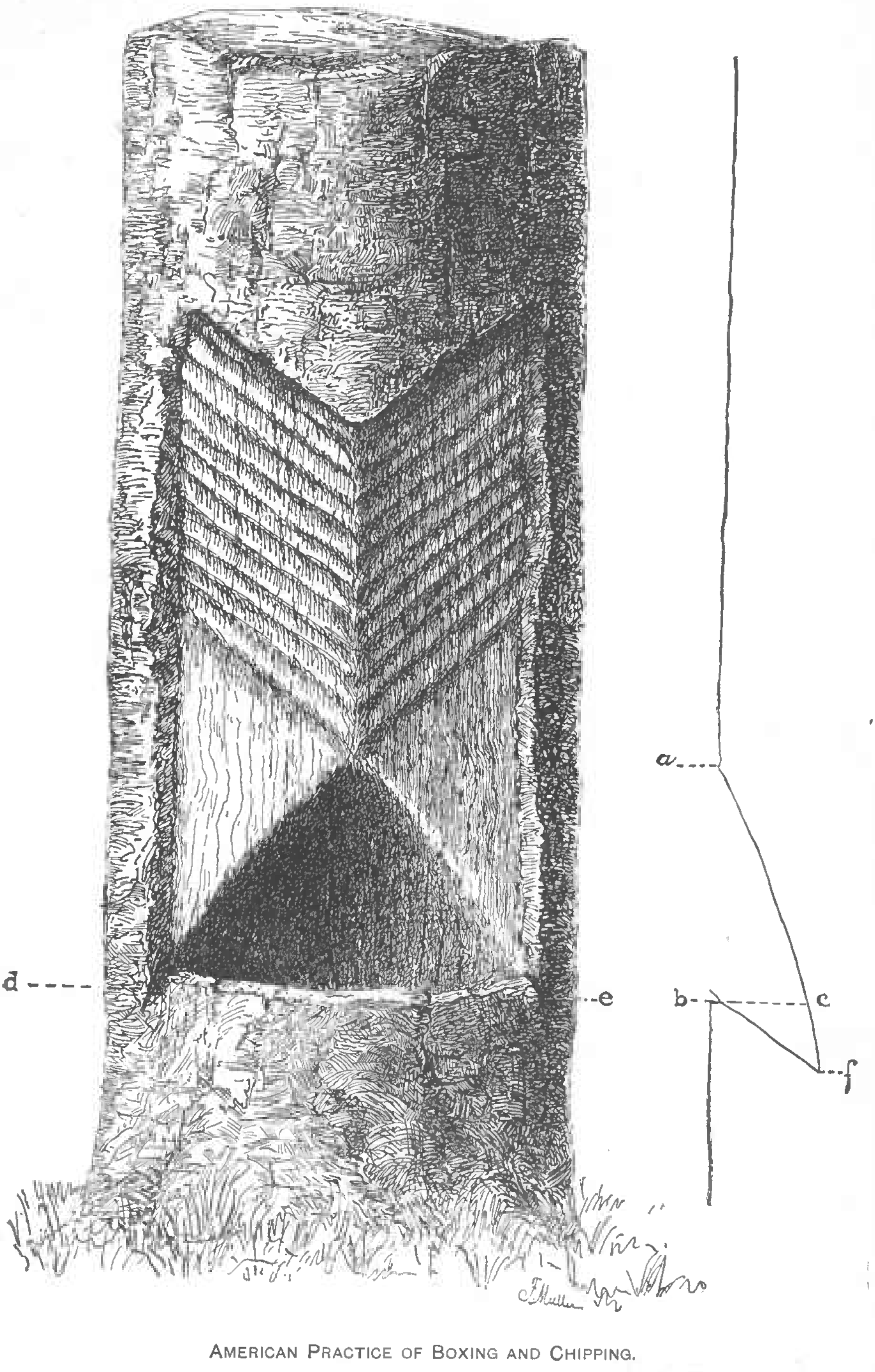
Frequent collection from receptacles at the trees also reduces loss from evaporation. Cleanliness, keeping impurities, sand, chips of bark and wood out of the receptacles is reflected in the better grades of the product. Scraping should be done as rarely as possible, since it injures the tree, and after the resin is once hardened the loss of oil by exposure is only insignificant.

TURPENTINE ORCHARDING IN AMERICA.

The American practice of boxing and chipping is thus described by Dr. Charles Mohr, agent of the Division of Forestry:

In the establishment of a turpentine orchard and still, two points must be considered, namely, (1) proper facilities of transportation to shipping points for the product, and (2) a sufficient supply of water for the condenser connected with the still. The copper stills generally in use have a capacity of about 800 gallons, or to carry a charge of 20 to 25 barrels, of crude turpentine. For such a still to be charged twice in twenty-four hours during the working season not less than 4,000 acres of pine land with a good average stand of timber are required. This area is divided into twenty parcels each of 10,000 "boxes," as the cavities are called, which are cut into the tree to serve as a receptacle of the exuding resin. Such a parcel is termed a "crop," constituting the allotment to one laborer for the task of chipping. The work in the turpentine orchard, as such a complex is called, is started in the earlier part of the winter, with the cutting of the boxes. Until some years past no trees were boxed of a diameter of less than 12 inches; of late, however, saplings scarcely over 8 inches in diameter are boxed. Trees of full growth, according to their circumference receive from two to four boxes; so that the 10,000 boxes can be said to be distributed among 4,000 to 5,000 trees on an area of 200 acres.

The boxes are cut (see Plate I) from 8 to 12 inches above the base of the tree, 7 inches deep (b–f) and slanting from the outside to the interior with an angle of about 35; they are 14 inches in greatest diameter (d–e) and 4 inches in greatest width (b–c) at the top, of a capacity of about 3 pints; the cut above this reservoir forms a gash of the same depth and 6 to 7 inches of greatest height (a–b). In the meantime



AMERICAN PRACTICE OF BOXING AND CHIPPING.

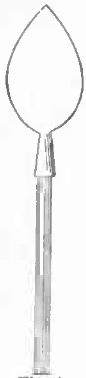


Fig. 1.

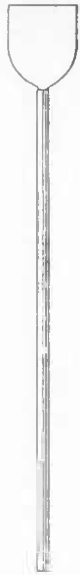


Fig. 2.

Fig. 3.

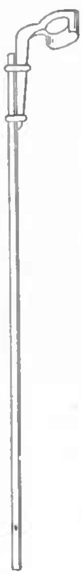


Fig. 4.

Fig. 5.

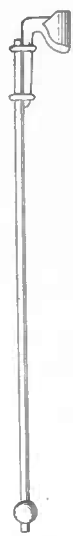


Fig. 6.

TOOLS USED IN AMERICAN PRACTICE OF TURPENTINE ORCHARDING.

the ground is laid bare around the tree for a distance of 2½ or 3 feet, and all combustible material loose on the ground is raked in heaps to be burned in order to protect the boxes against the danger of catching fire during the conflagrations which are so frequently started in the pine forests by design or carelessness. This work of raking around the trees is also done to give the chipper in the performance of his task a firmer foothold on the ground than could be obtained when covered with the slippery pine straw. The employment of fire for the protection of the turpentine orchard against the same destructive agency necessarily involves the total destruction of the smaller tree growth, and, left to spread without control beyond the proper limits, carries ruin to the adjoining forests, in many instances over areas many miles in extent. The tools used are illustrated on Plate II, and are described as follows: Fig. 1, chipper; Fig. 2, pusher; Fig. 3, open hacker; Fig. 4, closed hacker; Fig. 5, scraper; Fig. 6, puller.

With the first days of approaching spring the turpentine begins to flow and "chipping" is begun, as the work of the scarification of the tree is termed, by which its surface above the box is laid bare just beyond the youngest layers of the wood scarcely to a depth of an inch from the outside of the bark. To effect this, first a strip 2 inches wide is removed, extending vertically from the corner of the box to the height of about 10 inches ("cornering"), and then the surface between these strips is laid open. The removal of the bark and outermost layers of the wood, the "chipping" or "hacking," is done with a peculiar tool, the "hacker" (Plate II, Figs. 3 and 4), a strong knife with a curved edge, fastened to the end of an iron handle bearing on its lower end an iron ball about 4 pounds in weight, in order to give increased momentum to the force of the stroke inflicted upon the tree, and thus to lighten the labor of chipping. As soon as the scarified surface ("chip") ceases to discharge turpentine freely, fresh incisions are made with the hacker. The hacking or chipping is repeated every week from March to October or middle of November, extending generally over thirty-two weeks, and the height of the chip is increased about 1½ to 2 inches every month. The resin accumulated in the boxes is removed to a barrel for transfer to the still by a flat, trowel-shaped dipper ("dipping"). In the first season, on the average, seven dippings are made (from six to eight) the 10,000 boxes yield at each dip about 40 barrels of dip or soft turpentine, or ("soft gum") as it is called in Alabama; of 240 pounds net or 280 pounds gross weight. The flow is most copious during the hottest part of the season, July and August, diminishes with the advent of cooler weather, and ceases in October or November. As soon as the exudation is arrested and the crude resin begins to harden, it is carefully scraped from the chip and the boxes with a narrow, keen-edged scrape attached to a wooden handle ("scraping"). The product so obtained, called scrape or hard turpentine, or hard gum, is of a dingy white color, more or less mixed with woody particles and dust, and contains only half of the quantity of volatile oil obtained from the dip or soft turpentine.

In the first season the average yield of the dip amounts to 280 barrels and of the scrape to 70 barrels. The first yields 6½ gallons of spirits of turpentine to the barrel of 240 pounds net, and the latter 3 gallons to the barrel, resulting in the production of 2,000 to 2,100 gallons spirits of turpentine and 260 barrels of resin of higher and highest grades. The dippings of the first season are called "virgin dip" when almost without color, and white virgin dip, from which the finest and most highly priced quality of resin is obtained perfectly white, transparent, showing but the faintest tint of straw color, which enters the market under the grades of "water white" WW ,and window glass WG. The next grades of resin obtained by the distillation of the turpentine dipped during the latter part of the same season, the "second virgin dip," are of a decided straw color and designated by the letters N. M. K., (See Grade, page 344.)

In the second year from five to six dippings are made, the crop averaging 225 barrels of soft turpentine; the scrape is increased to 120 barrels, making altogether about 2,000 gallons of spirits. The rosin, of which about 200 barrels are produced, is of a lighter or deeper amber color, and perfectly transparent, of medium quality, including grades "I," "H," "G." In the third and fourth year the number of dippings is reduced to three. With the slow flow over a more extended surface the turpentine thickens under prolonged exposure to the air and loses some of its volatile oil partly by evaporation and partly by oxidation. To the same influence, no doubt, the deeper color of the crude turpentine is to be ascribed. In the third season the dip amounts to 120 barrels, the scrape to about 100 barrels, yielding about 1,100 gallons of spirits of turpentine and 100 barrels of rosin of a more or less dark-brown color, less transparent, and graded as "F," "E," "D."

In the fourth and last year three dippings of somewhat smaller quantity of dip than that obtained the season before and 100 barrels of scrape or hard turpentine are obtained, with a yield scarcely reaching 800 gallons of spirits and 100 barrels of rosin of lowest quality from a deep brown to almost black color, opaque and heavier in weight, classed as "C," "B," "A." After the fourth year the turpentine is generally abandoned.

Owing to the reduction in the quantity and quality of the raw product, resulting in a smaller yield of spirits and of lowest grades of rosin, it is not considered profitable by the larger operators to work the trees for a longer time. In North Carolina the smaller land owners work their trees for eight to ten successive seasons and more, protect the trees against fire, and after giving them rest for a series of years apply new boxes on spaces left between the old chips ("reboxing") with good results.

Distillation.

The process of distillation requires experience and care in order to prevent loss in spirits of turpentine, to obtain the largest quantities of rosin of higher grades, and to guard against overheating. After heating the still somewhat beyond the melting point of crude turpentine, a minute stream of tepid water from the top of the condensing tub is conducted into the still and allowed to run until the end of the process; this end is indicated by a peculiar noise of the boiling contents of the still and the diminished quantity of volatile oil in the distillate. On reaching this point the heating of the still and the influx of water has to be carefully regulated. After all the spirits of turpentine has distilled over, the fire is removed, and the contents of the still are drawn off by a tap at the bottom. This residuum, the molten rosin, is first allowed to run through a wire cloth and is immediately strained again through coarse cotton cloth, or cotton batting made for the purpose, into a large trough, from which it is ladled into barrels. The legal standard weight of the commercial package is 280 pounds gross, no tare being allowed.

The finest grades of rosin are largely used in the manufacture of paper, for sizing, of soaps, and of fine varnishes; the medium qualities are mostly consumed in the manufacture of yellow soap, sealing wax, in pharmacy, and for other minor purposes, and the lower and lowest qualities are used for pitch in ship and boat building, brewer's pitch, and for the distillation of rosin oil, which largely enters into the manufacture of lubricating agents.

A turpentine distillery, on the basis of twenty crops, can be said to produce, during the four seasons the boxes are worked, about 2,400 casks, or 120,000 gallons, of spirits of turpentine and from 11,500 to 12,000 barrels of resin, or 2,800,000 pounds (the lowest grade BA excluded), at a value of about $60,000 at average prices. The prices of spirits of turpentine vary from 28 cents to 40 cents a gallon, even during the same season, according to supply and demand in the market. The quotations on December 31, 1892, at Wilmington, were 28 cents for spirits and $1.91 for resin in the average down to grade C. The prices for different grades were per barrel: WG, $3.65; N, $3.10; M, $2.85; K, $2.15; I, $1.45; H. $1.15; G, $0.92; F, $0.85; E. D. C, $0..82.

Cost of establishment of plant and of working the crop.

Lands with the privilege of boxing the timber for the term of four years are rented at the rate of $50 per crop of 10,000 boxes (about 200 acres with 4,000 to 5,000 trees). The establishment of plant for theworking of twenty crops requires an investment of about $5,000, including the still, houses, sheds, tools, wagons, and working animals, mostly mules.

The following statement, made by an operator of many years' experience, exhibits the actual expenses incurred for the working of one crop during four years; the work is for the greatest part done by the job:

Chopping 10,000 boxes	$125.00
Inspecting and tallying the same	15.00
Cornering 10,000 boxes	12.00
Raking around the trees, at $10 per season	40.00
Chipping boxes during 111 weeks, at $5 per week	555.00
Dipping crude resin, 650 barrels, and scraping 460 stands, at 30 cents	333.00
Hauling dippings and scrapings, at 30 cents per barrel	333.00
Distilling, at 20 cents per barrel	222.00
Spirit barrels, 122, at $2.80	305.00
Making and filling 795 barrels resin, at 30 cents	238.50
Superintendence of the crop	80.00
Total working expense of one crop	2,258.50
Rent of land for one crop	50.00
Cost of one crop	2,308.50

Total expense of operating a plant of 20 crops during four years:

Labor,* rent, and materials	$46,170.00
Interest on capital invested, $5,000, at 6 per cent	1,200.00
Loss by depreciation of plant, 10 per cent per year for four years	2,000.00
Taxes and incidentals	630.00
	50,000.00

Yield.—It appears that the yield of the crop of 200 acres distributes itself about as follows:

	Dip.	Scrape.	Total crude turpentine.	Total yield.	Scrape.	Spirits.		Rosin.
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Gallons.*	*Per cent.*	*Barrels.*
First year	67,200	16,800	84,000	30.9	20.0	2,100	34.4	260
Second year	54,000	28,000	82,800	30.5	34.8	2,000	32.8	200
Third year	28,800	24,000	52,800	19.5	45.5	1,100	18.0	100
Fourth year	28,000	24,000	52,000	19.1	46.1	900	14.8	100
	178,000	93,600	271,600	100.0	29.0	6,100	100.0	669

If we assume that 4,500 trees produce these amounts in four years, the yield per tree in crude turpentine is about 60 pounds. The result at the still would indicate that each tree furnishes between 1¼ and 1½ gallons of spirits and one-eighth of a barrel, or 30 pounds, of rosin of better grade, or at best 75 cents' worth of product during the four years, which it has cost 55 cents to produce, leaving 5 cents net per tree per year, or from $1 to $1.25 per acre.

From the fact that 4,000 acres of timber land (20 crops of 200 acres each) during four years' working produce 120,000 gallons of spirits of turpentine, or 7½ gallons per acre and year, it follows that to produce the 17,000,000 gallons reported as the annual product, not less than 2,250,000 acres must be in orchard; and since the yield of the first year represents 35 per cent of the total annual yield, at least 800,000 acres of virgin forest are newly invaded annually to supply the turpentine stills in operation.

INSPECTION LAWS RELATING TO RESINOUS PRODUCTS.

In several of the Southern States, laws have been passed regulating the inspection of turpentine, etc., and defining its grades. The principal of these are as follows:

Virginia.—Barrels to be full of good, clean, sound, and merchantable tar, pitch, or turpentine, and to hold 31½ gallons.

North Carolina.—Soft turpentine barrels to weigh 280 pounds gross, and hard turpentine 240 pounds; pitch, 32 gallons to the barrel. Turpentine, tar, or pitch to be free from fraudulent mixtures. Casks to be of good seasoned staves, three-fourths of an inch thick, and not over 5 inches wide; not less than 30 nor over 32 inches long. Heads not less than 1 nor more than 1½ inches thick. To have 12 hoops to a cask, except hard turpentine, which may have 10 hoops. Water is declared not a fraudulent mixture of tar. Tar and turpentine barrels not limited as to weight, but the weight to be marked and certified. Turpentine to be branded "S," or "H," for soft or hard, and to show the initials of the maker's name. The inspector of naval stores at Wilmington is to gauge all spirits of turpentine.

South Carolina.—A barrel of crude turpentine to weigh 280 pounds gross.

Georgia.—Inspectors of turpentine, etc., may be appointed by cities, and their duties prescribed. Soft turpentine to be put up in barrels, as in North Carolina, and to be branded "V," for virgin turpentine; "S," for yellow dip, and "H," for hard.

Florida.—The governor may appoint inspectors of tar and turpentine. Makers required to brand their initials on the barrels. Inspectors are to mark the products that come under their notice as follows: "V," for pure virgin dip; "D," for pure yellow dip; "S," for pure scrape. If the first two of these be impure or mixed, the

*Laborers are paid $1 to $1.25 per day; one man chips 10,000 to 12,500 boxes per week by the job. A saving is made now in most localities in the matter of barrels and freight, by using kerosene tanks on cars, holding 3,500 gallons, into which the spirits are filled directly from the still.

"V" or "D" is to be inclosed in a circle. If the scrape is not passable, it is marked with an "X" in a circle.

Allowances and deductions are to be made on turpentine with reference to the following particulars:

(1) When virgin dip is dipped from burnt boxes, or contains burnt cinders or sand.

(2) When virgin dip is mixed with chips, bark, or other impurities.

(3) When virgin dip is mixed with yellow dip, or scrape.

(4) When yellow dip is mixed, or contains chips, straw, bark, scrape, or sand, or other impurities.

(5) When scrape contains more chips than are absolutely necessary to get it off, or dirt, or other impurities.

(6) When yellow dip, virgin dip, scrape, or tar contains water, or there is an excess of wood in the barrels containing it, or it is injured by long standing or leakage.

(7) When tar or turpentine of any class is contained in insufficient or unmerchantable barrels.

The size of barrels is fixed at 30 to 32 inches in length, and the weight 280 pounds gross, for turpentine and 320 for tar. Allowance is to be made for deficiencies, and records are to be kept, but inspection is not obligatory upon the producers of tar and turpentine in this State.

Alabama.—Inspectors are to be appointed by the cities, and their duties prescribed by municipal law.

TURPENTINE ORCHARDING IN EUROPE.

AUSTRIAN PRACTICE.

In Austria it is the black pine (*Pinus laricio*, var. *austriaca*) which is tapped for turpentine. The method is very similar to the American. In the spring, just before the sap rises (usually in March), a box (quandel) is cut into the tree about 1 foot above the ground (quandel). The box has about 3 inches depth and a breadth of from one-fourth to one-third of the circumference of the tree. From the corners of this box two upward diverging channels are notched, from the ends of which continues the scar or chip (sache). This is made with a carved hoe, 2¼ inches in width, by taking all the bark and the youngest two to four year old wood. The chip is at first made only about 2 inches high and increased very gradually, reaching during the first year 14 to 16 inches in height.

In the first year the chip is increased every week; in later years oftener, every four or five days. If the chipping is delayed longer the yield is smaller, since the resin thickens and incrustates the surface. The chipping is continued during eight to twelve seasons, and the chip increases every year at the rate of from 14 to 16 inches. The breadth remains even, and must never be more than two-thirds of the circumference of the tree. The time of chipping is from April to the beginning or the middle of October. In the first year most of the resin is liquid and flows into the box. Later, when it has to run a longer distance, so much of the volatile oils evaporates that the exudation thickens and must be scraped off the chip. So far this method does not differ from the American method, except as to the rapidity with which the chip is increased and the length of time the tree is worked. In order, however, to reduce the surface from which the volatile oils may evaporate, a channel is formed near the place where the exudation occurs by making two converging cuts and inserting two pieces of wood, which conduct the resin into a narrower channel down to the box. Otherwise there seems to be no difference in the two methods.

Yield.—In experiments regarding the yield, the following results were obtained on sixteen trees, from 90 to 110 years old, under various conditions. During nine years of chipping there was obtained of resin (per tree and year) the amounts given in the statement following.

	Minimum.	Maximum.	Average.
	Pounds.	*Pounds.*	*Pounds.*
Small trees below 10 inches.....	2.9	6.13	4.64
Large trees over 10 inches......	5.7	9.8	8.4

The last figure gives 75 pounds per tree altogether, or 25 per cent more than the average product in American practice. An 80-year-old growth, which was rented for twenty years, furnished in the tenth year of orcharding still a net rent of $12 to $18 per acre.

The scrape contains less spirits of turpentine, is mixed with chips of wood, and therefore obtains only two-thirds of the price paid for the dip. The amount of scrape depends, in the first place, on the surface of the chip; also on the temperature during the fall, warm weather producing more dips.

During the nine years of experimental chipping there were obtained for each 100 pounds of dip the following amounts of scrape:

	Minimum.	Maximum.	Average.
	Pounds.	*Pounds.*	*Pounds.*
Small trees below 10 inches.....	40.2	72.4	57.7
Large trees over 10 inches......	38.9	62.9	47.3

From the gathering to the distillation of the resin a loss averaging about 3 per cent was experienced by the evaporation of the oil of turpentine. No other resin seems to be so rich in turpentine as that of the black pine, 100 pounds of resin yielding 14 to 20 pounds of spirits and 60 pounds of rosin.

During the same experiment, in the course of nine years, the following percentages of loss in the trees by death or windfalls occurred:

	Minimum.	Maximum.	Average.
Small trees below 10 inches ..	4.0	42.3	10.4
Large trees over 10 inches....	1.3	27.3	8.3

Trees from 50 to 100 years old are tapped ten or twelve years before they are to be cut. The business is carried on upon a rent system per tree and year, under contract prescribing the dimensions and gradual extension of the chip and the time for chipping (usually till September 30) and scraping (not later than October 30), with heavy penalties in case of damage or excess of conditions. The total production in 1880—which has probably not materially changed since—was estimated at 13,288,000 pounds of resin, producing 9,260,000 pounds of rosin, 2,425,000 pounds of spirits, with an aggregate money value of, about, $300,000.

FRENCH PRACTICE.

Turpentine orcharding in France is carried on with more care than in any other country. The first difference between the industry in the United States and in France is that in the latter it is largely practiced in young plantations specially planted and protected for this particular business. The maritime pine (*Pinus pinaster* L. synon., *P. maritima*), which has been used in the celebrated plantations on the sand dunes along the coast and in the Landes of Gascony for over 2,000 square miles, furnishes the bulk of naval stores produced in France. The boxing or tapping is begun when the trees are 20 to 25 years old and is continued for a great many years. Trees have been known to have been boxed for more than two hundred years.

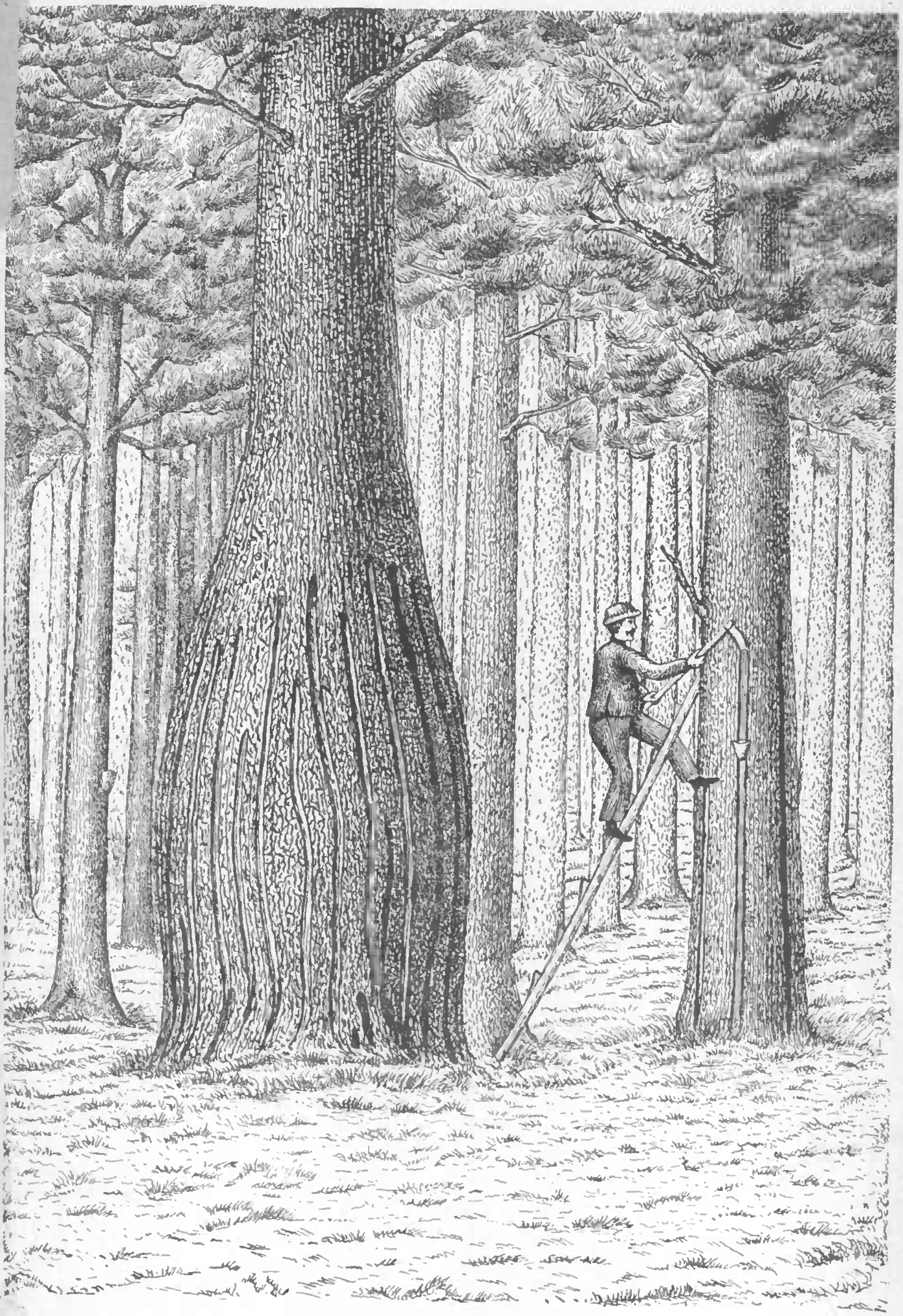
Two methods of boxing are practiced, which are known as *gemmage a morte* and *gemmage a vie*, or "bleeding to death" and "bleeding alive." The difference lies in the number of scars inflicted simultaneously. The bleeding to death is applied to trees which are to be cut out in the thinnings of a regular forest management and to those which are at the end of their usefulness. The illustration (Plate III), here reproduced from Prof. L. Boppe's work on Forest Technology, represents a pine 200 years old, with more than fifty scars or chips, without apparently any ill effects on the life of the tree.

The "bleeding alive" is practiced on those trees which are to grow on, and hence must not be injured too much. They receive, therefore, one chip at a time. When this, after five seasons' working, has attained a height of about 12 feet, the tree is allowed a rest of several years, and then another chip is opened, 6 or 8 inches from the old one, or else on the opposite side of the tree. In this way in time the whole circumference is chipped in alternating periods of bleeding and of rest until the trees are to be cut for lumber, when 100 to 125 years old or more. Sometimes exceptionally vigorous trees receive more than one chip at a time, but these are opened at different heights.

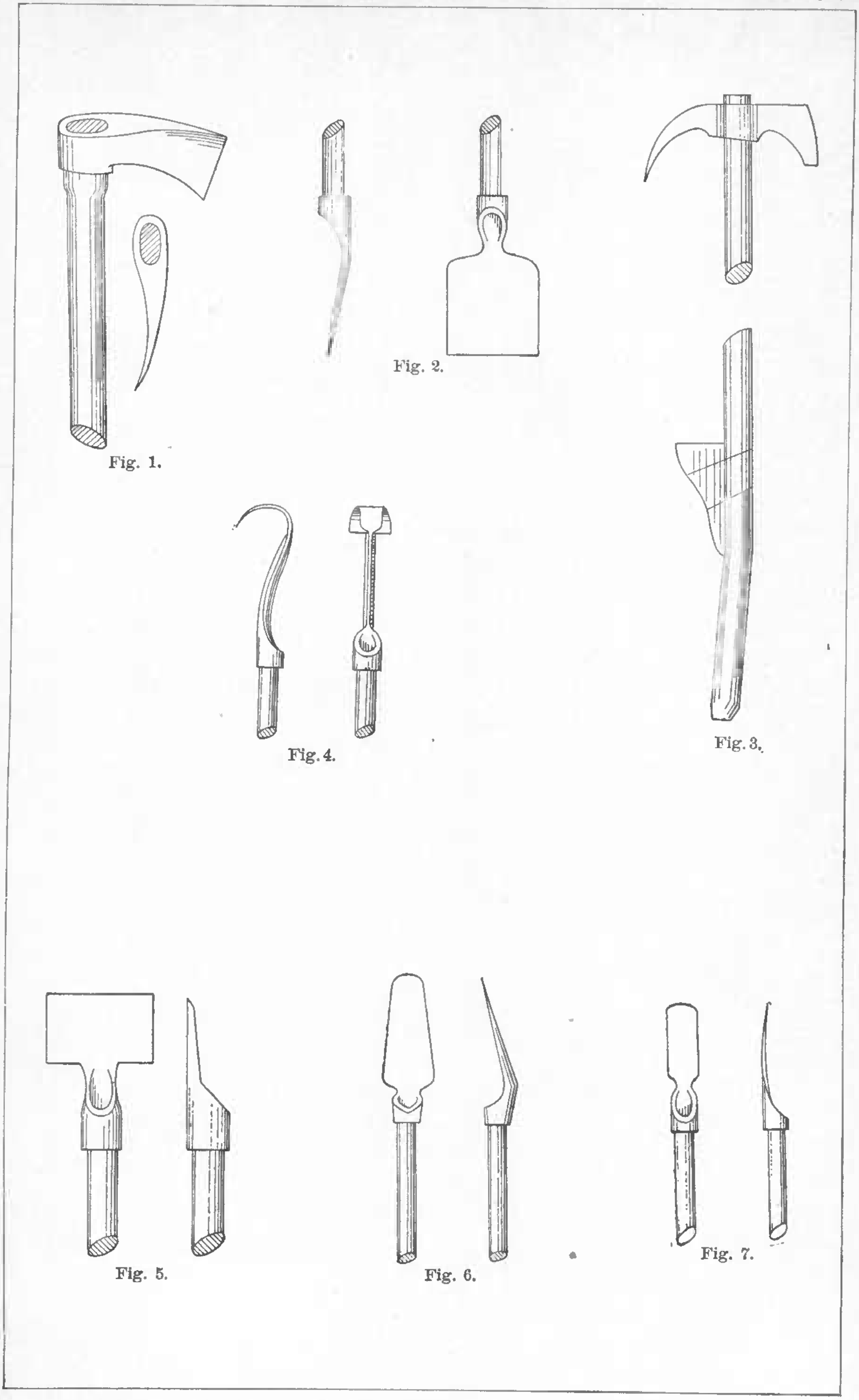
This successful continued bleeding can, however, be carried on only by corresponding care in the manipulation. The important difference between French and American practice consists in this, that the former is more careful in the chipping, and proceeds more slowly in enlarging the chip, which is made only 3 to 5 inches wide instead of 12 or 14. Further, in collecting the products with more care, the deep box cut into the tree in American practice is dispensed with and a lip and pot substituted.

The chipper begins his work in February or March by removing with a scraper from the whole portion of the tree that is to be chipped during the season, about 2 feet in height by 4 inches wide, the outer bark nearly to the wood. This is done to obviate the falling of bark chips into the pot, thus securing a cleaner product, and also to save the chipping tool. In the first week of March the chip is opened at the foot of the tree by making a triangular incision 3 to 4 inches wide and about $1\frac{1}{4}$ inches high, and not deeper than two-fifths of an inch. (Note the small size of the opening.) This chip is made with a specially and curiously fashioned hatchet, having a curved blade and a curved handle, difficult to make and use. (Plate IV, Fig. 1.) The chip is enlarged (chipping piquage) without increasing the width or even decreasing it. The art of the chipper consists in taking off just as thin a peel of wood as possible, and at each chipping he freshens up the old scar by removing another peel, taking care not to go deeper than two-fifths of an inch altogether. This chipping is repeated forty to forty-five times during the season, and during following seasons the chip is carried higher, until it reaches 12 to 13 feet in height, namely, 70 inches the first season, 30 inches each the following three seasons, and 38 inches the last season, when the tree is left to rest, and the wound heals up by the formation of new layers of bark and wood.

The cross-sections of trees bled through several periods twenty-four to twenty-seven years and more (shown on Plate V) exhibit the manner in which the chips are distributed through the various seasons around the tree, and the manner in which the scars heal over. To be sure,



TURPENTINE ORCHARDING IN FRANCE.



TOOLS USED IN FRENCH PRACTICE OF TURPENTINE ORCHARDING.

the wood formed on the chips is irregular and, therefore, not serviceable for anything except fuel.

An experiment made in Austria on the black pine with the Hugues system (Plate VI) produced more dip and less scrape, and that purer, but with less work, owing to the greater capacity of the vessel and the smaller surface to be scraped being confined to the chip of the year. Besides, quantity and quality of the spirits and resin were superior, namely, 78.5 pounds distilled gave—

	Common method.			Pot gathered.		
	Pounds.		*Per ct.*	*Pounds.*		*Per ct.*
Spirits turpentine	14.7	or	18.78	17.6	or	22.41
Resin	47.3		60.22	52.9		67.37
Water	10.6		13.44	5.3		6.72
Scraps	1.5		1.96	....		......
Loss by evaporation	4.4		5.60	2.7		3.50
	78.5		100	78.5		100

Yield.—In a growth of 45 years of age, each tree produces from 6 to 10 pounds of resin each season, more than we obtain from old trees The yield per acre varies, of course, according to the age and the number of trees bled "to death" and bled "alive," as well as on the nature of the soil—the sand soil of the dunes produces more than the gravel and limestone soil. The weather and the care of the workman also influences the yield, so that the product per acre vacillates between 200 pounds of resin in younger (30 to 35 years old) growths to 400 pounds in older growths. The yield is said to be greatest in trees about 16 inches in diameter. If bled "to death," 200 to 250 pines, 8 inches in diameter, will yield about 500 pounds each year for three years. M. Bagneris mentions a pine about 50 inches in diameter which had 10 chips working simultaneously, and yielded 12 to 14 pounds of resin annually. The men are paid by the cask of 517 pounds from $6 to $7, which allows them to earn about 80 cents to $1 per day. The price of the crude turpentine varies considerably from $8 per cask of 517 pounds. It reached the enormous figure of $58 during the American civil war. Orcharding in France is usually carried on on half shares between timber-land owner and orchardist.

EXPLANATION OF PLATES.

PLATE IV.—Tools used in French practice.

The tools employed in the French method of orcharding are: An ax (la cognee) for cutting trees and for removing the course for the chip and for opening the lower cuts. An ax with a concave blade and a curved handle (l'abchot); this is the principal tool of the orchardist, and it serves exclusively for the opening of the chips. The blade is razor-like in order to make a sharp and smooth cut through the resin ducts. The irregular form of its handle and of its sharp edge make it an instrument difficult to manufacture and particularly difficult to use, and it is only after a long apprenticeship that it can be used with exactness and dexterity. (Fig. 1.)

A scoop (la pelle) is made of iron, with an edge of steel. It is fixed at the end of a wooden handle of about 3 feet in length. This serves to clean the bottom part of the chip and particularly to draw out the resin from the reservoirs. (Fig. 2.)

The barker (la barrasquite) has a blade, steel-plated, narrow, and curved, and is furnished with a handle 5 feet long. This instrument is used for barking the trees at the highest point where it is impossible to use the ax, and for gathering the resin from such places. (Fig. 4.)

Another kind of barker (le rasclet) much edged, having a handle 6 feet long, which is furnished with a step, is used in certain regions to continue the chip above the height of a man. Often the orchardist holds on by the handle of the "rasclet" and works with the hatchet. (Fig. 3.)

A third form of scraper (la pousse), having a handle 8 feet long, used for the same purpose, has the blade so bent as to permit the worker to stand at a distance from the tree, thereby avoiding, while working, the falling bark and dripping resin. (Fig. 5.)

A shorter scraper (le palot) with a handle only 3 feet long replaces the scoop everywhere where the Hugues system does away with the dirt; it is used for cleaning, and is also used like a dibble at planting time for planting the acorns. (Fig. 6.)

A ladder made by cutting steps into a pine sapling, each step being held by a nail to prevent breaking, is used to reach the higher points.

The products are gathered from the chips or pots, to a reservoir established in the forest, in a sort of basket with a capacity of about 20 quarts. It is formed by a cylinder of rough cork surrounded with wood, the bottom being a round slab, made fast with pegs, the handle is of willow.

A spatula (l'espatula) is used to remove the resin that adheres to the sides of the pots or transporting vessels. (Fig. 7.)

PLATE V.—Cross-sections through bled timber.

This plate shows cross-sections of trees bled through several periods of years; also the manner in which chips are distributed, and healed scars.

PLATE VI.—Turpentine gathering—Hugues system; fire-safety strip.

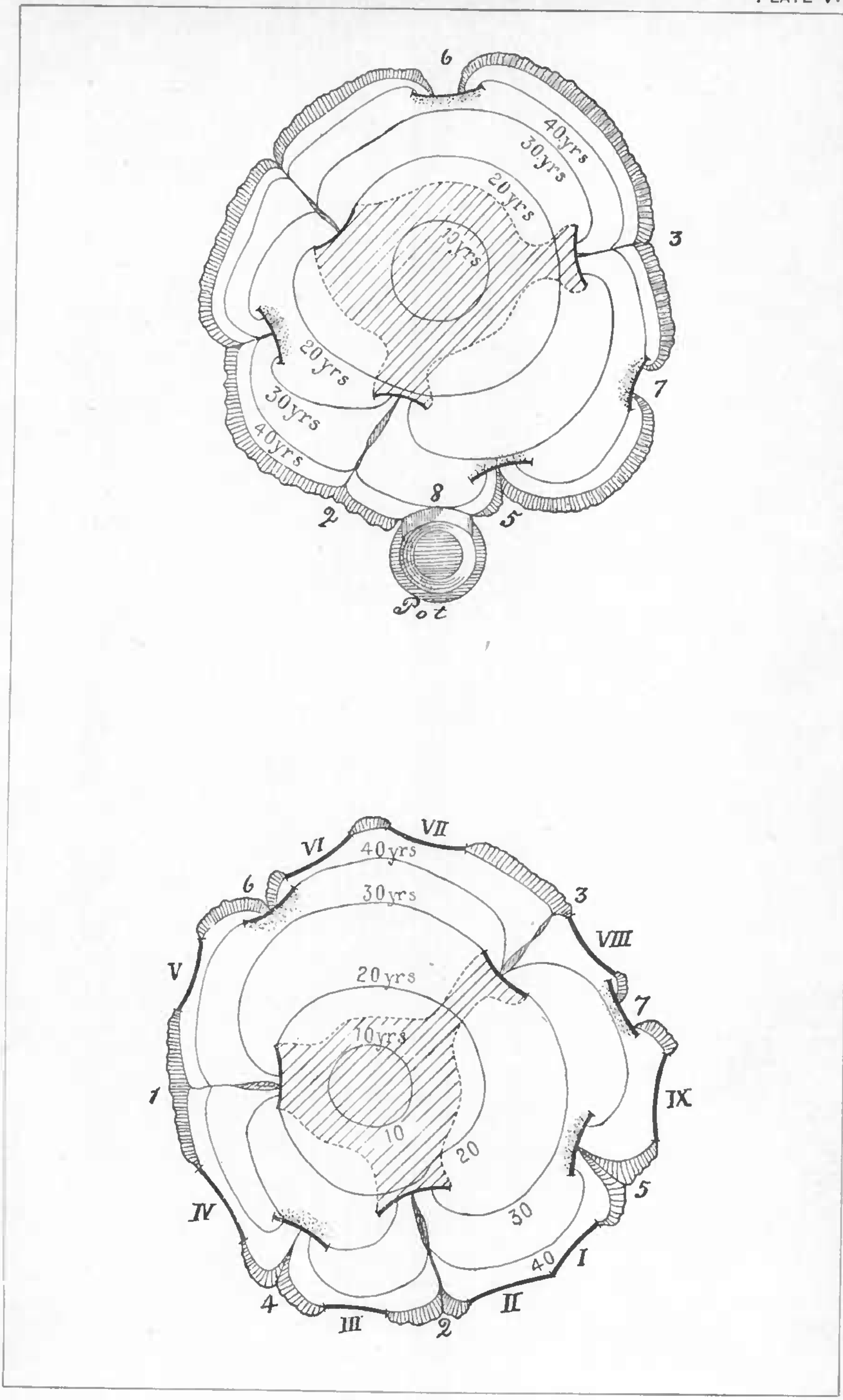
In this plate Fig. 1 exhibits the method of gathering turpentine by the Hugues system, and the use of the till and pot. While formerly the resin was allowed to run into a hole in the sand at the foot of the tree, since 1860, when the production was stimulated by the closing of the American sources of supply, an improvement on the crude method of collecting came into use. It consists in fixing a bent zinc collar or gutter cut from sheet zinc 8 inches long and 2 inches wide, with teeth (see figure) across the chip, which acts as a lip, and conducts the liquid resin into a glazed earthen pot or a zinc vessel of conical shape suspended below the lip. The pots are 6 inches high, 4½ inches at the opening, and 3 inches at the bottom, and hold about 1 quart. At first placed on the ground they are fastened each season above the old chip by means of a nail through a hole or otherwise (see figure). In this way, by shortening the distance over which the resin has to flow, the evaporation of the oil is reduced, and there is less liability of impurities to fall into the receiver. A cover over the pot is also sometimes used. The pots are emptied every fifteen or twenty days with the aid of a spatula (see Plate IV, Fig. 7). The scrape is collected only twice in the season, in June and November.

Another improvement which reduces the amount of evaporation and assures cleaner resin consists in covering the chip with a board. This improvement (Hugues system) is said to yield more and purer resin, the yield is claimed to be about one-third larger, and the difference in price, on account of purity, 80 to 90 cents a barrel, while the cost per tree per year is figured at about 1 cent, besides the proportion of scrape is considerably reduced. This (called galipot) is collected by hand, except the hardest impure parts (called barras), of which there is hardly any in this system of collection. Not more than 17.9 per cent of scrape is expected, as againt 29 in the American practice.

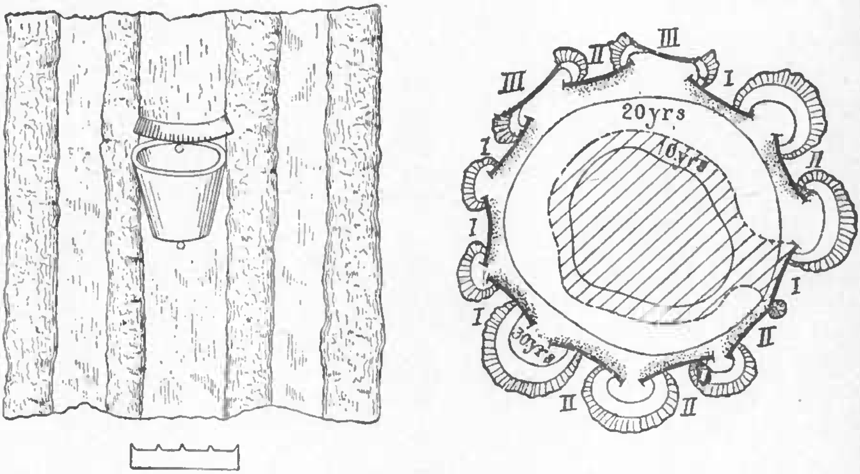
Fig. 2 shows safety fire strip along railroad; *a* is the elevated roadbed, *b* is a strip of ground about 25 feet wide, which is cleared of all inflammable material. Alongside of this the wooded safety strip about 50 to 60 feet wide; *c* is a ditch 5 to 6 feet wide, a foot or so deep, the soil being thrown toward *d*. Cross ditches are made through the safety strip every 300 feet. The total width of the whole system of the road on either side is, therefore, 80 to 90 feet. The strip *b* may be used for agricultural purposes if fit for it; strip *c* remains wooded, but the forest floor is cleared out and freed of all inflammable material.

MANAGEMENT OF TURPENTINE PINERIES.

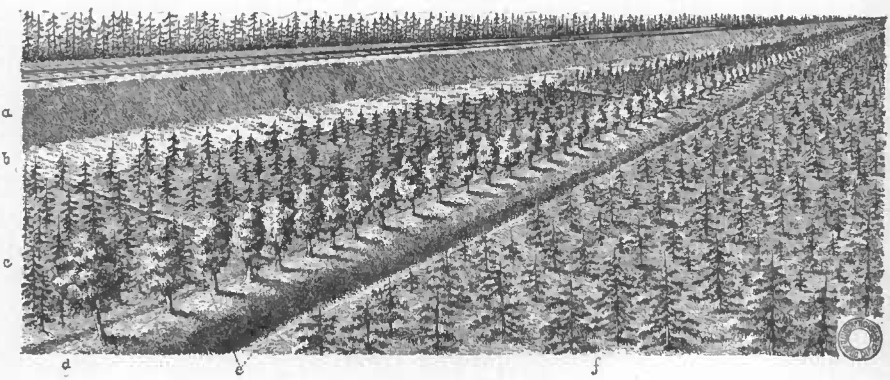
When the yield of turpentine falls below a certain minimum, the time has arrived when the growth must be regenerated. All trees are then bled "to death" and cut as they give out, and the openings are seeded with pine seed and the reproduction is completed in four or five years. The young forest grows up uniformly, densely, and quickly, and when 10 or 12 years old it becomes necessary to thin out and to repeat the operation every five or six years, so that at the age of 20 the pines are nearly isolated. Then there are about 250 to 280 trees per acre, and bleeding "to death" is commenced at the rate of, say, 80 or 85 trees which are to be taken out during the next four or five years. At



CROSS SECTIONS THROUGH BLED TREES—FRENCH METHOD.



TURPENTINE GATHERING (SYSTEM HUGUES), TILL AND POT.



FIRE-SAFETY STRIP ALONG RAILROAD.

the age of 25 another 80 are subjected to the operation, and at the age of 30 there may be left 100 to 125 trees per acre. At this age, when the trees are about 1 foot in diameter, bleeding "alive" is commenced on all trees. At the age of 60 to 80 years this number has dwindled down by casualties to 80, or even 65. If well managed, these trees may last 120 to 130 years; otherwise, if bled too much, they will succumb in half the time. A rest of a year or more every fifth year is necessary to recuperate the trees. When the circumference of the tree has been all chipped, the old chips may be opened again.

In order to produce resin abundantly the trees must stand isolated, their crowns well exposed to the sunlight, but it is only necessary that the crowns should just touch, when the trees are sufficiently isolated.

The best producers are the short, stout trees, with well-developed crown and well set with branches. To endure tapping without injury, they should be at least 14 inches in diameter, with a bole of 20 to 26 feet to the first limb on the dunes and 40 to 50 feet in the landes. There is no definite relation between volume and resin production. In fact, there is but little known as to the conditions and physiological processes which give rise to the formation of resin, except that full active foliage and heat seem to be essential factors.

GATHERING OF SPRUCE TURPENTINE.

The wood of the spruce contains few and rather narrow longitudinal resin ducts, but wider lateral ducts, which are strongly developed in the liber or new wood fibers. It is these that furnish the flow. Hence the methods of extraction used on the pines must be modified. In growths of 80 to 100 years old the yield is about 127 pounds of scrape and 40 pounds of dip per acre. Here the scrape is the purer material, and, therefore, more expensive, the dip being more or less impure. The operation is harmful to the trees, as it is apt to induce red rot. The pitch known as Burgundy pitch is derived from the resin of this species.

The resin of the spruce has also the property of hardening very quickly on exposure to the air; therefore it does not flow readily enough from the chip to permit the methods used in the pines. In May or June two chips are made at the same time, 3 to 3½ feet in height and only half an inch in breadth, on opposite sides of the tree. They are cut with a specially curved sharp knife, and deep into the sapwood. In order to prevent stagnant water from collecting at the bottom this is made pointed. The sides of the chip soon callous, which would prevent the flow, and, therefore, the sides must be renewed every two or three years, or yearly, gradually widening the chip, so that after a series of years only two small strips of bark remain between the two chips. The renewing of the sides is done in summer, so that they may protect themselves before winter sets in by forming new callous. In some localities alternate chips are made every two years, instead of enlarging the original one. The bleeding is continued for ten to fifteen years, and the yield per tree and year averages 1 pound scrape and 1⅓ pounds of dip.

GATHERING OF LARCH TURPENTINE.

The larch contains resin ducts of very large diameter, and the resinous contents are found mainly in the heartwood. The trees very often contain frost splits in the heart, in which the resin collects. The trees are bored into about a foot above the ground in horizontal direction. The bore-hole, being 1 inch in diameter and reaching into the center is closed with a wooden stopper. This hole fills up during the summer and the resin is taken out with a half-cylindrical iron and then closed up. One tree will furnish per year one-fourth to three eigths of a pound (120 to 189 grams) of resin. If the bore-holes were left open from spring to fall the yield could be increased to 1 pound, but the resin would be impure, would contain less spirits of turpentine, and the tree would be damaged. One bore-hole suffices for the whole period of orcharding, which is usually carried on for thirty years. With small amount of work and with a price two to three times that of the black pine turpentine, and no injury to the trees, this industry is quite profitable in spite of the small yield.

GATHERING FIR TURPENTINE.

The resin of the firs occurring mainly in isolated resin vesicles or cells and most abundantly near the bark (blisters), this is gathered by means of an iron pot with sharp-pointed till, with which the vesicles are pierced. From the European fir in this way the Strasburg turpentine used to be gathered; now the practice is nearly abandoned. The Canada balsam is gathered similarly from our own fir, *Abies balsamea.*

EFFECTS OF TURPENTINE ORCHARDING ON TIMBER, TREE, AND FOREST, AND SUGGESTIONS FOR IMPROVEMENT ON AMERICAN PRACTICE.

The turpentine industry can be carried on, but usually is not, without detriment to the value of the timber, to the life of the tree, and to the condition of the forest. The present practice, however, in the United States is not only wasteful, but highly prejudicial to present and future forestry interests.

EFFECT ON THE TIMBER.

As far as the timber of bled trees is concerned, it has been shown by the work of the Division of Forestry that the heartwood, the only part of the tree which is used for lumber, is in no way affected directly by the process of tapping. Not only has its strength been shown to be in no wise diminished, but since the resin of the heartwood does not participate in the flow, being nonfluid, the durability of the timber, as far as it depends on the resinous contents, can not be impaired by bleeding. Indirectly, however, by the boxes and large-sized chips, a considerable loss of timber in the best part of the tree, the butt log, occurs, which is avoidable. The parts surrounding the scar are furthermore rendered somewhat harder to work by an excess of resin which accumulates on and near the wound, tending to "gum up" tools. Indirectly, also, a considerable proportion of boxed timber becomes defective if not used at once or, if left on the stocks exposed for a series of years to destructive agencies, such as fires, followed by fungus growth and attack of beetles. The larvæ of large capricorn beetles bore their way through the soft wood formed in the shape of callous surrounding the borders of the chip and through and beyond the sapwood. Through the innumerable fissures which are caused by repeated fires, air and water charged with spores of fungi find entrance into the body of the tree, causing decay, the damage increasing every year, so that from this cause alone the timber from a turpentine orchard abandoned for ten or fifteen years was at the sawmill found damaged to the extent of fully 20 per cent.

Another prospective loss in timber is occasioned by the tapping of undersized trees which are not ready for the saw. Even if the trees survived all the changes of the years following the bleeding and healed over the wound, the timber formed after the process, at least in the portion of the tree which carried the chip, is inferior and not fit for sawmill purposes on account of malformations and change of grain. The loss of timber by fire is also only an incidental effect of careless management.

EFFECT ON TREES.

No doubt the normal life of the tree is interfered with by bleeding; not that the resin is of any physiological significance to the life of the tree, but the wound inflicted in the tapping, like any other wound, interferes with and reduces the area of water-conducting tissue. This interference may be so slight as practically to have no effect, or so great as to kill the tree sooner or later if other conditions are unfavorable. The experience in France shows that with care (narrow chips and periods of rest, which permit callousing of the scar) trees may be bled for long periods and attain old age (see p. 348); it also shows how fast a tree may be bled to death, if this is desired. (See Plate III.)

While the exudation of the resin covering the excoriated surface and the accumulation of resin in the wood near the surface act as an efficient antiseptic and firm protection against atmospheric influences, access of fungi and of insects to the interior of the tree—superior to any callous—it also endangers the life of the tree if exposed to fire, since the resin is highly inflammable, and the heat produced by its flame is capable of killing the trees outright. It is, therefore, again, this indirect effect which exposes the trees of the turpentine orchard to extra risk, even though the operation was carried on with due care and consideration for the vitality of the tree.

EFFECT UPON THE FOREST.

What has been said regarding the effects upon timber and trees applies naturally to the forest as a whole. With proper methods and proper care the turpentine industry need not be detrimental to the full and profitable utilization or the successful regeneration of the forest. In France the turpentine orchard is generally as well managed—with exceptions, of course—as any other forest property. Unfortunately, the ignorance and carelessness of our turpentine gatherers, as well as of the entire community regarding forestry matters, lead to most disastrous results.

The coarse, irrational manner of cutting boxes into the tree for gathering the dip, while reducing the yield of the valuable oil, weakens the foot of the tree, and those receiving more than one box or being of smaller size are generally sooner or later blown down; the broad chips out of proportion to the size and vitality of the tree cause many to die before they have yielded what they could; the same charge of wastefulness may be made against the methods of chipping and of collecting the resin, both of which reduce the yield considerably. But the greatest loss is that occasioned by the fires, carelessly handled by the orchardist himself in trying to protect himself against it, and still more carelessly allowed by the community to rage over large areas one season after another. In the orchard their destructiveness is increased by the broad resinous surfaces at the butt of the trees by the blown-down trees and the débris of the dead trees standing or lying on the ground. Dr. Mohr observes—

> The trees which have not been killed outright by the fire, or have altogether escaped this danger, are doomed to speedy destruction by bark beetles and pine-borers, which find a breeding place in the living trees blown down during the summer months, the broods of which rapidly infest the standing trees, which invariably succumb to the pest in the same season. Hence, the forests invaded by the turpentine men present, in five or six years after they are abandoned, a picture of ruin and desolation painful to behold; and in view of the destruction of the seedlings and younger growth, and of the vegetable mold, season after season, all hope for the restoration of forest life is excluded.

SUGGESTIONS FOR IMPROVEMENT.

No radical improvement or existing practice can, of course, be expected until the turpentine orchardists themselves can see that present conditions and methods are detrimental to their business, and can persuade the community that it is to the mutual interest of both community and orchardist to allay the fire nuisance.

Forestry—that is, rational use and management for perpetuity of our forest resources—will never succeed in our country until our communities discountenance the habits of the savages in the use of fire and learn that civilization consists in making nature do more than she voluntarily gives; in fact, that it consists in management, not in destruction, of natural resources.

It is the duty as well as the self-interest of the community to do all in its power to make rational management for continuity practicable, and the first step is to insure protection of individual property against loss, be it by depredation or by other preventable causes. Hence, protection against fire is a *conditio sine qua non*, if we would have rational and systematic management of our forest resources; for so long as forest property is made extra hazardous by lack of proper protection against fire, the inducement to rob it of its best parts in the shortest time and then abandon it to its fate is too great.

I would refer here to another part of this report, in which the general legislation for fire protection has been outlined (p. 310). In the States or portions of States in which turpentine orcharding is practiced, additional provisions would be necessary.

Regarding the practice in the technical operation of tapping, legislative regulations are probably out of question, the spirit of our institutions being against interference in the use of private property, except where such use is directly injurious to other persons. Otherwise it would be desirable for the indirect benefit of the community, and especially its future, to prescribe lowest size of trees to be tapped and broadest chip permissible.

The orchardist's own interest, if he owns the forest and proposes to make the most of it, or the owner's interest, if he leases it for turpentine orchard, would dictate the following considerations, which I have formulated into a set of instructions:

(1) Attend to the firing of the brush, when preparing for orcharding, at a season and time when a smoldering fire can be kept up which will not kill young growth and will not consume to ashes the vegetable mold.

(2) Abandon the "boxing" system and substitute the movable pot with cover and lip. (See Plate VI.) By this the tree is less injured or

liable to injury, and a larger amount of valuable dip and a smaller proportion of scrape is insured. The cost of making and cornering boxes—a wasteful operation—averages about $1\frac{1}{2}$ cents per box, while the cost of pots is very much higher (heavy tin or zinc iron pots might be used more cheaply); but if the orchard is worked for longer time, as proposed in the following, the cost per year will be reduced and amply repaid by better yield.

(3) Tap only trees large enough to make a good saw log, not less than 12 inches at the butt. Not only will such trees yield in better proportion to the labor expended, but the younger trees when left, after the saw timber fit for the saw has been taken, will assist in the reforestation by shedding their seed, and will in a few years have grown to proper size both for profitable tapping and profitable lumbering.

(4) Reduce the chip in breadth to not over 3 inches, and rather work more chips at a time on the same tree, if good sized; not more, however, than one for each foot in circumference simultaneously, so that a tree 1 foot in diameter would carry, say, three of these narrow chips, evenly distributed. Thus the tree will be kept in full activity and yield more turpentine for a longer time.

(5) Before starting the chip remove the rough bark down to a thin (reddish) skin for the breadth of 4 inches and, say, 2 feet in height, or a little wider than the chip is to be, and as high as it is to be worked for the season; this is for the purpose of keeping your pots clean of bark particles. Start the chip with as small an opening and as low down at the foot of the tree as is practicable for attaching the pot, and cut it triangular at the base, so as to allow any water to readily flow off, preventing its collection and consequent fungus growth.

(6) Do the chipping as gradually as possible, remembering that the flow depends mainly upon the number of longitudinal ducts cut through transversely and kept open. A rapid increase in height of the chip is a useless waste; the chipping is done simply to remove the clogged-up ends of the ducts; the removal of one-fourth to one-third, or at most one-half inch, of new wood every five to eight days, according to the weather, will accomplish this end. As to depth, it is useless to cut deeper than the sapwood, since the heart does not yield any resin. Whether the French method of deepening the chip gradually and only to a depth of one-half inch at most or a cut through the entire sapwood at once is, on the whole, more profitable, comparing labor and yield, remains to be ascertained by trial. Where trees are not to be managed for continuous bleeding, but are to be exhausted prior to their cutting for saw logs, it would appear proper to cut at once through the entire sapwood, using perhaps a sharp chisel for the work of chipping. When we have arrived at a time when the orcharding is done in young plantations managed for the purpose the more careful chipping of the French may be indicated.

(7) Do not collect the scrape more than once a year, in August or September, or early enough to give the trees a chance to protect their scars before winter sets in, but reduce the amount of scrape by using pots and lips and keeping these as close as practicable to the top of the chip. In this way the superior yield will pay for the greater care.

(8) Remember that it is more profitable to prepare for operating a given area for ten to fifteen years instead of three to four years, since many necessary expenditures remain the same whether the operation is carried on for the shorter or longer period, and hence in the latter case are distributed through a longer term. With the above methods and proper care an orchard may be worked profitably four or five times

as long as under present methods, and hence many precautions, especially against fire, such as ditches, roads, etc., to arrest the fire, too expensive if the orchard is soon to be abandoned, may be employed with advantage.

(9) If present methods must prevail and protection against fires can not be had, because the community is still too uncivilized or blind to its interests, do not subject your valuable timber to turpentine orcharding, unless you can dispose of it to a sawmill immediately after the orchard is abandoned. Otherwise the loss of timber by fire is apt to wipe out all profits made by the orchard.

In closing this long and yet not exhaustive paper on a subject of vital importance to Southern forestry interests of the present as well as of the future, I feel that more knowledge based on experiment is wanted before we can with assurance determine the most profitable and least injurious practice for the turpentine industry.

ADDITIONAL NOTES ON THE TURPENTINE INDUSTRY.

By Charles Mohr.

IMPROVEMENTS IN THE DISTILLATION OF THE CRUDE TURPENTINE BY THE APPLICATION OF STEAM.

In the ordinary way, the distillation of the crude turpentine yielding the largest quantity of spirits of turpentine and finest quality of rosin can not be carried to the total extraction of the volatile oil without impairing the quality of the residuary product. The higher grades of rosin are still retaining a considerable amount of spirits. To prevent such loss distillation by steam has been resorted to. This innovation seems, however, not to have received the deserved attention. From the latest information it appears that this method has proved completely successful at a turpentine distillery in New Orleans; there, by its introduction, an increase of fully 30 per cent is claimed over the yield of spirits of turpentine obtained by distillation by the open fire, the grade of rosin remaining unaffected.

PRODUCTS OF THE DESTRUCTIVE DISTILLATION OF THE WOOD OF THE LONGLEAF PINE.

The air-dried wood of the longleaf pine in its normal condition has been found to contain from 2 to 2¾ per cent of volatile oil, taking the specific gravity of spirits of turpentine at 0.87 and the weight of 1 cubic foot of the air-dried wood at 43 pounds. The spirit is obtained by subjecting the wood to the action of superheated steam in the same retorts in which its destructive distillation is carried on, a process with which its production direct from the wood is invariably connected, and of which it forms the first step. The quantity of spirits of turpentine obtained varies largely. As stated by one operator, it differs all the way from 5 to 18 per cent, according to the wood being fresh cut or dry, and to the different parts of the tree from which it is taken. From the results of numerous experiments made on a large scale in different parts of the longleaf pine region, it can be assumed that one cord of wood, green and of different degrees of dryness, yields, on the average, about 15 gallons of an impure spirits of turpentine. Owing to the presence of empyreumatic substances of yellow color it becomes darker on exposure to air and of an empyreumatic odor. It is easily freed from its impurities by redistillation; thus rectified the product is perfectly clear, colorless, and almost odorless, save a faint woody smell, answering all the purposes for which the spirits of turpentine obtained from the rosin is used. In 1881 Mr. William Mepan, of Georgia, secured a patent for the utilization of the wood wasted at the sawmills, of the refuse left on the ground in the logging camp and in the turpentine orchard, for the production of spirits of turpentine, pyroligneous acid, tar, and charcoal. By the operation of the apparatus of the patentee, on exhibition at the Atlanta International Exposition (in 1882), 600 pounds of dry, highly resinous wood, so-called lightwood, yielded—

	Pounds.
Spirits of turpentine	$21\frac{1}{4}$
Pyroligneous acid	95
Heavy oils and tar	150
Charcoal	127
Water and gas	$206\frac{3}{4}$
Total	600

Amounting to a yield by the cord of 24 gallons of spirits of turpentine, 88 gallons of pyroligneous acid, 120 gallons tarry and heavier oily products, and 56 bushels of charcoal.*

In several experiments made at the same place slabs taken from the sawmill yielded (to the cord) from 12 to 14 gallons of spirits of turpentine, 200 to 250 gallons of weak pyroligneous acid, from 64 to 108 gallons of tar and heavier oils, and from 50 to 60 bushels of charcoal. The operations subsequently carried on by the same parties in retorts of a capacity of about 6 cords of wood showed similar results. In the attempt made at Mobile by Mr. Maas, about fifteen years past, in connection with a sawmill, soon abandoned, however, the results were about the same. From a cord of green slabs 12 gallons of turpentine were distilled and 150 gallons of tarry and oily substances. The rectified spirits of turpentine was found not to differ sensibly from the product of the rosin. At the works of the Yellow Pine Wood Distilling Company at New Orleans, worked under the patent and superintendence of Mr. E. Koch, every kind of mill refuse, pine knots, stumps, branches, etc., are used. The patentee has kindly furnished the following information about the apparatus employed and the way it is being worked: The material is cut in short pieces, loaded in iron cars, which are run into steel retorts, 20 feet long and 8 feet in diameter, provided with rails and holding 3 cords of wood; doors are closed tight, superheated steam is let in and at the same time a moderate fire is started in the furnace. The distillation proper of the spirits begins in about six hours at a temperature of 300°, increasing during the next four hours to 350°, until the distillate ceases to run; at this stage the steam is shut off and the destructive distillation by the open fire is proceeded with; under the gradual increase of the temperature from 350 to 900 degrees the distillation is continued through the following fifteen hours, the whole operation consuming about twenty-four hours. The residue in the retort is a charcoal of good quality. The quantity of spirits of turpentine obtained from 1 cord varies from 5 to 18 gallons, of heavier oils and tarry products known as dead oil or creosote from 60 to 100 gallons, and of stronger acid (of a specific gravity 1.02) 60 gallons, or of weaker acid 120 gallons. The gas produced is used for fuel. The capacity of this plant is 6 cords of wood in twenty-four hours. By the increase in the value of dead oil that has taken place during the past five or six years the destructive distillation of the wood of the longleaf

*Report of awards at the Atlanta International Exposition in 1882.

pine is placed financially on a more promising basis than ever before. If the enormous amount of raw material be considered, which has heretofore gone to waste at the sawmills and in the forest, but by this process may be turned to a profitable use, this industry is capable of the widest extension and can not fail to add other resources of income to those already derived from the forests of longleaf pine.

With the augmenting demand for the mixture of heavier hydrocarbons and chryselic (phenylic) compounds known in the trade as dead oil, creosote, or pine oil for the impregnation of timber for the purpose of preventing its decay and destruction by the teredo, the distillation of the wood of the longleaf pine is at present carried on with the main object of securing the largest yield of dead oil. According to the statements of Mr. Franklin Clark, of Columbia College, N. Y., made in his paper on the subject, for this purpose the most resinous wood is preferred with which the retorts are charged.

These retorts, cylindrical in shape, made of wrought-iron or steel plates, and about three times as long as they are wide, are of a capacity to receive little over a cord of the perfectly air-dried wood. The distillation is effected by the open fire and the condensation of the distillate by the ordinary worm condenser. The light oils running over first at a temperature of from 350 to 500 degrees of a specific gravity of 0.88 to 0.90 are of a dark-red color; as soon as their density has increased to the latter figure they are caught separately. After twelve or fifteen hours, when the temperature has reached 600 degrees and the density of the oil is 0.98, with the formation of the chryselic compounds, the aqueous distillate at this stage shows a higher percentage of acetic acid, increasing with the rise of the specific gravity of the oil. The operation is generally finished at a temperature not exceeding 900 degrees. The process is terminated at the end of twenty-four hours.

The charge of the retort averaging 4,575 pounds of resinous, air-dried wood (little more than a cord) yields—

Light oil (of spec. grav. 0.875 to 0.95)	gallons	13
Heavy pine oil or dead oil (spec. grav. 0.95 to 1.04)	do	73½
Pyroligneous acid (spec. grav. 1.02)	do	185

Or a mean yield of:

Pyorligneous acid (spec. grav. 1.02)	1,527 pounds, or	34.37 per cent.
Total of oily products	729 pounds, or	15.94 per cent.
Charcoal	1,511 pounds, or	33.04 per cent.
Gas	761 pounds, or	16.64 per cent.

On settling, the pine oil—that is, the whole of the oily products of the wood—separates from the acid as a black or red oil, with a specific gravity from 0.907 to 1.30. For the purpose of creosoting it is subjected to a process of partial distillation, by which the separation of the lighter oil is effected, and the percentage of the phenylic compounds and of the heavy hydrocarbons to which the creosoting process owes its merits is increased.

The pyroligneous acid is of a yellowish or reddish color and contains 4 per cent of hydrated acetic acid. In its crude state it serves for the manufacture of pyroligneate of iron, the so-called black dye, and for the preparation of acetate of lime, acetate of lead, and pure acetic acid. The light oil is used for dark paints, fit to cover metals and stone. It does not work well, however, for wood.

REPORT OF THE SPECIAL AGENT IN CHARGE OF FIBER INVESTIGATIONS.

SIR: I have the honor to present herewith a report upon the principal operations of the office of Fiber Investigations during the past year. In this report I have given the results of my further explorations and experimental work in Florida upon the subject of the leaf fibers, so called, such as sisal and bowstring hemp, pineapple fiber, and similar forms, including a full account of the false sisal hemp plant which is found to be a new botanical species. Of sisal hemp this country imports fiber to the value of about $5,000,000 annually, while the Florida article is of better quality and undoubtedly will command a higher price in the market than that from Mexico.

Very respectfully,

CHARLES RICHARDS DODGE,
Special Agent.

Hon. J. M. RUSK,
Secretary.

LEAF FIBERS IN SOUTHERN FLORIDA.

Bowstring hemp is not a commercial fiber, though widely known in the Old World. The fact that it grows luxuriantly in southern Florida, producing a strong, beautiful fiber, suitable for higher uses of manufacture, makes it desirable for cultivation. Since I first called attention to this fiber, several years ago, many thousands of plants have been put out in Florida and are doing well.

Experiments with pineapple fiber are in progress. Pineapple culture is gradually extending in southern Florida, and as the leaves of the plant are known to contain a fine fiber, it has been thought that a new source of income might be given the Florida planter from the sale of the leaves of the plant when the fruit had been harvested. To ascertain the amount of fiber obtainable from these leaves, and its quality and value, has been the object of the Department's investigations in this direction.

I would also call attention to the fact that New Zealand flax is readily grown on the Pacific coast and could be produced in many other portions of the country. This country has imported in a single year, recently, as high as 67,000 bales of this commercial fiber, the United States being the chief consumer of the product. We could as readily grow this fiber at home as to bring it from the antipodes.

EXPERIMENTS AT COCOANUT GROVE (BISCAYNE BAY).

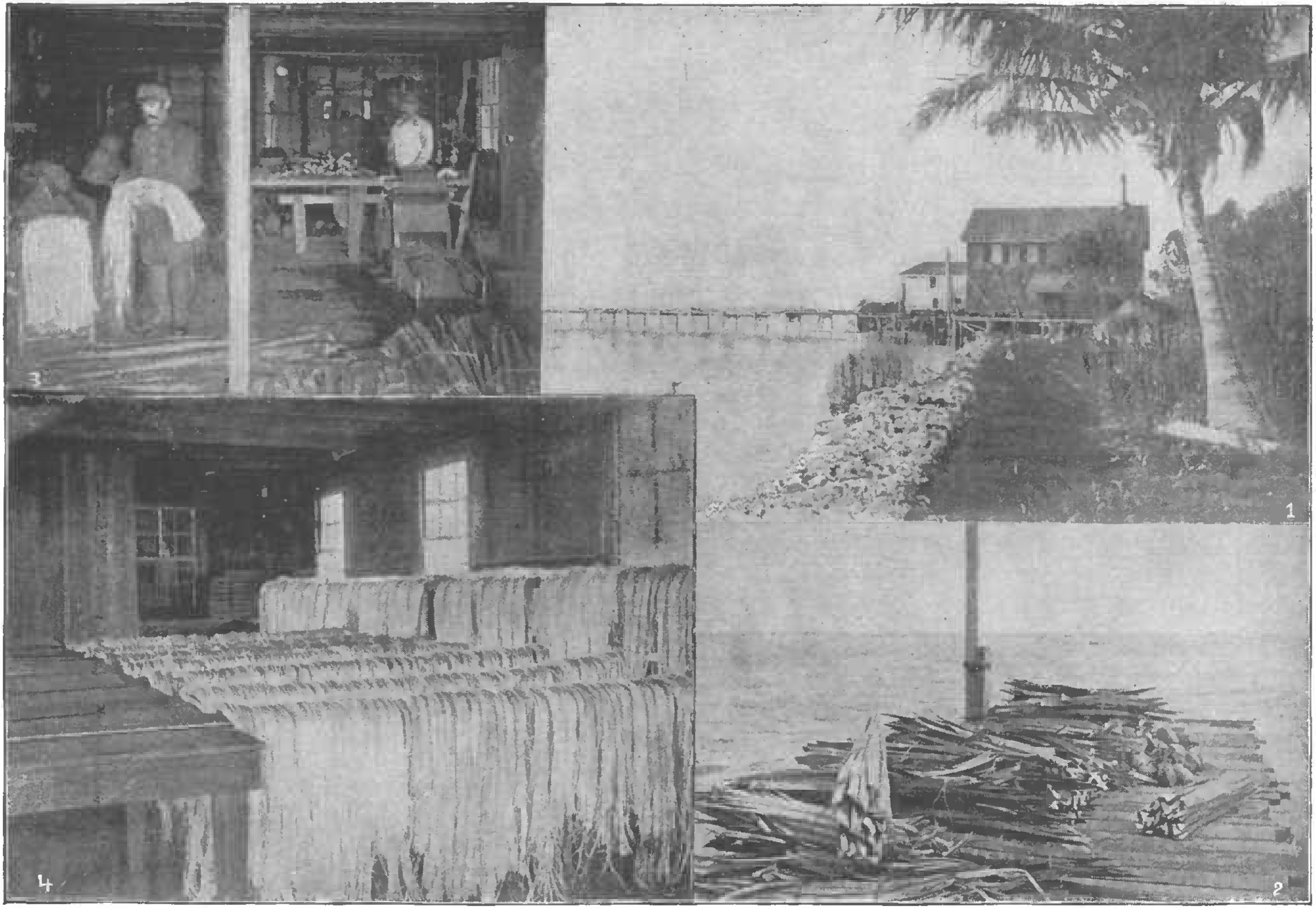
Since the publication of my last report on sisal hemp culture in Florida, considerable additional information has been secured and some new facts ascertained that have not hitherto been given to the public. Early in the season I spent two months in the Biscayne Bay region of Florida, from which point explorations were made covering nearly 200 miles of the coast from Key West to New River. Headquarters were established at Cocoanut Grove, on Biscayne Bay, where an experimental cleaning factory (Plate I) was established, machinery having been sent down by the Department for the purpose. The results of the season's work were in every way satisfactory, and a considerable quantity of valuable material in the form of fiber products was secured, which will enable the Department to test the fiber in manufacture and ascertain the facts regarding yield of fiber per ton, tensile strength, and commercial value.

With a fast sailing vessel at my disposal, I was able to collect plants and leaves from the principal tracts along the coast, where sisal has been growing for forty years or more, and to bring the latter to the cleaning mill in perfectly fresh condition. The chief sources of supply were as follows: Indian Key, two varieties from the original plantings by Dr. Perrine; the Metecombe's (upper and lower), more recent plantations from the first named; the Perrine grant, from plantings by Charles Howe, who was associated with Dr. Perrine; from Narre's Cut, opposite Miami, more recent, name of planter unknown; and from Jupiter, Fla., from plantations set out by Peter Stone at Jupiter Point about the close of the war. Very small lots were also secured from Fort Dallas and other points along the coast, where small areas were found growing. A quantity of fiber from the false sisal was also obtained, from leaves grown on Sands, Elliotts, and other keys, but which will be referred to in a special chapter on "False Sisal Hemp."

In regard to the distribution of these two species of plants it is appropriate to mention here that in all the territory covered by my explorations, plants of the true sisal hemp were always found in situations near to the habitations of man, or near the former sites of such habitations. On the contrary, on both mainland and keys where the face of the country is still in a state of nature, no plants of the true sisal were ever seen, though such situations were frequently found to be covered with dense growths of the false sisal, the species often being distinguishable from offshore before the boat had made a landing.

Regarding the existing tracts of the true sisal hemp plant (*Agave rigida*, var. *sisalana*), that upon Indian Key is the largest, as it circles the island, growing for the most part near the shore line, and not found in the center of this key, which is one of the smallest of the group. Here the greater quantity of leaves secured for the purpose of extracting the fiber were taken, the next largest lot coming from Capt. Addison's place, on the Perrine grant. Only the lower leaves of a plant were cut, though as a rule fully one-half of all the leaves were taken off.

A study of the distribution of the true sisal hemp plant over the east and west coasts of the southern portion of Florida is most interesting because of its wide extent, while the plantations are often, at the same time, quite remote from each other. This might be taken as satisfactory proof that the original plants were set out by man, if no other proof existed. Fortunately it has been possible to trace the history of the principal plantations, the facts showing that at various



1. U. S. EXPERIMENTAL FIBER FACTORY, COCOANUT GROVE, FLORIDA. 2. CARGO OF SISAL HEMP LEAVES ON FACTORY WHARF. 3. FACTORY INTERIOR, EXTRACTING SISAL HEMP FIBER. 4. LOFT OR DRYING ROOM OF FACTORY.

Fiber Report, U. S. Dept. of Agriculture, 1892.

NURSERY OF SISAL HEMP PLANTS AT NEW RIVER, FLA.

times during the past forty or fifty years sisal enthusiasts have endeavored to carry out Dr. Perrine's work of establishing this industry in Florida.

LIMIT OF SISAL HEMP CULTIVATION.

Regarding the west coast, which I have but partially explored, it will be impossible to speak authoritatively. The northern limit of safe cultivation on the west coast was stated in my first report to reach only as far as latitude 27° 15′, which would place it a little below the center of Manatee County. This statement was made on the authority of a valued correspondent, Mr. Ranson, who says that this latitude marks the frost line. A writer in the Port Tampa Mail, commenting on the above, states that there is no county in Florida where the henequen grows more rapidly and to greater perfection than in Hillsboro County, lying above Manatee, and he places the limit of safe cultivation on the west coast as far north as the Anclote River, practically the boundary line between Hernando and Hillsboro counties, or fully a degree higher than stated by Mr. Ranson. I have seen thrifty plants in cultivation at Punta Gorda and around Tampa, and even in more northerly portions of the State, but have not regarded cultivation absolutely "safe" much above Charlotte Harbor, one year with another. A frost even once in five years is once too often where sisal hemp is grown commercially. Dr. Washburn, of the subtropical experiment station at Fort Myers, informed me that there are marked climatic differences between the two regions immediately bordering the Caloosahatchee River; that is, north and south of this body of water. And in proof of this he referred to many tropical plants growing immediately south of it which would not thrive on the other side of the river from Myers. Concerning the east coast I made this statement in the Annual Report of the Department for 1891: "The frost line marks the limit of safe cultivation. This line is drawn from latitude 28° 30′, commencing on the Atlantic coast, in a southwesterly direction across the State of Florida to the Gulf coast, in latitude 27° 15′."

I still adhere to this opinion, and while accepting the statements of our two east and west coast correspondents, which would fix the line above latitude 28°, I consider latitude 27°, running across the State, a safer limit for the establishment of plantations on a commercial scale. I am perfectly well aware that the opinion exists in many minds that no specified limits can be stated where vegetation is wholly exempt from occasional frost. I am only endeavoring to establish a "safe" limit in south Florida for sisal hemp culture.

In the earlier report I gave a detailed account of the different localities where the plants were growing in a semiwild state from former plantings. There is nothing of particular interest to add to that account. It was my pleasure, however, to visit the sisal hemp plantation at New River, 25 miles north of Miami, where the Florida Fiber Company of Jacksonville has 1,300 acres of land which it is proposed to devote to this culture. A substantial beginning has already been made under the personal superintendence of Mr. J. R. Kuckler, of Jacksonville, and the work of planting is being rapidly pushed, the U. S. Department of Agriculture having encouraged the enterprise to the extent of 100,000 plants. I visited this tract in April and was able to take a number of photographs illustrating the company's operations, one of which is reproduced. (Plate II.) The plants being young and small, cuttings of course will not be made for several years to come, when some very interesting questions regarding the industry will be settled.

A study of this wide distribution of the sisal hemp plant seems to confirm Mrs. Walker's statement that when these plants (set out by her father) had multiplied to some extent the officers at Fort Dallas, at the mouth of the Miami River, were in the habit of gathering the young ones to send to other posts, where they were grown as ornamental plants. As a fact the principal tracts of plants now growing in Florida are either in the neighborhood of former army posts, or are located where Dr. Perrine, or his associates, set out plants at the time of his experiments.

WORK AT THE EXPERIMENTAL FACTORY.

The Department was extremely fortunate in securing use of such portion of the plant of the Biscayne Bay Manufacturing Company at Cocoanut Grove as was necessary for its operations, this being the nearest available power to the sources of supply of the leaves, although 80 miles by sail from Indian Key. The Van Buren cleaning machine previously purchased by the Department was shipped to Florida, and set up on my arrival. With ample space on the main floor of the building, and with a large loft in which to spread out the cleaned fiber after it had been partially dried in the sun on the long factory wharf, the equipment was all that could be desired. Mr. Ralph Munroe, the superintendent of the Biscayne Bay Manufacturing Company placed his schooner yacht *Micco* at the disposal of the Department, which enabled quick transportation of leaves, so essential to the success of the experiments. I may state that both the gathering of the leaves and the factory work was done under my personal supervision.

METHOD OF GATHERING LEAVES.

As to the manner of cutting or gathering the leaves, the plants being almost in a state of nature, and their lower leaves spreading out very near the surface of the ground, it was found impossible to use the Mexican *machete* employed in Yucatan for this purpose. The implement is in very common use in southern Florida, however, for cutting out the dense undergrowth in thickets, and was always carried with us. While the greater part of the leaves were cut with sheath knives, which the men always carry, the handiest implement used was a large pruning knife, having a blade nearly 4 inches long. The hook-like point of this knife often made it possible to sever a leaf with a single drawing cut, which could be accomplished more rapidly than a man could strike a blow with the *machete*, and the cutting was accomplished rapidly. As fast as the leaves were cut they were bound in bundles of about fifty and thrown in piles to be transported by small boat to the sailing vessel.

As to the quantity of leaves that one man would be able to cut in a day, while I have not the data to make positive statements, I should estimate that a ton and a half would be a fair day's work, though this form of labor was new to our men, and the plants were so close together in the sisal thickets that the work was necessarily slow.

WEIGHT OF SISAL LEAVES.

In my former report the average weight of a sisal hemp leaf was stated at a pound and three-fourths, the range being from $1\frac{1}{2}$ to 2 pounds. To verify these figures, all the leaves cleaned at the experimental factory were sorted, and the bruised or discolored ones rejected, after which they were weighed out in 50-pound lots and counted. The countings of the first 2,000 pounds of leaves (*sisalana*) from Indian Key were recorded, by 50-pound lots, as follows:

35	39	34	34	36	35	34	34
35	38	35	34	35	34	41	34
37	38	32	38	33	35	35	32
37	41	35	38	34	35	36	33
33	36	34	37	35	34	35	35

This shows an average weight of 1.41 pounds, or about 1 pound 6½ ounces to the leaf. This average is lower than would have been the case had the cuttings been made invariably from old, mature plants. In some instances younger plants were cut, the difference in size not being readily distinguishable where the plants were growing in dense masses. Weighings of leaves of the spined form, also from Indian Key, fell below this average, and for the same reason; so few plants of the spined variety were found on this key it was necessary to cut some of the leaves from smaller plants to secure the quantity of fiber desired. Referring to the counts of individual bundles, the largest number of leaves in a 50-pound bundle was 41, and the smallest number 32, which makes the range from 1 pound 3¾ ounces to 1 pound 9 ounces. The second Indian Key lot, cut about two weeks later (*sisalana*) gave an average of 1.42 pounds to the leaf.

Several smaller lots of specially selected leaves from mammoth isolated plants, growing on the Metecombes, gave the following weights per leaf, in pounds and fraction of pounds: First lot, 2.64; second, 2.08; third, 1.85; and fourth, 2.27. This shows a range from 1 pound 13⅓ ounces to 2 pounds 10 ounces. Quite a difference was noticed in the weights of the leaves from different portions of the same plant. The extreme bottom leaves, from Indian Key (rejecting those, of course, lying on the ground and partly decayed) when weighed and counted as above, gave a weight of 1.2 pounds, or 1 pound 3 ounces and a fraction average per leaf. The weighings of lots from the Perrine grant and Jupiter Point gave similar results to those obtained from weighings of the first ton of Indian Key leaves, and detailed statements are not necessary.

No attempt was made to estimate the cost of cleaning, the main object being to secure thoroughly well cleaned fiber without regard to the time occupied in passing the leaves through the machine. Then, too, the work was new to the men who operated the machine, and any figures based on the output per day of ten hours would be very misleading. All fiber was carefully weighed after drying, and the waste of several lots washed out, dried, and weighed, so that a very fair estimate of the yield of Florida fiber per ton of leaves can be made.

A study of the weighings of leaves and the dried fiber obtained from these leaves is interesting. But before making statements regarding the rates of yield of Florida sisal compared with the Yucatan and Bahamian, let me again refer to the fact that the variety grown in Yucatan is different from that grown in the Bahamas and Florida. In my former report it was stated that the *sisalana*, as grown in Florida (Dr. Shott's *yaxci* form) produces less fiber, but excelling in softness, flexibility, and luster, and bringing a higher price in the market. The *latifolia* (the *sacci* form) cultivated throughout Yucatan produces a far greater quantity of fiber than the preceding, and furnishes the principal bulk of the sisal hemp of commerce.

The average weight of a leaf of the Mexican form of plant is 1 pound 10 ounces, according to reliable authorities. A calculation placed on the above figures places the yield of dried fiber from 2,240 pounds of leaves at 82 pounds and a fraction. The actual product of a long ton of Indian Key (Florida) leaves from the *sisalana* form was a very little short of 79 pounds. The machine made a very considerable waste, which, after being carefully washed and dried, gave a weight of 22½ pounds from the ton of leaves. This gives a total of very nearly 102 pounds of straight fiber and waste from a ton of leaves. Regarding the waste made by the raspador in Mexico, I have no authoritative information, but I know it is not 20 per cent of the total weight of fiber in a ton of leaves, which is enormous.

Mr. T. J. McLain, United States consul at Nassau, informs me that the average yield of 2,000 pounds of sisal leaves in the Bahamas is 75 pounds, equivalent to 83 pounds to the long ton, or about 4 pounds more than the yield of Indian Key fiber. This difference is more than accounted for in the excessive waste made at the Florida experimental factory, due probably to a slight defect in the "shoe" of the individual machine used by the Department for cleaning the fiber. It should be noted that Mr. Van Buren claimed a loss of not over 5 per cent for his machine when in perfect running order.

The statement has been made in connection with the question of soil that the better the soil and the larger and heavier the leaf, the less percentage of fiber to the ton of such leaves. It has been stated that the Jupiter Point leaves cleaned by me weighed, on the average, about 1 pound 9 ounces, against 1 pound 6½ ounces for the Indian Key lot. The result from weighings of dry fiber from the two sources shows that a long ton of the heavier leaves from Jupiter Point yielded at the rate of 71 pounds of dried fiber, against the 79 pounds, actual, from Indian Key, the percentage of waste being about the same in each lot.

Leaves from the spined variety, grown on Indian Key, yielded at the rate of 72 pounds of fiber to the ton. As less than a fourth of a ton could be secured, however, owing to scarcity of the plants of this variety, this estimated quantity can not be stated as absolute.

REGARDING CULTIVATION.

The question of soil was fully discussed in the former report on sisal hemp culture, and there is little of interest to add to the statements already published. That the plant thrives in the keys (Indian Key, especially) upon the almost naked coral rock is evident from the luxuriant growth it makes in these situations. With a deeper soil, overlying shell, as at Jupiter, where vast shell mounds occur, the plants seem to do little better. I found soil on the peninsula opposite Miami so poor, however, that a long row of plants set out ten years ago to form a boundary line had hardly made any growth, if they had more than held their own. This soil seemed to be mainly fine sand, with no trace of the underlying rock which always occurs on the mainland.

Some interesting specimens of leaves were received from Polk County, in the interior of the State, which show that the plant will grow away from the seacoast. Samples of soil were also sent from this locality. One of them, submitted by Mr. Alonzo Cordery, has also the appearance of fine sand, but it is much darker in color than the Narre's Cut soil, and evidently contains some vegetable matter as well as phosphate. A sample taken 18 inches below the surface, of a color somewhat resembling cayenne pepper, though lighter, contains fragments of rock, not analyzed, which is doubtless phosphate. These samples were taken in the "sandhills" district, 5 miles east of Fort Meade, where old sisal plants are growing. Mr. C. G. Colburn Wright sends from this locality

(Fort Meade, Polk County) another sample of surface soil quite different from that sent by Mr. Cordery, as it is whiter, and, I should say without analysis, more deficient in elements of plant growth than the other samples submitted.

A writer living on the Gulf side states, as the result of his observations, that he believes the plant will grow almost anywhere and thrive; that it is indifferent to moisture, although it grows best in localities not too far from the sea; that it will thrive on scrub lands, where nothing else but a scraggy growth of spruce and rosemary will grow—lands practically worthless at present in Florida. He considers that these lands are even better than the soil, rocky and sterile, and almost without moisture, upon which the Yucatan fiber is produced, and states that while the plants make a heavier growth in rich soil, they will produce a far smaller proportion of fiber. Commenting on this, I should say that there are thousands of acres of better sisal hemp land in southern Florida than in the fiber-producing districts of Yucatan.

Reference was made in my last report to the bad effect of shade upon the growing plants. My observations in Florida the past winter confirm all that was there stated. Plants growing in partially cleared land do very little better than when more completely shaded, as in the hummock, the leaves being thin and less rigid and darker green in color, and the growth will be much slower and the plants smaller at maturity. The clearing of the land is one of the largest expenses connected with establishing a sisal plantation, and when it is not properly done there will be a pretty good chance for failure.

THE MACHINE QUESTION.

In my last report the principal machines in use for cleaning sisal hemp were mentioned, and several of them figured. The two classes or types of machines into which these devices are divided were also stated. The only new machine for cleaning sisal hemp leaves that has been brought to my attention since the publication of the last report is the device patented in 1892 by J. L. Acosta, and manufactured by Joseph C. Todd, Paterson, N. J. The claims of the inventor are set forth in a paragraph which follows.

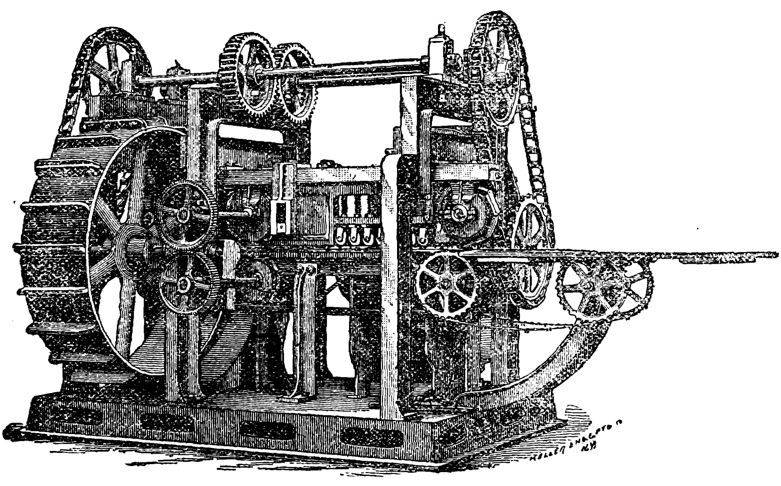


FIG. 1.—The J. C. Todd-Fiber Machine.

In Figure 1 is shown clearly the arrangement of the machine for cleaning henequen leaves without the use of crushing cylinders. The operator seats himself before the table, and lays the leaves on the feeding chains. Care should be taken to lay the thick ends of the leaves to the right side, with something more than half of the length of the leaf hanging down. The chains will then carry the leaves to the holding belts, by which they will be presented to the first scraping wheel. The leaves having been cleaned for the greater part of their length by the first wheel, a device placed between the two scraping wheels transfers the cleaned portion of the fiber to the second holding belt, and the remainder is cleaned by the second wheel, leaving no uncleaned or partially cleaned portions in the middle, as is usual in other machines. The leaves of the Pita* plant need to be crushed by finely corrugated cylinders in order to separate the fine fibers of the back of a leaf. They should be crushed and scraped while still green and fresh, so that the cleaning may be assisted by the juices of the leaves. Knives or scrapers and brushes in alternation around the wheels are indispensable. It is also desirable to have a pump to furnish water to two small tanks fixed above the upper belts of both wheels. The water flows from these tanks to spread the leaves on the surface of the shoes and to clean and wash the fibers. Otherwise the fibers may be cleaned and washed after being scraped, if it is desirable to avoid the expense of the pump and tanks.

With a single man to put the leaves on the feeding chain, and a boy to take away the clean fiber from the end of the machine, it is capable of cleaning thoroughly 50,000 to 60,000 leaves in a day. I have not seen this machine running on sisal hemp leaves, but witnessed its work on the leaves of bear-grass furnished by the Department, the cleaning being accomplished in a thorough manner.

As I have stated, the machine used by the Department in Florida is known as the Van Buren, this individual piece of machinery having been used by Mr. Van Buren at the various exhibitions which he attended. As to the quality of fiber turned out, its work is very satisfactory, though its capacity is limited. I am informed by Consul McLain at Nassau that the Van Buren machine is extensively employed in the Bahamas for extracting sisal hemp, its capacity being about 150 to 200 pounds of dry fiber per day of ten hours.

In Mr. Stuart's recent report there is quite a chapter on this subject, from which the following extracts have been made:

> There are several kinds of machinery used for extracting the fiber on the different estates. Those cleaning less than 75,000 leaves per day use the large common wheels, Raspador and Barraclough, and those cleaning from 80,000 to 120,000 per day use the larger and more complicated machines, the Prieto, Villamore, Weicher, Death & Ellwood, etc. The planters, if using one of the large machines, keep several of the Raspadors in reserve for use in case of accidents, for should the large machine break down or get out of order, leaving 70,000 or 80,000 leaves on hand, and there be no means of cleaning them, it would involve a loss of over 4,000 pounds of fiber.

CLEANING MACHINES.

The Raspador is a 54-inch "wheel," said to be invented and manufactured in Mexico. It requires a two horse-power engine to run it at a steady rate of 200 revolutions per minute, at which speed the best results are obtained. Capacity, 500 pounds dry fiber per day of ten hours; requires the services of two men.

The Barraclough, constructed by T. Barraclough & Co., Manchester, England, is similar to the Raspador, but of superior make. Capacity, 500 to 600 pounds dry fiber daily.

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* Supposed to refer to *Agave americana*.

The Prieto machine is manufactured by Ping & Negre, Barcelona, Spain; it requires a sixteen horse-power engine and the services of two men and a boy. Capacity, 7,000 pounds dry fiber per day of ten hours. Cost, $4,500.

The Villamore machine, made by Krajewski & Pesant, 35 Broadway, New York, requires a fifteen horse-power engine and the services of two men and a boy. Capacity, 6,000 pounds fiber per day of ten hours. Frame made of wood. Cost, $500.

The Weicher machine, constructed by J. J. Weicher, 108 Liberty street, New York, is fitted with a service pipe for throwing a stream of water on the fiber as it is being cleaned, and is claimed by the inventor to lose but 1½ per cent only, as the leaves are fed into the machine endwise. Requires twelve horse-power engine and services of three men. Capacity, 2,500 pounds dry fiber per day of ten hours.

The Death & Ellwood machine, constructed by W. E. Death, of Brixton, England, requires a three horse-power engine to drive it at a velocity of 400 revolutions per minute, and washes the fiber when cleaning. Like the Weicher, the leaves are fed into the machine endwise. Capacity, 250 pounds (?) of dry fiber per day of ten hours.

FALSE SISAL HEMP.

So many references have been made to this plant, which is so intimately connected with the recent history of the true sisal hemp plant as found in south Florida, that it is a matter of congratulation that all doubts concerning its identity are now cleared up. On my return from Florida I was able to send specimens of the living plants, with fresh leaves, and both fresh and dried flowers, to Dr. Morris, assistant director of the Royal Kew Gardens, England, and which arrived in good condition. They were accompanied, also, by samples of the fiber, and with considerable photographic and descriptive material relating to the habits of growth. The whole series was referred to the botanist, Dr. Baker, an eminent authority on this important family of plants, who decided the species to be new, naming it *Agave decipiens*. Dr. Baker's description of the plant appears in the Kew Bulletin for July and August, 1892 (pp. 183, 184).*

It is a matter of surprise to me that this plant has so long been confounded with the true sisal, when the two forms differ so greatly in habit and in general appearance. The men who accompanied me in my investigation work along the keys and up the coast on the mainland so soon learned the differences in the appearance of the two forms that they were able to state by means of the ship's glass as we sailed by whether plants growing on the shore were the true or the false species. Throwing out its mass of leaves from the top of a footstalk sometimes 6 feet high, which is habit of the mature plant, the leaves seem to radiate from a common center like a many-pointed star, while the color is always in strong contrast to the surrounding vegetation. The true sisal plant, on the contrary, sends up its mass of leaves from the surface of the ground, though sometimes with a very short footstalk, this difference alone rendering identification easy, for before the lower leaves of *sisalana* have been cut, as in cultivation, the plant never shows this habit. Other marked differences are the shorter, narrower leaf in *decipiens*, nearly always (on the keys) rolled in at the sides so that a cross section appears like the letter U. (See Fig. 2.) In color it is a brighter, more livid green. Its spines, which are very thickly set along the edges, are strongly recurved and so sharp that it is impossible to go about among the plants without lacerating the flesh or tearing the clothing. (See Fig. 3.) Even the young plants which have not acquired their footstalks differ so greatly from the young plants of *sisalana* that no one should mistake them

*Also reproduced in Bulletin No. 5, Fiber Investigations.

after having had the differences once pointed out. The young *sisalana* grows very erect, the leaves being flatter and of a dark green, and without spines. The *decipiens* throws out its leaves with a more spreading habit, the lower series usually bent (recumbent) to the ground, the leaves themselves being short, stocky, and with the edges more or less turned up. The color, even in the young plants, is a brighter green than *sisalana*, the general appearance presenting a particularly marked form of plant. In their manner of poling we find the only similarity between the two, and this doubtless has caused the expensive mistakes so often made by those collecting sisal plants, and through which shiploads have been taken from Florida to the Bahamas in past time. Dr. Baker even says, "I can not make out any material difference between the flowers of the two species." The poling is not only similar, but the young pole plants are similar, though I soon learned to detect a difference in the stockier appearance of the *decipiens*. But when once fixed in the soil, the identity of the species is soon brought out in a marked manner. (See Plate III.)

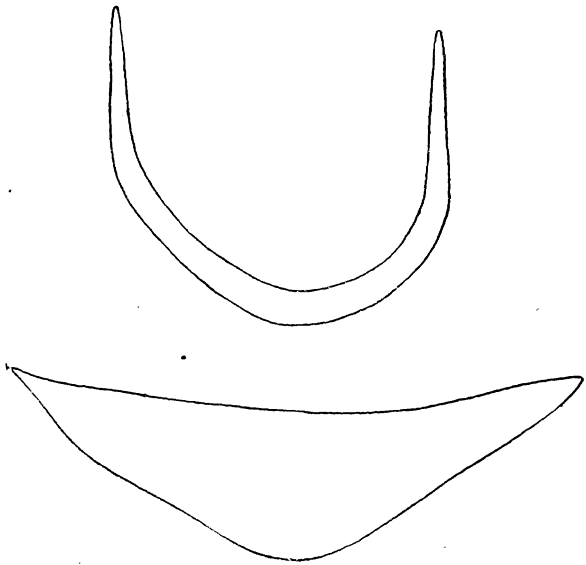


FIG. 2.—Cross-sections of leaf of false sisal plant.

Coming to the fiber, we find the strongest mark of difference between the two forms of fiber plants. In *decipiens* it is whiter, finer, softer, but greatly deficient in strength, though it approaches nearer the appearance of the true sisal fiber than that of any of the allied Agaves not varieties of the *A. rigida*. I found *A. decipiens* growing all along the coast and keys from Jupiter almost down to Key West, always most abundant in the wilds, where *Agave sisalana* was never found.

It is a singular fact, however, that in the Lake Worth region it changes its form somewhat, the leaves being longer, often more flattened (sometimes perfectly flat), but always provided with the footstalk and with the terrible spines.

The leaves of *decipiens* used for fiber were collected chiefly from Sands Key, one of the line of keys forming the southern boundary of Biscayne Bay, though a few specimen lots were secured from other points. This key is uninhabited, and the plants were found in masses so dense (and so mixed with the prickly pear) that we were only able to secure leaves from the outside plants. The work of cutting the leaves, even from these isolated plants, was in the nature of an ordeal. Every member of the party took a knife and attacked the thicket, no one

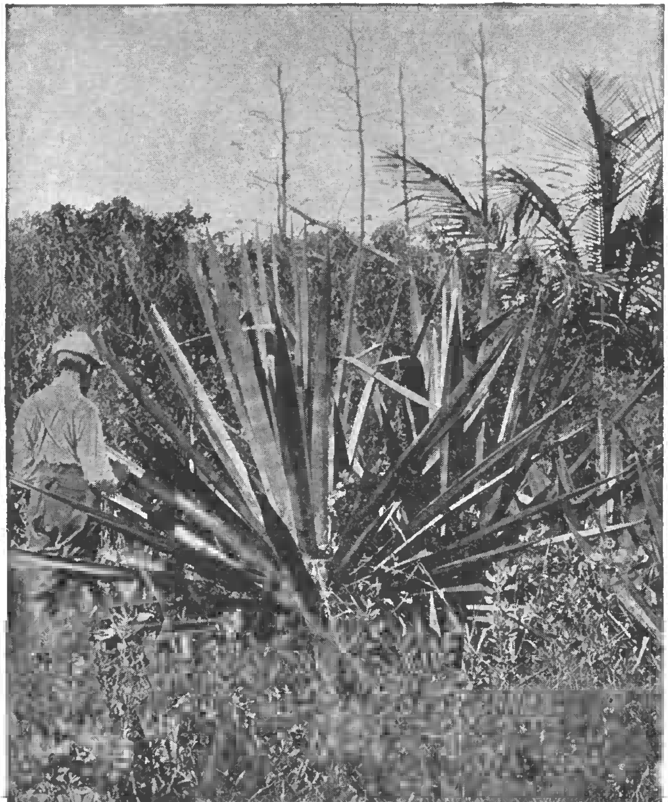


FIG. 1. TRUE SISAL HEMP PLANT.

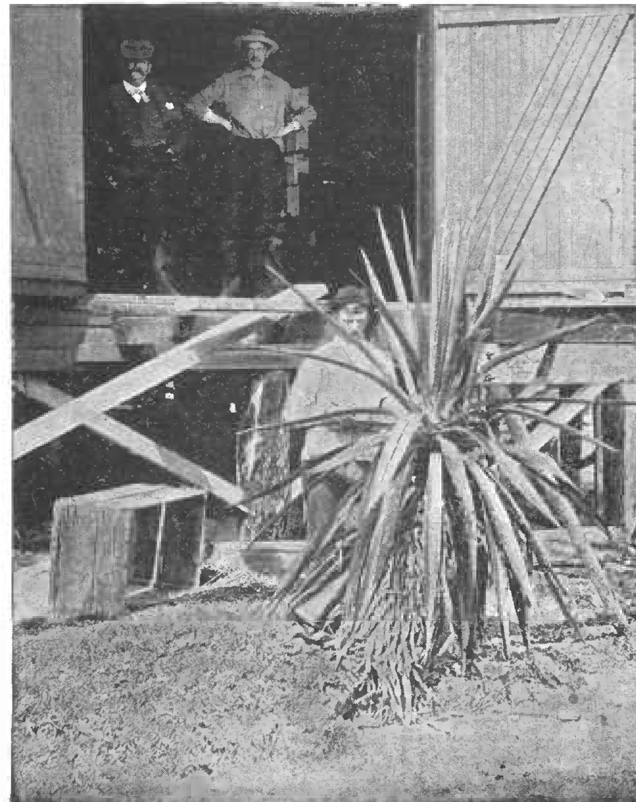


FIG. 2. FALSE SISAL HEMP PLANT.

escaping the experience of bleeding hands and arms and of more or less injured clothing.

Some of the plants of this species growing on Sands Key are magnificent specimens. Radiating in all directions from the top of an immense footstalk, clothed to its very base with the dead leaves of former years of growth, its mass of leaves often reaches an expanse of 8 or 9 feet, the topmost tips being 12 feet from the ground, while rising out of this dense cluster of leaves is frequently seen a huge mast, often reaching a height of 20 feet more, the branchlets thickly set with pole plants. I have seen masts on Sands Key 4 inches in diameter, though 3 inches is the normal measurement. If *A. sisalana* does not thrive in the shade, this species will grow in the densest tangles of saw palmetto and low shrub-like vegetation, thrusting up its head defiantly in lusty vigor from the dense undergrowth. Sometimes it is covered with rank growths of wild vines, whose tendrils bind firmly together whole bunches of leaves. I saw one plant so bound in this manner that the larger part of its leaves were tied closely together at the tips, yet it grew and put forth new leaves as though free like its fellows.

I do not think the spines of *decipiens* poison the flesh like the spines of the prickly pear, but the juice extracted from its leaves by the machine was found so acrid that handling the pulp would cause the hands to smart in a very few minutes.

In my first report I called this form *Mexicana*, on the authority of a gentleman who has brought together in his collection many species of Agave, his examples of this plant being so named. The correction should be made in the former report.

In Bulletin 3 allusion was made to a correspondence with the Bahamian authorities, in which this statement occurs: "We do not approve of the fiber plants received from Florida, which are very inferior in product, both in quality and quantity, to what we get from the indigenous plant."

I do not think now there can be any doubt concerning the identity of the "fiber plant" alluded to in the above. We know that the Bahamians carried off, by purchase or otherwise, schooner loads of the false sisal. The true sisal hemp plant of Florida, as I have shown, produces an equal quantity of fiber to the Bahamian, and of a superior quality, as far as I have been able to make comparisons with the Bahamian product. The fiber from *decipiens*, on the contrary, has been found "very inferior in product, both in quantity and quality." The species should be carefully avoided, therefore, by those collecting plants to start plantations.

FIG. 3.—Spines on a leaf of false sisal. (Enlarged.)

THE PINEAPPLE FIBER.

In this country the pineapple is cultivated wholly for its fruit, and chiefly in Florida. The principal plantations on the keys are found at Elliotts and Key Largo, though plantations are found to the southward of these for many miles. On the mainland there are more or less extensive plantations from the extreme southern portion of the State northward on the west coast to Charlotte Harbor, and on the east along the Indian River to the Lake Worth and Jupiter region.

Considerable quantities of the leaves were treated by me at the experimental factory at Cocoanut Grove, the experiments being continued after my return north under the direction of the Department's special agent, Mr. R. M. Munroe. The fiber was extracted with the Van Buren machine, which, while it turned out a superb product, would be wholly inadequate for the work from the commercial standpoint, as only two or three leaves could be fed in at a time. As the object of the experiment was to secure fiber for future test and obtain it in the best possible condition, the question of cost of production was not considered.

The Florida fiber, when simply plunged into cold water for a few moments after coming from the machine and then dried in the sun, came out almost white, with a fineness and softness unequaled by any other fiber that I have extracted. The fiber will be further prepared and, if possible, spun.

At the close of Special Agent Munroe's work an interesting report on the culture of the pineapple and extraction of the fiber was submitted by him. The following is an extract from this report:

> Regarding the fiber side of the industry, it has long been known that the leaves of many varieties of pineapple contain a more or less valuable fiber. With the idea that the leaves from the common variety grown in this vicinity might be of commercial value in this respect, and thus prove an extra source of profit to the planter, the Department began its present investigations in this direction. Although in the end it may prove more advantageous to plant special fruitless varieties for fiber production, the only object at present has been to add if possible an extra source of profit to pineapple farming in the shape of ready sale of the leaves after their usefulness to the plant has passed and the fruit has been cut. The practice has been to let the leaves decay under the plant and afford possible nourishment to the young suckers. The general opinion on this point is in favor of cutting the leaves, but experiments covering several seasons will be necessary to properly decide this point. Owing to the practice on the keys of planting very close, it was found that a very large proportion of the leaves was injured by chafing one on another, and also from being crushed under foot in weeding and cutting the fruit. This condition seems to be almost entirely obviated by spacing the plants at least 2 feet, as has been done on the mainland. Another defect was found in the withered condition of several inches of the tip or end not noticeable in the younger leaves. This, however, may be due to the excessive drought of the past season. It does not occasion much loss of fiber, it is true, but adds to the cost of extraction, the decayed parts having to be cut off. At this date there are but few farms on the mainland with any considerable acreage in fruit, so that any statistics from these would be of little value as regards the supply of leaves for a year or so to come. Judging from the amount of land taken up for this special purpose, the clearings already made and slips engaged for planting, the mainland leaves will exceed by far those on the keys and continue to increase in the same proportion. The approximate acreage actually in pineapples on Keys Metacomba, Largo, and Elliotts is 930, and the number of apples shipped this season (1892) about 1,916,400, which does not include many thousands marketed after the close of the season. The average yield of good leaves from the red Spanish (Plate IV) for this year (which has been very unfavorable) is about ten out of the average twenty-five of each plant and the weight 1 pound, making the total for fruited plants in round numbers 958 tons. Adding the leaves to be gotten after close of season and from abandoned fields, the quantity might be varied to 1,000 to 1,100 tons. I inclose with this the memorandum of work at the factory under my supervision, with weight of leaves and other data.

In going over the details of the work of Mr. Munroe, the ressult with different lots are found to be so similar that statements will be confined to lots Nos. 1 and 5, leaves from Elliotts Key and the mainland.

Lot No. 1 was 1,022 pounds of red Spanish leaves from Elliotts Key, cut a day after the fruit had been gathered, and the leaves much injured by chafing and bruising; 202 pounds of this lot were assorted, and 10 pounds of the selected leaves numbered 89 by count. The weather was very favorable for drying the extracted fiber, the prod-

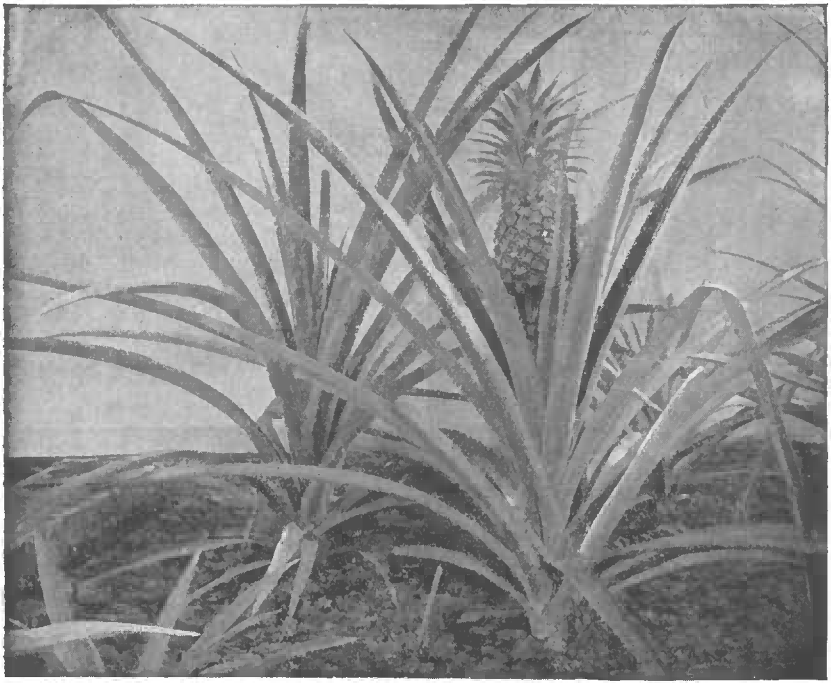


FIG. 1. PINEAPPLE PLANT WITH FRUIT.

FIG. 2. PINEAPPLE FIELD, ELLIOTTS KEY.

uct from this 1,022 pounds, when thoroughly dry, weighing 25 pounds, or a fraction less than 55 pounds to the ton of leaves.

Lot No. 5 was from Fuzzard's plantation, 1,000 pounds of leaves, tips cut off. The leaves averaged 10 to the pound. Good drying weather. Dry fiber from this 1,000 pounds weighed 18 pounds 2 ounces, or a little over 40 pounds to the ton of leaves.

Another similar lot from the mainland gave fiber at the rate of 42 pounds to the ton of leaves, the tips of the leaves having been cut off.

Allowing for excessive waste, this experiment shows that the yield of fiber from freshly cut pineapple leaves will range from 45 to 60 pounds from a ton of 2,240 pounds of leaves, which is certainly a very good showing. An important point to be noted in studying the weights of the different lots of leaves run through the machine in these experiments is the proven fact that selected leaves, as to size, do not give as high a yield of fiber as average leaves. Lot No. 1 was 820 pounds of average leaves and 202 pounds of selected, while the total 1,022 pounds of leaves gave 25 pounds of fiber, the 820 pounds gave 21 pounds of fiber, against a yield of 4 pounds from 202 pounds of leaves. Reduced to equivalents, the average leaves yielded at the rate of 57½ pounds to the ton, while the selected leaves yielded less than 44½ pounds of fiber to the ton.

As to the value of pineapple fiber, no figures can be given, as it is not quoted as a commercial product. There is no doubt that if the fiber can be produced in quantity at economical cost, manufacturers would soon find a use for it, and would then know what price they could afford to pay for it, as the market price would be fixed by demand and supply. The machine question enters largely into the problem, however. As the leaves are small, a quantity would need to be cleaned at one feeding of the machine, to make it pay. Estimating 10 leaves to the pound, there would be over 22,000 leaves to the ton, which, as we have seen, would produce from 50 to 60 pounds of fiber.

Were the fiber used in the manufacture of delicate fabrics, there is no doubt that it would command a price considerably higher than the product of the other leaf fibers described in this report. The Department will carry its experiments with this fiber further and give manufacturers an opportunity to examine it.

BOWSTRING HEMP.

Early in 1890 beautiful samples of this fiber were sent to the Department from Trinidad by T. J. St. Hill, accompanied by specimens of living plants. The plant had been met with frequently in conservatories, and upon inquiry I learned that it also grew out of doors in Florida, particularly in southern portions of the State, and considerable correspondence was received on the subject. There are three species of *sansevieria*, to which the name bowstring hemp is usually given, though there are a dozen species in the genus. The three species are *S. guineensis*, *S. zeylanica*, and *S. latifolia*, the first named being known as African bowstring hemp; *S. zeylanica* is the best known, however, and is common on the Ceylon coast, from which it takes its name.

Dr. Buchanan found this plant employed in the manufacture of cordage at Bangalore, and bowstrings are still made of it in the Sircars and along the coast of Bengal. In the interior of Bengal it is equally common and wild, but not as largely used for fiber. The leaves are stated by most authorities to be from 3 to 4 feet in length, though I have cleaned leaves for their fiber in Florida that measured nearer 7 feet, and a hundred pounds of selected leaves in one lot cleaned averaged 6 feet. One species native to tropical Africa is said to produce leaves 9 feet in length.

Among other species I may mention *S. roxburghiana*, which is considered by English authorities as a distinct species common to the Bengal coast, and larger than *zeylanica*, though Royle does not admit it. The commercial fiber is described as hair-like and silky, and closely resembling the fiber of the pineapple. It is claimed to take dyes readily.

In the Kew Bulletin for April, 1887, it is stated that plants of this genus require a rich, moist soil and a comparatively humid climate, and that, being essentially tropical plants, they do not thrive in a temperature less than 60° F. Under such conditions they grow rapidly and establish themselves permanently by means of their large spreading rhizomes or underground stems. It is true they will grow in comparatively dry districts, and even in soils strongly impregnated with salt, but their growth under such circumstances is very slow, and the leaves are seldom large enough to produce marketable fiber.

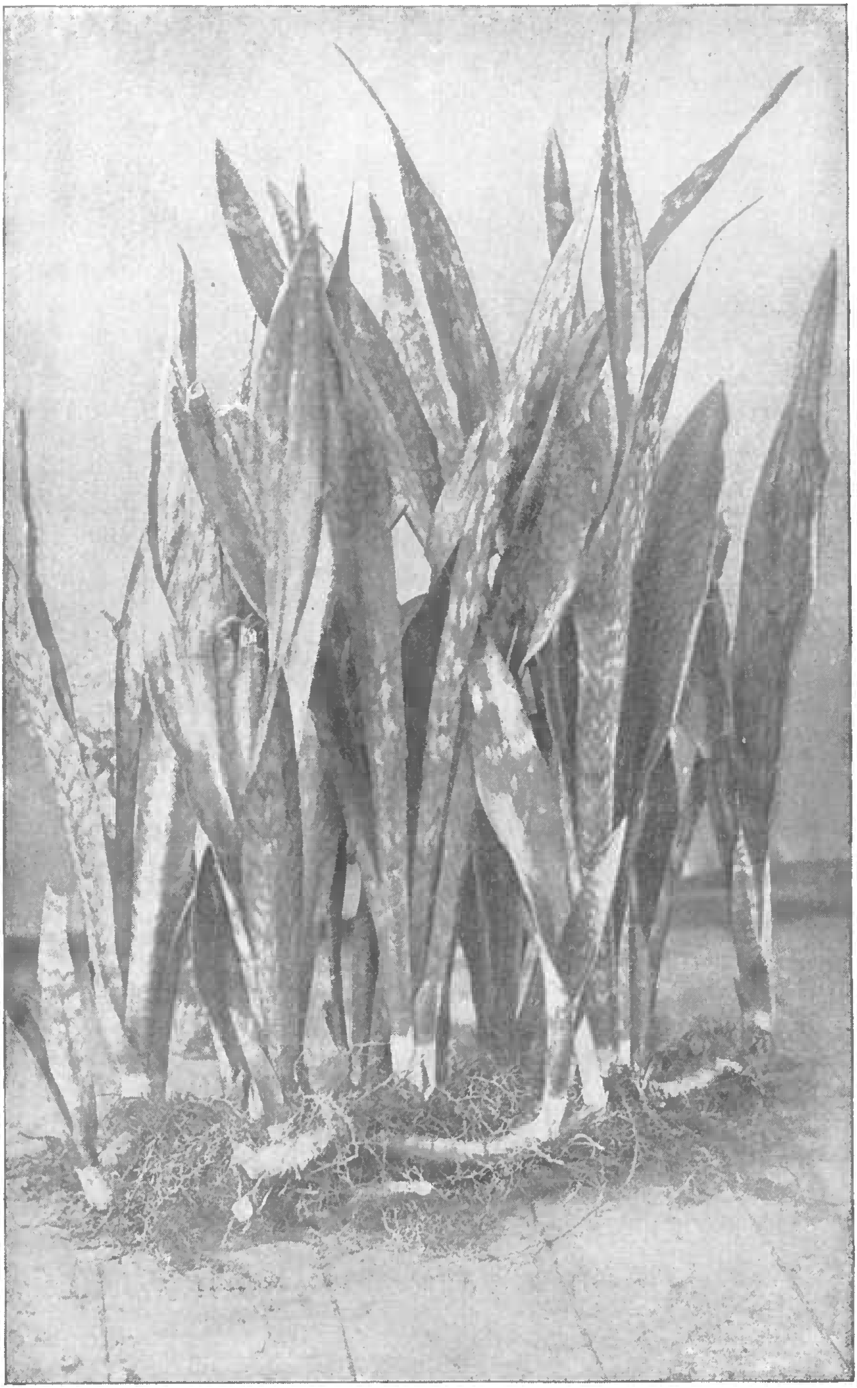
The fiber of *S. guineensis*, which sometimes appears in the markets of Europe, has been thought by some to be superior to New Zealand flax. The strength of its fiber, as tested by the Agri-Horticultural Society of India, was found sufficient for hawsers and cables, while their fineness and tenacity are attested by their being used by jewelers for thread upon which to string pearls. It is too valuable and too fine a fiber, however, for cordage, in view of the fact that manila, sisal, and common hemp are to be obtained abundantly and are sufficiently strong for this purpose.

The native method of preparing this fiber is to place the leaves upon a smooth board, then press one end of the leaf down with one of the great toes, and with a thin bit of hard stick, held between the two hands, they scrape the leaf from them and very quickly remove every part of the pulp. This is also accomplished by steeping the leaves in water until the pulpy portion decays, when the fiber is washed and cleaned, though in some cases steeping injures the fiber. It is estimated that 40 pounds of fresh leaves 3½ or 4 feet in length will yield a pound of cleaned fiber, or over 1,600 pounds of cleaned fiber per acre at a gathering; with a favorable season two such gatherings may be assured annually.

Sansevieria guineensis is the best known form of plant producing bowstring hemp, and is one of the oldest species. Specimens of leaves and flowerless plants grown in Florida, and sent by the Department to Dr. Morris, of the Kew Gardens, were thought, in the absence of the flowers, to be examples of this species. (Plate V.) A cross-section of the leaf accompanies. (Fig. 4.)

During my investigations in Florida in the winter of 1890–'91, I found the plants growing at several points, principally at Key West, on Boca Chica Key, and at Miami, on the east coast. Nothing was accomplished, however, further than to demonstrate that it would thrive out of doors in southern Florida, though a brief mention was given to the plant in Bulletin No. 3 on sisal hemp culture, and a reference made to the value of the Florida-grown fiber, several samples having been secured. This brief mention of the plant brought a letter from Dr. J. V. Harris, of Key West, with interesting statements, and asking for further information, which was supplied at length.

Through Mr. George H. Bier, the Department was able last season to secure almost a ton of leaves of the *sansevieria*, which were shipped to the Department's experimental fiber factory on Biscayne Bay.



BOWSTRING HEMP PLANTS.

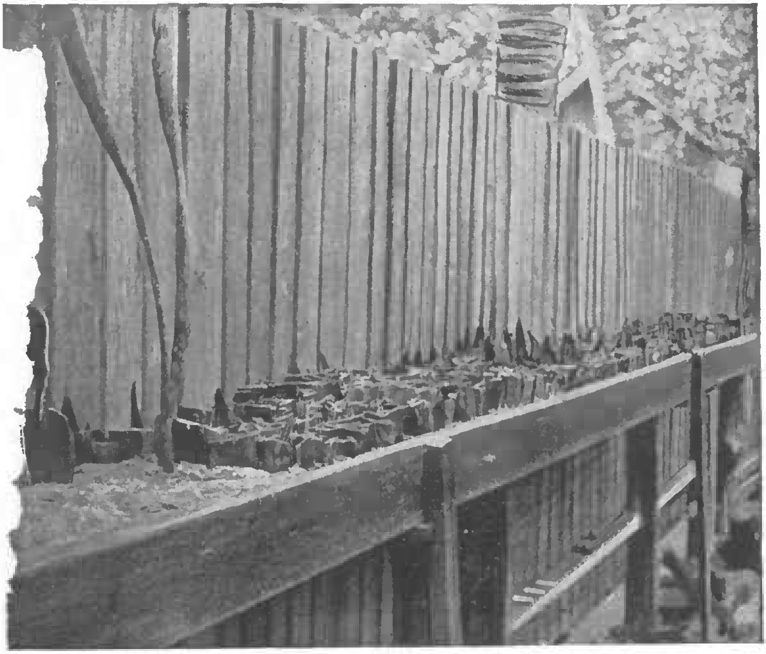


FIG. 1. CUTTINGS OF SANSEVIERIA IN PROPAGATING BED.

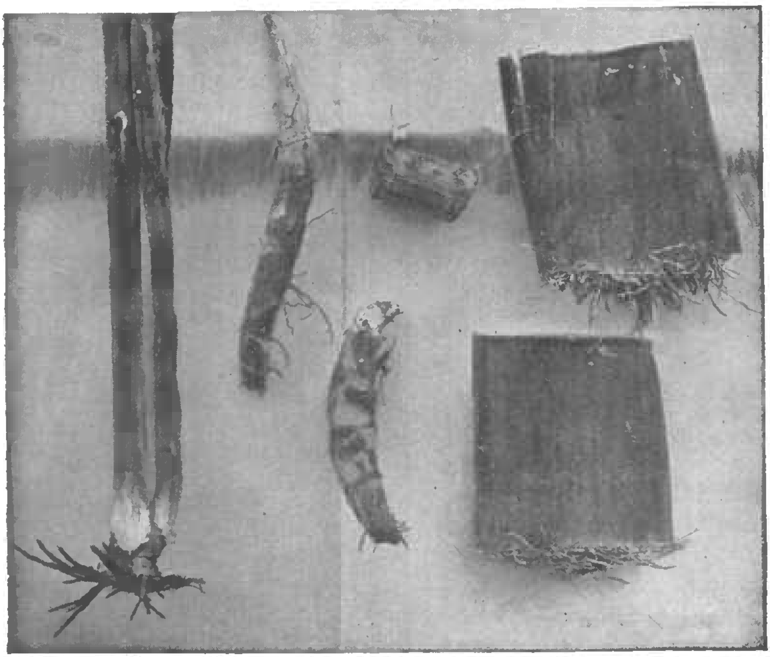


FIG. 2. ROOTED CUTTINGS, LEAVES, AND ROOTS.

These were cleaned on the Van Buren machine and a quantity of superb fiber secured. The leaves varied in length from 2½ feet to 7 feet in length, and it was possible to select over a hundred pounds of leaves that averaged 6½ feet and which gave fiber averaging 6 feet in length.

Careful estimates, based on the quantity of *Sansevieria* fiber produced in our experiments, would fix the yield at about 40 pounds of fiber to the ton of leaves. It has been explained in a former chapter that the machine made too large a percentage of waste. The *Sansevieria* waste was not weighed, but it is very safe to state that with only reasonable wastage (cut fiber and fiber drawn out with the pulp) the yield of fiber per ton would come nearer to 50 pounds. Even if this is considerably lower than the yield of sisal hemp, the quick growth of the plant, the ease with which it can be harvested and handled, and the higher price of the fiber will probably more than make up for the difference in yield of cleaned fiber.

The material is too good for cordage, in the usual acceptance of the term. It is so much better and finer than the cordage fibers, so called, that it would doubtless find a use in the manufacture of fine twines, and, I think, with proper preparation, could be made into a fair spinning fiber and possibly be employed in some new form of manufacture. The fiber is fine, white, and lustrous, the leaves yielding readily to treatment in the machine in the fresh state. The Department samples of fiber will be further prepared and tested.

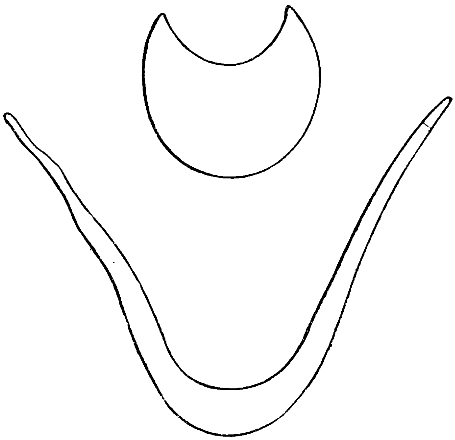


FIG. 4.—Cross-section of leaf of Sansevieria (bowstring hemp).

Dr. Harris has so much confidence in the value of the bowstring-hemp industry that he has planted out many acres of the young plants, propagated by himself by subdivision of roots and by leaf cuttings. When in Key West, in February, 1892, I visited his place, and was able to take photographs showing the manner in which the plant is propagated and exhibiting the appearance of the rooted cuttings. These are reproduced on Plate VI.

Regarding propagation, cultivation, etc., Dr. Harris says:

For convenience, the leaves are cut into sections about 4 inches long, and inserted into boxes of earth to the depth of about 2 inches; the soil must be moderately dry, as too much moisture will cause the leaves to rot; the boxes must be placed in a moderately shady place, and in a few weeks' time will put out numerous fibrous roots, which will soon be followed by suckers. The plant can also readily be propagated by sections of its rhizomes or roots, which grow without any difficulty. (See Plate VI.)

Sansevieria requires good, rich soil to succeed well, and will, under favorable circumstances, acquire its full growth in about twelve months' time; ordinarily, however, it will not acquire its full growth until sometime in the second year.

When once the land is stocked with its growth, it will always, when cut, get a full growth from the roots inside of twelve months, so that it is perfectly safe after the second year to count on a full crop every year, the growth each year becoming denser, and in a few years becoming so thick that it would appear to be impossible to cultivate it; which, however, appears to be needless, as, when once fully established, it takes entire possession of the soil, entirely eradicating everything else; it does not appear to materially exhaust the soil, as it will grow for a number of years in the same place and continue to make a vigorous growth.

Sansevieria is essentially a tropical plant, but will stand a slight frost; it will grow luxuriantly upon the rich lands south of the latitude of the Caloosahatchee River, upon the west coast, and of Lake Worth, upon the east coast. It will, after reaching maturity, if not cut, stand without injury for a number of years, the plant at the end of that time affording just as good fiber as in the first or second year of its growth. I am satisfied that a plantation would last over ten years without any necessity for renewing it or for interfering with it in any manner. *Sansevieria* will, after it is well established, afford a crop of 5 tons of clean fiber per acre, worth, upon estimate, about $100 per ton. I selected a few square feet where the growth was thickest, as an experiment, to show how much a crop was capable of producing, cut and cleaned the leaves, and found it gave at the rate of 13½ tons of clean fiber per acre; I do not, however, believe that the average crop will go over 5 tons per acre, which I consider a fair estimate.

This closes the account of my work in southern Florida. Before leaving this section, however, I desire to state that through the courtesy of Mrs. Tuttle, of Fort Dallas, Miami, who furnished transportation and guide, I was enabled to enter the Everglades of Florida and secure photographs of this wonderful inland sea. Although no fiber plants exist, to my knowledge, in this undeveloped district, the brief visit was interesting and profitable.

NEW ZEALAND FLAX.

This plant, belonging to the same family as the sansevieras and yuccas, is a native of New Zealand, but was early introduced into Australia, and is now found in many portions of the globe. It has been naturalized in France, Algiers, the Azores, St. Helena, the Scilly Islands, and other similar localities. Capt. Cook first brought the fiber to the notice of Europeans, he having found it in common use by the natives of New Zealand. He speaks of it as "a grass plant like flags, the nature of flax or hemp, but superior in quality to either." It grows on the north and south coasts of New Zealand, and is cultivated in Australia, though to no great extent. It was brought to Ireland by Underwood in 1798, and has been grown successfully in the open ground in gardens in Waterford, Cork, Limerick, Dublin, and Wiclow counties. It also flourishes on the west coast of Scotland, though the winters there have occasionally been too severe for it. The leaves of the plant in Ireland grow to 5, 6, 7, and 8 feet high, and it is propagated by offsets which are not removed until the parent root is 4 years old. It thrives in California and could be successfully introduced into many other localities in the United States where the climate is not too cold for it and that are not too remote from the sea.

The several varieties grown in New Zealand are: *Harakeke*, the common variety of the lowlands, *Paritanewha*, the yellow variety of the high regions or hills, and *Tihore*, a superior quality. It is also called *Koradi* or *Korere* by the natives, while the fiber is known by the name *Muka*.

At the close of the Philadelphia Exhibition, 1876, a large and valuable collection of the raw and manufactured products of New Zealand flax was presented by the representatives of the colonial government to the U. S. Department of Agriculture. In this collection the many uses of the fiber were fully illustrated, both hand and machine cleaned fiber having been shown. Specimens of cordage naturally come first in an enumeration of the list. Among these were 3-inch cables and ropes of all sizes, horse halters, small cordage, lead lines, fish lines (for sea fishing), and twine of the finest finish. The series of mattings illustrated the many ways that the fiber could be used in the household, as door mats, parlor and bed-room mats (in colors), and hearth rugs, while the finer kinds of fiber were made into cloth not unlike linen duck, into satchels, table mats, shoes (a kind of sandal), sacks, etc. Floor matting, carriage and railway mats were exhibited in variety, plain and in colors. The nets, of which there were many samples, could hardly be told from linen, both in color and finish. Some of the museum samples seemed to the touch as soft as the finest flax, and I have no doubt many other beautiful fabrics could be made finer than now shown. Murray, in a pamphlet regarding the plant, speaks of bedticking being made from it, and states that he has seen "fine fabrics of various kinds, affording demonstrative evidence that its fiber is susceptible of being woven into tissues of the most delicate description."

At that time much of the fiber was manufactured at home because the English ropemakers would not pay a price proportionate to that given for Manila hemp, and it was found to pay better to export the cordage rather than the baled fiber. The trade, however, has changed greatly in the past decade.

While considerable New Zealand flax came to the country in the past, Manila and sisal finally superseded it, but toward the close of the last decade the demand for binding-twine fiber brought it again to our market. The imports of this fiber into the United States, for the fiscal year ending June 30, 1889, were 51 tons, worth $6,971. Referring to the circulars of Crocker & Co., fiber brokers, New York City, for three years, we find that 64,730 bales were imported in 1890, 76,000 bales in 1891, and 42,391 bales in the year just passed. This shows a demand for the fiber in the United States, without which, of course, home culture would be useless.

The plant has been grown in California for many years, and thrives in many localities. I have endeavored to learn the history of its introduction, but am unable to make positive statements at this writing. Prof. Hilgard, the director of the State Agricultural Experiment Station at Berkeley, has grown it at the station for several years, sending plants to substations and to farmers to be grown for its leaves, that are used instead of rope for tying vines.

Small lots of leaves received by the Department from California were cleaned by Mr. W. T. Forbes, and a strong, valuable fiber was obtained from them. An effort was also made to secure leaves in sufficient quantity to obtain enough fiber for a practical test, but as the leaves do not stand transportation and would necessarily be several weeks on the way, the attempt was abandoned.

It is said that while the plant will grow in almost any soil, the quality of the fiber is dependent largely upon the favorable character of the soil. For example, in New Zealand the *harakeke* swamp variety thrives almost everywhere, but is rank in growth and the fiber coarse. The finer kinds, on the contrary, are grown on the uplands, where the soil is dry, or at least free from moisture.

Propagation is most readily effected by division of the root, and one large plant will give from 20 to 50 roots suitable for planting. In planting, the roots may be set singly, or two and three may be placed together, particularly where close planting is not followed. As to distances apart, 6 feet in the rows and between plants is usually recommended, though 4 feet between rows and 3 feet between plants is considered a better distance, as the plants shelter each other, the leaves thus grown being in better form and producing finer fiber. An acre of ground set out on the first plan will contain about 1,000 plants; the closer plan will require about a third more plants to the acre.

In the United States Consular Report for May, 1890, appears a report from John D. Connolly, the consul at Auckland, which accompanied some New Zealand flax seed subsequently distributed by the Department. It contains interesting statements regarding the flax industry of New Zealand at the present day, with suggestions regarding the cultivation of the plant in our own country which may be perused with interest.

REPORT OF THE SUPERINTENDENT OF GARDENS AND GROUNDS.

SIR: I have the honor to submit the following report for the year 1892, together with brief remarks on subjects connected with general horticulture, mostly suggested by communications from correspondents of the Department.

Very respectfully,

WILLIAM SAUNDERS,
Superintendent.

Hon. J. M. RUSK,
Secretary.

NOTES ON HORTICULTURAL SUBJECTS.

PINEAPPLE CULTURE.

The number of plants distributed during the year amounted to over 60,000, consisting of quite a variety of useful species considered worthy of propagation and dissemination, and which are in demand for trial culture. Pineapple production is a pronounced success in southeastern Florida, and applications for plants of good kinds are far beyond the ability of the Department to supply with its present limited facilities. Foreseeing that pineapple culture was to be a profitable industry, the Department, something over ten years ago, erected a glass structure for the sole purpose of propagating pineapples. A collection of named kinds was procured from England, where the finest varieties of this fruit are to be found. The kinds mainly propagated are (1) Queen, (2) Trinidad, (3) Moscow Queen, (4) Montserrat, (5) Carrington, (6) Ripley Queen, (7) Prickly Cayenne, (8) Black Prince, (9) Black Jamaica, (10) Prince Albert, (11) Princess Royal, (12) Lambton, (13) Charlotte Rothschild, (14) Smooth Cayenne.

Numbers 4, 8, and 9 are rather small-sized fruits, rarely exceeding 3 pounds weight. Numbers 1, 3, and 6 are well-known kinds of fine flavor, and not often seen over 5 pounds in weight. Number 2 grows to a large size, from 10 to 12 pounds in weight, and is an old cultivated kind, better known as the Providence. Numbers 5 and 12 are fine fruits, and will average about 8 pounds in weight. As to flavor, there is not an inferior sort in the collection. Pineapples of Florida growth will soon acquire as great a reputation for excellence as oranges grown in that State have already reached.

OLIVES.

Special attention is given to the propagation of olives, and their distribution is almost of daily occurrence throughout the year. To assist those who desire to make a selection of varieties, a list of those now being propagated by the Department is here given: Ascalana, Atrovialacea, Columballa, Corregioli, Du Guazzo, Gentili, Grossaia, Infrantoi, Leccini, Manzanillo, Macrocarpa, Morinello, Nevadillo, Nigerina, Oblonga, Oriola, Polymorpha, Precot, Pendulina, Picholine, Piogenti, Regalis, Rubra, Razza, St. Caterina, and Uvaria.

The European olive is not a tender plant, although it will thrive best in climates where the thermometer shows not more than twenty degrees of frost. It grows best on a loamy soil; if clayey, it should be properly drained, as it is said not to flourish on stiff clays where water may be retained to excess. The trees should be set about 20 feet apart, and treated very much like an orchard of peaches.

TEA.

Correspondents occasionally make application for the plant that yields the green teas of commerce, or it may be the black-tea plant that is called for. It is now known that the mercantile distinctions of this commodity are the results of modes of preparation or manufacture, all commercial teas being produced from the plant called *Thea chinensis*—a name which includes formerly supposed species, such as *Thea viridis*, *Thea bohea*, and *Thea assamica*, which are considered varieties merely, having no distinctive botanical characters.

Inquiries have been frequent of late in regard to the production of tea in this country; information is wanted as to its extent—the parts of the United States where tea plantations have been or are being established, and the profits of the industry. Replies to these questions state that, so far as this Department is advised, no reliable effort has been made in this country to cultivate tea for the purpose of supplying the markets with its product. Many persons, mainly in the Southern States, have a few tea plants growing in their gardens or on their lawns from which leaves are gathered and prepared for domestic use, and some amateurs in this line produce teas which command the respect of credited experts of the article; but the opinion is not entertained that there is any indication of prospective profit in producing teas in competition with those countries from which the world's supply is at present obtained.

PRUNING.

Natural laws are constant and unvaried in their operations. Our knowledge of these laws is derived from accurate observations of causes and effects. Science is the systematized explanation of these observations. The science of pruning trees is, therefore, the explanation or concentrated evidence of effects produced by manipulation of the branches and other portions of plants, derived from the accumulated knowledge of centuries of observations and experiences; and, when we take into consideration the lengthened period during which pruning has been performed, the general intelligence of the operators, and the countless repetitions of similar processes ending in similar results, it is reasonable enough to suppose that a sufficient number of facts have been observed to establish a perfect science and render its practical application easily understood and followed, but the frequently expressed opinions of cultivators of the present time prove that no such final conclusions are yet recognized.

The proceedings of the last session of the American Pomological Society contains a brief discussion on this subject, which was introduced by a member who believes that pruning of any kind is not only unnecessary, but positively ruinous to trees. Among other remarks he recites as follows:

It really appears as though horticulturists were born with the ineradicable idea that a fruit tree comes into the world totally depraved, and that its first and every subsequent impulse is to go wrong. At any rate, our present practice of pruning proves that we implicitly believe in the present totally depraved tendency of all fruit trees, and that they can only be controlled for good by constant butchery.

The demon of the pruning hook is venerable, and as shrewd as he is venerable. Nearly two thousand years ago he succeeded in getting some first-class free advertising by having a general recommendation issued that all the war spears then on hand should be beaten into pruning hooks. That recommendation gave the pruning-hook business an impetus that has never been stemmed down to this day. We prune to make a tree grow, and to check growth. We prune to make a tree bear, and to reduce the number of fruit. We prune to make upright trees spread, and to make spreading trees upright. We thin trees out to let in the sun and air, and we head them back to make them more compact. We prune them up to make them tall, and prune down to make them short. We prune with ax, saw, knife, and thumb nail. We prune in spring, summer, autumn, and winter. We prune because trees ought to be pruned, and finally and chiefly we prune because that was the way we were brought up, and it has never occurred to us that there is any other way to do. It has, in some way, become a part of our horticultural consciousness that the mere act of cutting a fruit tree is beneficial, and nothing is more shocking to the sensibilities of the moss-grown practitioner than to behold a vigorous, healthy, prolific orchard which has not been "judiciously pruned."

Now, I lay down this proposition, and I do it without fear of successful refutation, that the first and inevitable result of cutting any tree is to do it a direct and irreparable injury. I claim it to be a self-evident truth that whenever you remove by violence a single branch, or root, or leaf, from any living tree you just so far threaten its vitality. You just so far disarrange its circulation and make it susceptible to the attacks of diseases and insect foes. I believe no student of vegetable physiology, or clear observer of facts, will dispute this proposition. It then follows as a matter of course that pruning to make a tree grow is a myth. I am willing to assert that there is no such thing as pruning for growth. The more you prune a tree the smaller it will be to-day, to-morrow, and ever afterwards. Correct theory teaches this, and careful experiment and observation corroborates the theory.

The injuries to fruit trees and the losses to fruit-growers from vicious and altogether unnecessary pruning can not be estimated. The popular idea that trees must be pruned in order that they should exist, and especially if fruit-bearing trees, so that they should bear fruit, is one of the most persistent of all prejudices. He is looked upon as a careless fruit-grower who neglects to visit his orchard at least once during the year, armed with knife and chisel, saw and ax; and to strew the ground with twigs and branches is deemed evidence of skillful treatment by those who, like the operator, are ignorant of the laws which govern vegetable growth. Some years ago there was on the grounds of the Department a pear orchard which was planted and maintained for the special purpose of illustrating the best method of management for the production of fruit. They were all standard trees, and at the time of planting were deprived of nearly all the growths of the previous year; they looked very much like walking canes. After the summer growth was matured some of the shoots were cut back in order to establish a proper disposition of branches. From that time they were untouched by the pruning knife. They commenced to bear the fourth year after planting, and continued to yield heavy crops of fine fruit until it became necessary to remove them.

This is the proper treatment for all trees that form fruit buds of short spur branches, on young growths 2 and 3 years old. Such are the apple, pear, plum, and cherry. When young shoots of these trees are pruned, or shortened in, as it is termed, it only promotes a further increase of barren growths, which in turn are cut out or pruned back, thus keeping a constant supply of wood buds which develop into slender shoots of no value whatever. On the other hand, when the yearly growths are left entire, even if they have reached a length of 4 feet, they will in the course of two years become thickly studded with fruit buds over their entire length, and in due time cover the shoots with clusters of fruit.

As regards the permanent or fatal injury to a plant by the removal of a few branches at any season of the year, observations do not support the statement. Even if the pruning is so severe as to visibly affect active growth for a time, the plant will rapidly assume its normal condition, unless the operation is repeated to a careless and needless extent.

When summer pruning of grape vines was a common practice, on the plea of cutting out or stopping the extension of young shoots so that light and air could reach the fruit—the very thing that modern grape-growers endeavor to reverse—it was not unusual to find vegetation checked to a degree that endangered the ripening of the crop; the operator would leave behind him a heavy ridge of luxuriant branches and foliage, and the vines would often be subjected to this process several times during the summer, and then the cultivator would be unable to account for the paucity and immature condition of his fruit when he came to harvest his crop. When this method is pursued for a continued series of years, the plants become weakened and fall a ready prey to diseases, because their impaired vitality easily succumbs to fungoid and insect attacks.

The above is an instance of improper summer pruning, but is not on that account to be considered as condemnatory of the practice under intelligent restrictions. On the contrary, it may be stated that the highest results sought to be attained by pruning can best be reached by a proper application of the principles which govern practice in this operation. The whole aim of pruning is to modify and direct growths so as to render the plant subservient to the wishes of the cultivator, and this can most readily be accomplished during the time of active growth.

The evil of summer pruning lays in the wholesale destruction of foliage at a time when it is most essential to the life of the plant; but the object desired can be attained by a timely suppression of the extension of a shoot by merely bruising its growing point, or by removing it without sacrificing to the extent of a single leaf, and thus inducing a stronger and more extensive growth on other parts of the plant. Where a shoot is not desired it is much easier, as a matter of manipulation, to rub off the bud as soon as it can be seen, than to wait until its growth requires the application of a knife or pruning shears for its removal; and thus, by the former method no injury whatever is sustained by the plant.

Allowing that pruning, no matter at what period, is a strike at the vitality of the tree (which seems quite probable), yet it often happens that, where fruit is the sole object, a certain condition of weakness (as opposed to mere growth of wood) is a desideratum which the fruit-grower finds suited for his purpose. If the production of timber is the main object of tree growth, regardless of shape or form, it seems certain that pruning in any degree would be in a line adverse to such production.

While it may be admitted that pruning tends to shorten the life of a tree, it is equally true that, in certain exigencies, pruning lengthens its life. When blights of any kind attack the branches of an apple, a pear, or any other tree, if the diseased portion is removed as soon as it is discovered the tree will be saved. If not promptly removed, the disease will spread until the tree is destroyed. It is a popular supposition that a tree once attacked in this way will never recover, and that it should be at once grubbed up and burnt. This is an erroneous conclusion; trees which have suffered severely from blights have, after the removal of the diseased portions, recovered to a sound, healthy, fruiting condition, no more liable to blight than those which have never been attacked.

Again, in the case of trees that have been injured by frosts overtaking the maturity of the young shoots, the immature, succulent points of these are easily injured when in this state, if subjected to frost, just as the soft budding growths of spring on the hardiest oak are killed by a slight frost. Figs, peaches, oranges, etc., frequently suffer in this way, and when left undisturbed will speedily develop the disease known as yellows. This will be avoided if the injured points are promptly removed after the injury has occurred.

"If well directed, pruning is one of the most useful, and if ill directed it is among the most mischievous, operations that can take place upon a plant."

PEAR-TREE BLIGHT.

The cause of blight in the pear tree has long been a matter of conjecture. The fact that bacteria have been found in the diseased shoots does not seem to prove that they are the cause of the malady, but that they are simply a consequence of the disorganization and decay of vegetable tissue. At all events, this view is held by some investigators who claim that bacteria are not found short of fermentation; others maintain that the fact of producing blight by inoculating healthy trees with bacteria taken from diseased pear shoots is sufficient evidence that these minute parasites cause the disease. This conclusion has been assailed on the ground that such inoculations convey disease to plants, similar to that of inoculating a healthy animal with a blood poison which would cause its death.

In a paper read before a meeting of a pomological society, the author claims the discovery of the cause of pear blight, referring it to climatic influences, as follows:

> I have noticed that during the month of May, when there was over 30° difference in the temperature within the twenty-four hours, that nine days thereafter twig blight would set in. I also noticed that when it was followed by a more uniform temperature, that the blight would stop, and at that point shoots would put out, but if these differences of temperature should be frequent thereafter the blight would extend down the limb and form a nucleus for the destruction of the tree.
>
> On May 18, 1888, I noted the thermometer 50° at sunrise and 85° at 4 p.m. Twig blight set in the 27th.
>
> On May 8, 1889, the difference of temperature between morning and the warmest part of the day was 30°; I wrote to friends that twig blight would set in on the 17th, and it appeared as I predicted.
>
> On the 11th of last May I found the difference of temperature to be such as to request through our public newspaper that pear-growers should examine their pear trees on the 20th, and see if twig blight had set in. The report is that twig blight had not only set in on some varieties of pears, but had appeared quite extensively on apple trees.
>
> I have noticed that where pear trees have been out about fifteen years, that if green crops are cultivated among them, the sap flow is increased, having a tendency to increase pear blight, particularly on the Bartlett variety.

So far as has been recorded the connection between sudden extreme changes of temperature and pear blight has not hitherto been noted. To those conversant with the evil effects of sudden extreme changes of temperature on vegetation, the above remarks will recall many coincidents. For instance, the leaf-blister, which may occasionaly be seen on peach trees in early summer, is well known to be caused by extreme changes of temperature acting upon the tender, newly formed foliage. It is a prevalent opinion that this blistered appearance on peach leaves is due to the attacks of aphis, because these insects are frequently to be found on the injured leaves, notwithstanding the fact that they are as often absent as present on the foliage. The effects of aphis are seen in the curling of the foliage; but they do not cause blister, which is due to a fungus growth consequent upon the disorganization of the tender leaves by cold. Protection against a sudden reduction of temperature will prevent blister on peach trees.

The powdery mildew which attacks roses, grapevines, and the foliage of many other plants, when grown in glass structures, is produced by careless ventilation. If the ventilators are opened when the outer temperature is twenty or more degrees lower than that of the inside, mildew will speedily appear on the leaves which have been suddenly cooled, and the injury will first show itself on the portion nearest the opening of the ventilator.

Roses that are wintered in glass-covered frames or pits, without artificial heat, may remain for several weeks without there being any necessity for ventilation; but as the warm, sunny, spring weather raises the temperature and necessitates the admission of cooler air, then mildew will appear on the plants, at least on those more directly under the opened sash.

A current of dry air coming into contact with tender leaves, especially when quite succulent, will be cooled by the evaporation of moisture from their surfaces, the ultimate result being a consequent appearance of the powdery mildew on such leaves.

It therefore seems quite probable that extreme changes of temperature, when sudden in their action at a time when pear trees are in active growth, would produce the malady known as blight, followed by bacteria and other agents of decomposition.

GRAFTING—ITS PURPOSES.

Grafting is employed as a method of propagating or increasing plants which will not reproduce themselves, in all their characteristics, from seed, and which are difficult to propagate by cuttings. For instance, if it is desired to multiply the Newtown pippin apple or the Seckel pear, we will be unable to do so by sowing the seeds of these respective fruits; neither can they be profitably increased by the same process with which we propagate a willow by cuttings of the young branches, therefore grafting is resorted to as a ready means of multiplying the particular varieties required.

Grafting is also employed as a means of adding vigor to weak or slender growing plants. This is accomplished by choosing a stock of well-known vigorous growth. For instance, weak-growing roses, when grafted upon strong-growing briars or other equally vigorous kinds, produce better growths and finer flowers than they do when raised from cuttings. This practice of grafting with the special purpose of imparting vigor is not systematically applied to fruiting plants, although some cultivators of the grape vine have found great advantages to be derived by grafting certain comparatively weak-growing varieties, such as the Delaware, upon more robust kinds, such as the Clinton. The grafting of grapes is now being extensively practiced in

Europe, the stocks used being mostly our American species and varieties. This is done because some kinds of our native species resist the attacks of the phylloxera or root louse, so destructive to the vines of Europe.

Again, grafting is employed for an opposite purpose to the last mentioned, that is, for the repression of vigorous growth, and through that to hasten and increase the production of fruit. This is in some cases known as the dwarfing process, and results in securing technically dwarf trees. Instances may be noted, such as the dwarf pear, which is produced by grafting pear shoots on quince stocks, and the dwarf cherry, which is produced by grafting our large fruited cherries upon a weaker growing European species known as the Mahalab cherry. This process is in accordance with a well-established law in vegetable physiology, that repression of growth is favorable to early maturity.

Grafting is also usefully employed in testing seedling fruits, in so far that by grafting a shoot of a young seedling apple upon an old bearing apple tree the process will cause an earlier fruiting condition of the shoot thus grafted as compared with the fruiting condition of the seedling. It is a common observation that seedling orange and lemon trees will not bear fruit until they are grafted. This is not, however, strictly true; the grafting of these with scions from bearing plants will have a tendency to hasten the fruiting period and insure a good variety of fruit, provided the scion has been obtained from a good kind, but it does not follow that seedling oranges or lemons will not fruit if time is allowed for them to do so. Some of the finest oranges in the groves of Florida are from seedlings which have never been grafted. Allowing seedlings to fruit is the only way to get improved varieties.

Grafting is only successful when the stock and scion are nearly related. It can only be practically useful with varieties of the same species, species of the same genus, or genera of the same natural order. In the latter class there are many exceptions, and in all the results are very varied.

The operation known as "budding" is subject to the same laws as that of grafting. Inarching is also another method of reaching the same results.

PLANTS FOR PROTECTING A SLOPING BANK.

A correspondent makes inquiry as to the best plant for covering a sloping bank caused by filling up a deep hollow in crossing it for a road. In answer we would state that one of the best plants for this purpose is the *Forsythia viridissima*, sometimes called the golden-bell plant. This plant has widely ramifying roots, which sends up shoots or suckers, and rapidly makes a perfect thicket with roots spreading in all directions. The plant is very hardy, and is one of the earliest and most profuse blooming shrubs we possess; it is one of the most effective plants in shrubberies. Masses or groups of these plants when distributed judiciously in parks and ornamental grounds, flowering as they do on the first approach of spring weather, form one of the brightest ornaments of the vernal season.

CULTIVATION OF FIGS.

The fig tree is a native of western Asia and the shores of the Mediterranean, both in Europe and Africa. It has been cultivated from time immemorial for its fruit, which has been esteemed in all ages, both in the fresh and the dried state. The process of drying figs is probably very ancient, as we read in the Bible of a present of cakes of figs having been made to David.

The figs of ancient Athens are mentioned and praised by Aristotle, Pliny, and other classical writers. The Athenians were so partial to figs that they did not allow the fruit to be exported; and the informers against those who violated this law being called *sykophantai*, from two Greek words signifying the discoverers of figs, gave rise to our modern word sycophant.

The fig is cultivated to a large extent in the south of France and in Italy, where it forms an article of diet, besides being largely exported in the dried state. The ripe fruit of the fig is esteemed as a demulcent and laxative, and has long been used as a poultice for boils. The numerous seeds in the fruit are indigestible, and sometimes have an irritative action. The wood of the tree is soft and spongy, and is sometimes used for polishing tools, when charged with oil and emery. The bark contains an acrid, milky juice which has some of the properties of caoutchouc.

The process of drying figs is very simple. The fruits are first dipped in scalding hot lye, preferably made from the ashes of the fig tree; they are then dried in the sun, or in ovens made for the purpose, then pressed in boxes and drums for sale.

The culture of the fig has not attracted much attention in the Middle and Northern States, owing to the susceptibility of the plants to frost. The trees are perfectly adapted to the climate of the Southern States, where they have long been cultivated for domestic use, but not produced in sufficient quantities to be included among commercial products. They are cultivated to a considerable extent in California, and the dried figs from that State are but little inferior to those imported from Europe.

The fig may be fruited in sheltered localities in the Northern States by taking the precaution of covering the branches during winter so as to protect them from severe frost. This is not difficult to accomplish, the most simple and effective method being that of bending down the branches and fastening them as close to the ground as practicable with pegs, in which condition they can readily be covered with 8 to 10 inches of soil, or an equally thorough coating of forest leaves, protected by a covering of boards to exclude rain.

Due care must be given to the timely removal of the covering in spring. If delayed until the buds commence to unfold they will suffer injury from sudden exposure, and if uncovered too early they may be nipped by late spring frosts. A gradual removal of the protecting material will obviate both contingencies.

The fig produces fruit most satisfactorily when it is planted in gravelly or sandy soil. In heavy, rich soils it produces extra luxuriant growths, and the young fruit will drop prematurely, the wood will be ripened imperfectly, and thus diminish the number of matured fruit buds. After the fruit makes its appearance, and all during its progress toward ripening, the plant requires an abundance of water. If the soil becomes very dry at any time during this period the fruit will probably turn yellow or shrivel and drop, but when the fruit becomes soft, indicating approaching ripeness, a less supply of water will improve its flavor as well as hasten the ripening of the young shoots, upon which depends the future crop.

It is of some importance to know when a fig is properly ripe and fit to eat. In most cases the fruits drop to the ground, but that injures them; therefore, select one which is dropping its head a little, which has a large drop of juice at the eye, and at the sides cracked, with the juice exuding and standing on the surface like drops of dew; then take the stalk in one hand, and with a knife cut off the top of the fruit, and peel off the skin in flakes, making one mouthful of the luscious interior.

The following list embraces the varieties of figs at present under propagation by the Department: Angelique, Adriatic, Black Marseilles, Brunswick, Brown Turkey, Black Bourjassotte, Bourjassotte Grise, Brianzola, Black Dattato, Black Brogiotto, Black Ischia, Black Province, Brown Ischia, Castle Kennedy, Dom Pedro, Dalmatino, Early Violet, Grosse Verte, Guigliona, Negro Largo, Osburn's Prolific, Poulette Pitaleuse, Pegustrata, Rubado, Rue de Noir, Smyrna, Sanvito, Trojano, Violet de Bordeaux, White Marseilles, White Genoa, White Brogiotto, White Dattato, White Boyasotti.

ORNAMENTAL TREES FOR LAWNS.

A prevailing error, in planting lawns of not more than one or two acres in extent, is that of selecting trees of the largest growth, which soon become a serious evil, and one which is not easily remedied except by their entire removal, which is sometimes, although reluctantly, done. Ornamental grounds depend quite as much for their beauty on the stretch of unobstructed grassy lawn as upon trees and shrubs. The skillful combination of trees and grass forms the art of landscape gardening, so far as planting is concerned, and no small part of this art consists in the selection of trees, which, both in form and size of growth, are best adapted to the size and disposition of the grounds to be ornamented.

The following list embraces only medium-sized trees, well fitted for limited lawns and ornamental grounds:

Acer campestre, the European field maple, is one of the most desirable of small trees for its dense foliage and symmetrical habit of growth. *Acer palmatum*, an elegant Japan species. *Acer polymorphum*, also from Japan; there are numerous elegant varieties of this species, all highly interesting and ornamental. *Acer striatum*, the striped barked maple or moosewood, is a native species, conspicuous in winter on account of its beautifully striped bark. *Cercis Canadensis*, the Judas tree, well known for its early spring flowering and handsome summer foliage. *Cornus florida*, the large flowering dogwood. *Cornus mascula*, the Cornelian cherry; the variegated form of this species is one of the finest of all hardy variegated leaf trees. *Shepherdia argentea*, the Buffalo berry, has an abundance of scarlet fruits, which are sometimes eaten for their acidity. *Fagus sylvatica asplenifolia*, the cut-leafed beech, is a very unique, ornamental plant. *Chionanthus virginica*, the fringe tree, has curious flowers, as if cut out of white paper. *Halesia tetraptera*, the silver-bell or snow-drop tree, so named from its numerous bell-like flowers. *Kolreuteria paniculata*, a Japan plant, having finely pinnated leaves, yellow flowers, and bladdery seed vessels. *Magnolia glauca*, the fragrant swamp magnolia; *Magnolias, conspicua, Soulangeane*, and *Lenne*, are spring flowering kinds of much beauty. *Ptelea trifoliata*, the hop tree, both useful and ornamental. *Pyrus prunifolia*, the Siberian crab apple; there are several varieties of this species, mostly compact growing trees of medium size, well adapted for ornamenting lawns, and at the same time yielding useful fruits.

PARLOR PLANTS AND THEIR MANAGEMENT.

There are not many fine flowering plants which will grow and bloom in perfection in the common atmosphere of a dwelling room; the air is too dry, and it is not consistent with comfort to keep the air saturated with moisture, even were it practicable to do so. Parlors are usually warm enough for plant growth, and there need be no difficulty in keeping the soil as wet as is necessary, but although everything that skill and care can suggest may be judiciously applied, yet the want of a proper degree of moisture in the air will go far toward counteracting all other efforts to induce a satisfactory growth in most flowering plants.

But the plants which suffer most are those having the largest leaves, because they present a greater surface for evaporation than smaller foliaged plants; hence it is judicious to select the latter, as far as they are desirable for parlor culture, as being more likely to remain healthy under the circumstances. Undoubtedly the best arrangement for parlor plants is that of providing a deep bay window for their accommodation, which can be isolated from the room proper by sliding sashes on a line with the walls of the room, so that when the sashes are closed a cabinet will be provided for the plants, the atmosphere of which can be kept in a condition more congenial to vegetable health and the plants still be conveniently enjoyable as parlor ornaments.

In the absence of any special provision as above, a selection of plants may be made which require only a minimum amount of water in the air. Such, for example, are the smaller forms of the Cactus family, many of which are novel and interesting plants, with handsome and sometimes showy flowers. The night-blooming Cereus does well in a room, although not so well adapted as some others, on account of its lengthened stems and the space they occupy. The flat-stemmed Epiphyllums, or Crab Cactus, as they are sometimes called, make fine parlor plants, and bloom profusely with ordinary care.

There are various species of Oxalis, or wood-sorrel, which are exceedingly well adapted for parlor culture; they are usually very prolific in flowers; they are mostly tuberous rooted, and the leaves indicate maturity of the bulbs by turning yellow and fading; they can be then set out in the garden, and again lifted and placed in the pots toward the fall. Among the best flowering kinds may be mentioned *Oxalis bowcii*, *Oxalis versicolor*, *Oxalis rosea*, and *Oxalis flava*.

The *Cyclamen persicum* is now a popular winter flowering plant. Of late years many fine varieties of this species have been produced, some of them having a delightful fragrance. They naturally flower during the winter and early spring. After the bloom fades the leaves will continue to grow, and about the end of May they can be set out in the border; when the weather becomes warm and dry the leaves will fade and drop. About the end of August the leaves will again appear, when the bulb should be carefully lifted, placed in pots, and taken into the house, where they will continue to grow and again flower in due season.

One of the best parlor plants for winter flowers is the Chinese primrose, especially the varieties which have double flowers; they are exceedingly floriferous and keep in bloom for months. They are somewhat difficult to preserve during the summer, but will generally succeed when set in a shaded position, keeping them in the pots, and watered only when very dry. They require to be watered with care at all times. If kept too wet the stems will decay; hence the soil for them should be of a porous character, and the drainage in the pots should be perfect, so that when water is given the surplus will readily run off. The single varieties are best managed when treated as annuals; that is, a supply of young plants being raised from seeds which are sown in the fall.

HYBRIDIZING AND CROSSING.

These terms are frequently used as if they were synonymous, which is far from being correct. The Concord grape, for example, we have seen pronounced as being a hybrid, the result of much skill and care. On the contrary, it is a seedling raised from seeds indiscriminately gathered from a fox grape. It is related that a Catawba vine was growing in the neighborhood of the vine from which the seeds were gathered, and that an accidental cross may have taken place, a supposition, however, which does not seem apparent; certainly no artificial means were employed in the conveyance of pollen from one flower to another, and it is, therefore, nothing more nor less than an accidental good seedling. Even if the pollen of the Catawba had been purposely conveyed to the flowers of the parent of the Concord, the progeny would only be a "cross" of one variety with another variety of the same species.

The Lady Washington, Duchess, and Salem are reputed true hybrids, inasmuch as they are said to have originated from artificial pollenization of two plants belonging to different species—that is, from some one of the different American species and the foreign species *Vitis vinifera*. There are also hybrids among cultivated grapes whose parents were of different American species, but most of our useful grapes are seedlings, pure and simple, from American species, having no claims to hybridity.

The fact is that but few of our best varieties of fruits are the result of special pollenization. They are simply selected varieties which have been produced from seeds gathered from good fruits, and some are of unknown origin, such as the Seckle and Sheldon pears, which were found growing in fields where the seeds had accidentally been dropped. The same may be said in regard to our best apples; most of them have been picked up in old fields and by waysides, and further than this nothing of their origin is known. The Kieffer pear is usually called a hybrid, although the evidence in this case is only circumstantial. The seed from which it was produced was collected from a Chinese species called the sand pear, a plant which has long been planted as an ornamental tree, being conspicuous for its large, shining foliage and its round, hard, uneatable fruits. In the vicinity of this tree were fruiting trees of Bartlett, Flemish Beauty, and other varieties, and from this circumstance it is supposed that pollen from the flowers of some one of these varieties had communicated with the flowers of the sand pear.

The lesson to be learned from all this is, seeing that so many fine varieties of fruits have been produced incidentally or from mere variation, how much greater improvements may be made by careful selection of varieties to be crossed for the production of fruits having specially desired characteristics. There is an immense field for this kind of experiment, as applied to all cultivated plants.

FARMERS' GARDENS.

The garden of the farm is usually a portion of ground neatly fenced in, so as to guard it from the depredations of animals that might happen to stray into an open field. It is generally laid out into beds, with plenty of paths introduced, which most of the season are covered with weeds, and during wet weather are not inviting as promenades. The beds or borders thus defined and appropriated to the culture of vegetables are too contracted for the introduction of the plow; consequently, the soil is but imperfectly turned up with a spade or digging fork. Under these circumstances everything depends upon hand labor, and the work is not always performed in an effectual manner. Should there happen to be any of the more permanent crops, such as currants, raspberries, or strawberries, they soon become weedy and the ground hard for the want of culture, which is in such cases a laborious operation, and, altogether, the garden is seldom a success, and is a thing of vexation rather than a thing of beauty.

The farmer's garden, so far as vegetable culture is concerned, should be accessible to the plow and the manure wagon. A suitable spot of ground—in shape long and narrow rather than square—should be properly fenced if necessary (which is not always the case), and worked altogether by the plow and horse cultivator. The land can be plowed deeply and efficiently, manure can be conveyed and spread with facility, and all the necessary operations performed by using the ordinary implements of culture on the farm. At each end of the inclosure thus appropriated a space of 15 feet in width should be sowed in grass and kept for the convenience of turning the teams when working the crops. All crops should be grown in rows, and these placed sufficiently apart to allow for culture. Fruit bushes should be planted so that the plow and cultivator can be introduced between the rows if desired. In this way all kinds of vegetables may be profusely and economically produced.

TRANSPLANTING TREES DURING WINTER.

The system of removing large trees with balls of frozen earth is frequently recommended and occasionally practiced, but seldom with success. No amount of soil, frozen or otherwise, will compensate for the destruction of roots, and to remove all the soil occupied by them is simply impracticable. The larger and older the tree the further will the roots extend, and consequently the fewer of them can be secured in a limited space. There is a great want of discriminating judgment shown in the matter of lifting and transplanting large trees. It seems to be an opinion held by some persons that, provided they lift a ton or two of soil, success must be certain. Experience proves that but a small percentage of such removals ultimately live; they sometimes linger for years in a stunted or comatose state, and finally die. In many, perhaps in most, cases the tree could be saved by a heroic pruning operation, cutting the branches severely so as to reduce the tree to a mere stump. To secure a healthy continued growth, the branches must be reduced in a corresponding ratio with the reduction of the roots. It is roots, then, and not soil, that ought to be removed; and the roots can best be traced and secured when both the soil and the air are free from frost. In any case success will mostly depend upon the discriminate pruning of the branches, and this must be left to the judgment of a competent and experienced planter. During the progress of removal he will acquaint himself with the probable degree of root mutilation; he will also recognize the kind, age, and health of tree operated upon, and these factors will have a special influence in controlling the future management of and care to be given to the plant.

Occasionally we meet with instances where success is all that could be desired, and that, too, in the absence of any special knowledge of the matters involved; but such instances are not to be taken as infallible precedents. All practice not founded upon principle is empirical. It may be successful because it may by chance be in accordance with natural laws; but this being unknown and not recognized, no continuance of success can be insured, and all future efforts are involved in uncertainty.

THE CASSAVA PLANT.

This plant is now being much extolled as a source of starch for the manufacture of glucose, for which purpose it is to take the place of Indian corn. Its culture is strongly advised in Florida and California, and in the way of answer to several inquiries which have been received the following remarks upon the plant, or plants—as there are two, the sweet and bitter—may be useful as reference. The bitter cassava (botanically, *Manihot utilissima*) is a straggling, crooked growing shrub, which attains a height of from 6 to 8 feet. It is a native of the West Indies and South America, but long introduced into the East Indies and other tropical regions for the sake of its fleshy roots, which furnish the starchy product called tapioca. The roots are bitter and contain a poisonous substance which is said to be hydrocyanic acid. This is separated by rasping the roots to a pulp, which is placed in coarse bags, and the poisonous juice expelled by heavy pressure. This juice has sometimes been used by the Indians to poison their arrows.

The pulp, after being pressed, has parted with the greater portion of the poisonous juice, and what remains is dissipated by baking the squeezed pulp upon heated iron plates; it there becomes friable, and is then broken into small pieces and stored for use. So volatile is this poisonous principle that when the fresh root is cut into slices and exposed for several hours to the direct rays of the sun, cattle eat it with perfect safety. The Indians also partake of the root after roasting it in hot ashes without any previous preparation.

The process of drying on hot plates lessens the nutritive value of the product, as many of the starch cells are thus broken and dextrin is produced, but it is essential in order to get rid of the poisonous acid.

The fecula, or starch, is prepared by torrefying and granulating on hot plates; the grains burst and agglomerate in irregular gum-like masses, and in this condition is known as tapioca.

Brazilian arrowroot is the fecula that deposits from the expressed juice when it is allowed to settle; it is known as cassava flour, or mandiocca meal. An intoxicating beverage called piwarrie is made by chewing cassava cakes, or dried pulp, and placing the masticated material into a vessel to ferment, after which it is boiled for use.

The juice of the root, concentrated by boiling—which also dispels all injurious properties—under the name of cassareep forms the basis of the West Indian dish called pepper-pot. It is highly antiseptic, and meat which has been boiled in it will be preserved for a much longer period than can be done by any other culinary process. In South America a sauce called arube is prepared by boiling down the fresh juice before the starch is precipitated. This is concentrated to a yellowish paste and seasoned with peppers; it is kept in stone jars, and is used as a relish to fish. Tucupi sauce is made from the juice after the starch has been separated, boiled, and seasoned with peppers and small fishes. It is used in a liquid form and tastes like essence of anchovies.

The sweet cassava (*Manihot aipi*) is supposed by some to be merely a variety of the preceding. Its roots are sweet and wholesome, and are eaten when cooked as any other edible vegetable. With the exception of the poisonous quality, the products of the sweet and bitter cassavas are perfectly alike. The bitter is most cultivated because it is most productive.

The plants are propagated from cuttings made of the stem, prepared and planted in a manner similar to that employed in the culture of the sugar cane. A warm, dry soil is essential; in wet soils the roots decay or are worthless. The most careful cultivators repress the flowering buds, so as to increase the size and vigor of the leaves, upon which depends the greater increase in the size of the roots.

WINTER COVERINGS FOR PLANT FRAMES.

In protecting pits and hotbeds from frosts there are some simple points which should be kept in view. Everything should be kept as dry as possible in frosty weather; dampness, from whatever source, whether it arises from insufficient drainage of the interior or by using damp material for covering, should be carefully avoided. Where no artificial heat is applied there will not be much occasion for frequent waterings, and the dryer the soil can be kept without injury to the plant the less effect will cold have upon it. When water is applied it should be early in the day, choosing bright weather, and ventilate to get rid of superfluous moisture before evening. Another important point is to endeavor to inclose a stratum of air reposing between the upper surface of the glazed sashes and the protecting material. A single cover of canvas, if elevated 3 or 4 inches above the glass by a light framework, so as to inclose a portion of air between the sashes and the cover, will exclude frost more effectually than half a dozen thicknesses of covers would do if placed in direct contact with the glass. A few inches of thickness of loose straw or dry leaves form a good protection. It is not to be expected that many plants will bloom during the winter in a frame of this kind, but many of the hardier kinds of summer flowering plants, such as petunias, verbenas, geraniums, centaureas, roses, etc., may be safely carried over for spring planting.

MANURING ORCHARDS.

When complaints are heard of the worn-out condition of fruit orchards they mean, in ninety-nine out of a hundred cases, that the soil is poverty-stricken and needs manure. The best manured orchards yield the best crops everywhere, and nowhere can fine fruits be produced on poor soils. This seems easy to understand, and yet many orchards throughout the country are suffering for want of manure. It is a common opinion that trees are more liable to blight in rich lands than they are on poor lands—an opinion which will not hold, for the worst blighted orchards may be seen on very poor ground. It does not seem that the nature of the soil has anything to do with the blight on pear and apple trees. On the other hand, whether an orchard is profitable or otherwise depends mostly upon the character of the soil.

On visiting a pear orchard which was very unprofitable, although its owner spared no expense in manures for it, plows were seen at work making deep furrows close up on all sides of the trees, thus cutting off all roots as soon as formed; but the owner did not attribute his want of success to that which was the main or perhaps the only cause of failure.

When fruiting trees are not able to produce a fair crop of fair fruit, and do not at the same time make from 18 inches to 2 feet of growth on the main shoots, it is evidence that the soil needs enriching or cultivation, or both; for it may be enriched by top-dressing without cultivation. If the orchard is in grass, a top coating of 20 tons to the acre of good barnyard or stable manure spread over it in spring will help to enrich it; or if 1 ton of bone meal to the acre is applied it will induce vigor of growth. If the orchard is in cultivation, the manure should be lightly plowed under, and the surface kept clean and stirred during summer. One thing is certain, that fine fruits can only be had from rich soils.

THE JERUSALEM ARTICHOKE.

The botanical name of this plant is given as *Helianthus tuberosus*. It is a hardy perennial, having an annual stem which reaches to a height of 8 or 10 feet, and closely resembles the sunflower. It is stated to be a native of Brazil, but it is surmised to be a cultivated form of a wild species which is found in some of our Western States, and known as *Helianthus doronicoides*. This plant has numerous creeping roots, which produce tubers like the common potato; these tubers are of a longish, slightly flattened shape, and are considered to be more nutritious than those of the potato, and when properly cooked they are well flavored, and may be eaten by invalids when other vegetables are denied them. They are used in soups, and they make fine pickles when partially boiled, sliced into half-inch thicknesses, and placed in vinegar. Most kinds of live stock will eat them, and swine are particularly fond of them. In flavor they do not equal the common potato, but from the productiveness of the plant and its suitability to warm and dry climates it seems probable that it may become of sufficient importance to secure attention, in selecting particularly valuable varieties with improvement of flavor.

The stems of the plant contain a useful fiber, and the leaves are said to contain niter. A chemical substance is found in the tubers which is called *Inulin*, a starchy substance, which is rendered of a yellowish tint by iodine. An analysis of the tubers is given as follows: Starch 30, albumen 10, sugar (uncrystallizable) 138, gum 12, fixed oil 1, woody fiber 12, inorganic matter 27, water 770.

Although not generally cultivated by farmers in this country, yet in the aggregate large quantities are grown as food for live stock. They are planted in rows like the common potato; a greater distance is, however, allowed between the rows to admit of cultivation as the stalks rise in height. By cutting off the flowers as they appear, the size as well as the quality of the tubers will be increased. They are not easily destroyed by frost, and in rich, loose soil will yield a large crop, and are not easily eradicated unless great care is exercised in harvesting them.

THE MEDLAR TREE.

This is a low spreading tree, a native of Europe, and is sometimes cultivated for the sake of its fruits, which are highly esteemed by some, although they are not in popular favor.

The fruit is gathered just before frost; it is globular and about an inch in diameter; the skin is brown, the flesh green, hard, austere, and uneatable; but when kept until it begins to decay the green color disappears and the pulp becomes soft and acid. There are several varieties in cultivation. The largest fruit is produced by the kind known as the Dutch medlar, but the best flavored is said to be the variety called the Nottingham medlar.

Medlar jelly, which greatly resembles guava jelly, is made by first washing the soft fruits, then placing them in a cooking vessel, merely covering them with water; they are then boiled gently till they form a pulpy mass; this is strained through a flannel bag, and after adding three-fourths of a pound of fine sugar to each pint of the juice, it is boiled for about a couple of hours, when, if properly managed, it will be firm and of a beautiful clear yellow color. The botanical name of the tree is *Mespilus germanica*.

THE ARTICHOKE.

The artichoke (*Cynara scolymus*) is a hardy perennial plant from southern Europe; it is a coarse-growing, thistle-like plant, having robust, spiny leaves reaching from 3 to 4 feet in length. It is cultivated for the imbricated scales of its large globular heads; these scales are fleshy at the base or bottom, and this "bottom" is the eatable part, which is much used in parts of Europe, but as a vegetable it furnishes a very meager article of food, although it is considered a delicacy by many persons; it is seldom cultivated in the United States. In France the bottoms are cooked in various ways, and the small heads which form on side shoots are used for pickling when they are about half matured. The flowers of the plant are said to have the property of curdling milk; a good yellow dye is also furnished by them. The artichoke requires rich soil to produce the best quality of heads; it is propagated by suckers, which are freely produced at the base of old plants. After the flower heads have been gathered, the stem and leaves are then cut off close to the ground for the purpose of producing the vegetable dish called chards. This consists of the young leaves which spring up after this cutting, and having reached a length of 18 inches are tied closely in a bundle, which whitens and blanches the inside leaves, after which they are ready for use.

PLUNGING-POT FOR PLANTS.

Many years ago I had a quantity of flowerpots made expressly for the purpose of growing plants which should be planted out during summer and kept in the greenhouse or parlor window during winter. These pots had their sides perforated with holes, so that when the plant was removed to the garden border it was not taken out of the pot, but a hole was made large enough to receive the pot, which was plunged so as to be entirely concealed in the earth. Roots soon protrude through these holes, and the plant thrives about as well as it would do without the pot. At the end of the season the protruding roots are cut off smooth with the sides of the pot, a little moss is stuck in at each hole to prevent too rapid escape of water, and the plant soon recovers the effect of removal. There are many plants which can be successfully grown in this way; for example, the fig in northern regions can be managed so as to produce a crop of fruit when plunged out in the open ground during summer and lifted and wintered in any cool cellar where but little if any frost penetrates. After using pots for a few years it will be found to answer quite as well to lift the plants in the fall with a good ball of earth and roots—induced in the first place by the pots—place them in the cellar to winter, and set them out in the ground in the spring. For window gardening these pots are peculiarly adapted. Abutilons, oleanders, roses, heliotrope, and a host of plants can be set out during summer and lifted in the fall without any retarding check, and they will soon begin to flower and continue blooming during the winter months, if under favorable conditions for growth.

ACTION OF FROST.

The process of congelation is curious and interesting. It is well known that water when frozen is expanded, and occupies more space than it did before, and hence that ice is lighter than water and swims upon it. If a bottle full of water, tightly corked, be left to freeze, the bottle will be broken for want of room for the expansion of the water while assuming the solid form. This property of water, when frozen, tends every year to diminish the height of mountains. Fissures and crevices become filled with water during the summer, and its expansive power when frozen detaches masses of rock, which will roll down to lower positions. In its more moderate and minute effects, the operation of this general law is productive of a very beneficial consequence to the gardener, for the hard clods of turned-up soil are loosened and broken into pieces by the expansion of water which they contain when frozen. The earth is pulverized and brought to a finely divided condition for receiving seed. Hence the utility of turning up strong or clay soils to be acted upon by the frosts of winter, thus saving mechanical labor in trying to accomplish what the natural force can do so cheaply and well.

USES OF THE SWEET CHESTNUT.

The fruit of the chestnut has long been an article of value, and in Europe many varieties are cultivated for their fruit alone. The largest nuts are produced in the South of France, Spain, and Italy, where they have some importance as an article of food. They are generally cooked either by roasting or by boiling them in water, with salt, fennel, and various kinds of flavoring herbs. They are also dried and ground into flour, which is made into a kind of porridge, or polenta, by boiling in water or in milk. It is baked in cakes, which are cooked by frying, and it is used to thicken soups. In whatever way they are cooked, chestnuts are said to furnish a wholesome and nutritious food. It is also stated that sugar has been extracted from chestnuts by the same process as is used for the extraction of sugar from beet.

They are prepared for keeping during winter by drying them in the sun, or in ovens, after which they are packed with dried leaves in barrels, and are kept in a cool cellar until wanted for use. In France the best varieties are called marrons; when roasted they have a rich, creamy flavor and an aromatic odor, in which the common varieties are quite deficient.

They are roasted by various methods, but in whatever way, a slit is made in the skin of all except a few, and when these crack and the skin parts, it is considered an indication that the rest are cooked.

SUMMER FLOWERING BULBS.

The gladiolus has become one of the most popular of summer flowers. It has many commendable qualities, and requires but little of what may be called skill in its management. The bulbs may be planted as soon as the frost leaves the ground in spring, and if a succession of flowers is desired, planting may be made weekly until the middle or end of June. The bulbs for late planting must be kept in a very cool cellar to prevent them from growing prematurely. Like most other bulbs, gladioluses thrive best in sandy or at least a light soil, and if the finest flowers are to be obtained, the soil must be well enriched. In dry seasons the blooms will be short lived, but this can be materially counteracted by mulching around the stems. This is preferable to watering, which sometimes injures the bulbs. They ripen seed very freely, but it is at the expense of the young bulbs, and where it is not proposed to save seed, the future flowering bulbs will be greatly helped in growing by removing the flower stem as soon as the flowers fade. Each bulb will form two bulbs for future planting, and in addition to these, numerous small bulblets will be found clustering at the base of the larger bulbs. These small bulbs will vary in size from a marble to a pea. These should be carefully gathered and sown in rows like peas, when they will soon reach the size of flowering bulbs. The bulbs should be lifted in the fall, and after being well dried in the sun, stored in a dry place where no frost can enter. In dry soils, even in the Middle States, they can be planted deep enough to escape injury from freezing, but it is the safer plan to lift the bulbs after the stems decay, and keep them dry during the winter.

The *Tigrida*, or tiger flower, is a Mexican bulb which produces tulip-shaped flowers of a scarlet color, spotted with yellow. The flowers are very beautiful, but of short duration, lasting only one day; but it continues flowering for sometime, several flowers being produced from the same stalk. The bulbs are small and appear almost worthless, but if they are planted in a deep, light, rich soil they will flower satisfactorily. They are very tender, and will not stand any frost, consequently they should be lifted and kept in a dry place where there is no frost. They should not be planted until the ground becomes warmed in spring, otherwise the bulbs will be apt to decay.

OLD TREES.

There is an interest in old trees which seems to be a never-failing topic of discussion. The oldest tree or the biggest tree in any country is sure to have a reputation hardly equaled by any other local curiosity. Old people, too, love to talk of these familiar topics, and their children after them repeat with pleasure the queer old stories and ideas about "the old trees" which still live, while everyone else grows old and drops away forgotten. Here is a practical argument to the young and of the present generation to plant trees for all futurity. They may fall from the ranks of life at any time, but the trees they planted bear their names on for years with many a precious memory. And of all old trees none are so fraught with reminiscences as old fruit trees. Everyone who has planted a fruit tree is a benefactor, and long after the planter has gone to his last rest and been forgotten, someone, grateful for the fruits which he enjoys, will ask, "Who planted that old tree?" This is well expressed by Bryant:

What plant we in this apple tree?
Sweets for a hundred flowery springs,
To load the May wind's restless wings,
When, from the orchard row, he pours
Its fragrance through our open doors.

What plant we in this apple tree?
Fruits that shall swell in sunny June,
And redden in the August noon,
And drop, when gentle airs come by,
That fan the blue September sky:
While children come, with cries of glee,
And seek them where the fragrant grass
Betrays their bed to those who pass,
At the foot of the old apple tree.

And after ages have elapsed, and when the hundreds who have enjoyed its fruits have turned to dust—

The children of some distant day
Thus to some aged man shall say,
Who planted this old apple tree?

THINNING FRUIT.

It has been remarked that "when our fruit is most abundant it is of the poorest quality." There is a good deal of truth in the remark, and it comprises a mild kind of censure upon fruit-growers, especially when it is found that a year of great abundance is followed by one of great scarcity. Reasoning abstractly upon this condition of things, it might be concluded that good fruit would be the rare exception as seen in our markets, and the reasoning is not far from being borne out in fact, as all who have studied the various fluctuations of our fruit markets can readily indorse. To secure the best quality of fruit, trees must not be allowed to overbear, that is, to bear more fruit than the tree is able to ripen to a normal degree of perfection, otherwise large quantities of fruit are produced, and that of a very inferior quality, to be followed by a season of scarcity, causing the alternations of a bearing year and a barren year in orchards. The comparatively inferior heavy crop checks the growth of the tree to that extent that the following season is required for its recuperation. This can be obviated by a little careful management in thinning out the fruit when it has set in excess. By this means a moderate crop of the best quality of fruit can be secured yearly, and orchards be made doubly remunerative as compared with the let-alone system of management in fruiting.

The greatest objection to thinning fruit on trees is its cost, but those who have had the courage to meet this extra labor have found it to be a profitable outlay. It is always wise to economize labor, but that does not mean that it is wisdom to withhold labor when it can be employed profitably, and those who have experience in thinning out peaches when the trees were overloaded maintain that it is an outlay which pays better than any other expenditure on the farm.

SEA KALE.

This is a perennial plant which grows to the height of 2 or 3 feet; its leaves are large, wavy, and deeply notched at their edges, and have thick, fleshy footstalks and midribs. It is a native of sandy coasts in Europe; the leaves have been used for greens since a very remote period, and the young shoots, gathered as they appeared above the sand, were cooked and eaten as asparagus. It is much used in some parts of Europe, but always in a blanched state, by keeping the light from the plants when they start to grow, either by covering them with sand or partially decayed manure; but where the vegetable is regularly cultivated and in demand, large pots, somewhat like flowerpots inverted, having a movable lid or cover, are employed. These are set over the plants and covered over with leaves and manure, which ferment, and the heat thus generated forces the plant into early growth. In starting a plantation from seed, the usual method is to sow in hills which are placed 3 feet apart. Three plants are retained to each hill. The plant will attain considerable size the first year, and should be protected from severe frost by a covering of manure or leaves. Previous to growth in spring, the plants should be uncovered and the crown pared off, in order to prevent the formation of a flower stem, and to encourage side bulbs to develop, which will not produce seed. The botanical name of the plant is *Crambe maritima.*

THE CHINESE POTATO.

Thirty-five years ago this plant was introduced from China as a wonderful production, designed to supersede the common potato as well as the sweet potato, as it was said to combine all the good qualities of these popular roots with others peculiarly its own. The botanical name of this plant is *Dioscorea batatas*. It has a tuberous root, with a twining stem, which grows from 20 to 30 feet in a season. It is said to be exclusively cultivated in China and Japan for its tubers, which are used for food and take the place in consumption that our potatoes do here.

The tubers, or roots, are long, rather slender, and of unequal thickness; they contain a large quantity of starch and mucilaginous matter; they are very white, and when cooked are very palatable, and are preferred by many persons to the sweet potato, which they somewhat resemble in taste; they are a nutritious and wholesome food.

Various attempts have been made to popularize the cultivation of this plant in this country, but although it is excellent food, its growth is too protracted and the yield too scant to make its culture profitable. It is of easy culture and the roots are quite hardy. They remain in the ground for several years, gradually increasing in size. The stem is of such a rapid and slender growth, and the foliage so ornamental, that the plant is frequently used as a summer covering for arbors and lattice work, under the name of cinnamon vine.

A great drawback to its culture is the depth to which the roots penetrate, which renders its removal a costly operation. It is stated that in China there are varieties which form roots quite close to the surface, and are also more productive, but these have not yet been introduced into this country to any extent.

THE POMEGRANATE.

The pomegranate (*Punica granatum*) is a small tree, seldom reaching more than 20 feet in height; it is a native of northern Africa and western Asia. The ancients called it the Carthagenian apple, because it was first known to grow in the vicinity of Carthage. It is cultivated in many warm climates for the sake of its fruits, and in temperate climates as an ornamental plant for the beauty of its flowers, as well as that of its fruits, even where the latter do not attain perfection of ripeness.

The fruit is held in high esteem among the people of eastern nations on account of its delicious, cooling, and refreshing pulp. Before it is eaten the seeds are removed and the pulp sprinkled with sugar and rosewater. Several varieties are cultivated, some being sweet and vinous, and others acid, or of a bitter, astringent taste, and the color of the pulp is much redder in some than in others. The rind of the fruit contains tannin, and is used in tanning leather; it is said to give the yellow color to morocco leather. The bark of the root is used in medicine; it abounds in a peculiar acrid principle called punicin. The flowers afford a yellow dye, and a kind of wine is sometimes made of the fruits.

In ancient writings the vine, the fig, and the pomegranate are generally mentioned in connection. Its cuture is, therefore, of great antiquity.

ROSE BEDS.

There is no flowering plant more beautiful or more worthy of care than the rose, and yet it does not always receive the best treatment. Roses only flower finely when they are growing finely—a condition which depends altogether upon their being planted in rich soil and kept rich by manurial applications.

A circular bed, 20 feet in diameter, properly prepared, and planted with good varieties of free-blooming roses, is always satisfactory. The soil should be broken up to a depth of 18 inches to begin with—depth of soil is indispensable to secure continuous growth in dry weather—a heavy dressing of rotted manure should be well mixed with the top surface, and vigorous growth should be maintained by surface applications of fertilizing materials whenever it is found necessary. The most satisfactory blooming roses are unquestionably those known as teas, but in northern climates they require winter protection, and the best method of protection from frosts is to lay the shoots close to the surface and cover them with a few inches of sand or soil, spreading over all a good covering of strawy manure. The best mode of preparing the plants for this winter treatment is to peg the shoots close to the ground during their growth. This will not prevent their flowering; on the contrary, it favors the growth of numerous upright shoots, each terminating in a flower. The most perfect rose bed can be produced by planting a bed exclusively with that fine old free-blooming variety, the Hermosa; if the shoots are trained close to the surface, a thicket of young growths covered with flowers will present the appearance of a verbena bed.

If all the flowers are removed as they fade, and the shoots slightly pruned back, a continuous bloom will result. Plants grown in this way can very readily be protected by covering during the winter.

PEARS CRACKING.

A correspondent desires information in regard to pears cracking when about half grown, and whether it is true, as he has been informed, that the sweepings of a blacksmith's shop, which contain iron filings and iron turnings will, if worked in among the roots, have the effect of preventing this cracking.

The answer to this is, that all the iron in the world would not help it. The disease is climatic, and is altogether independent of soil or cultivation. The cause of cracking is a fungous growth which destroys the vitality of the skin of the fruit and prevents it from expanding as the growth progresses, and, in its effort to expand, it cracks. The same effects are seen on mildewed grapes and mildewed gooseberries. What causes the fungous growth is another, and is really the primary, question. To this question can only be given the vague and indefinite answer, that it is caused by climatic influences, these influences being produced by sudden changes of temperature, or by a continuation of dry weather, or the reverse when the fruit is forming.

This much is well established, that pears do not crack when grown in orchard houses. Even that inveterate cracking fruit, the White Doyenne, or butter pear, one of the best of all pears, may be had in all its pristine excellence when grown in a glass structure. Of course, it is not necessary to resort to a glass house for our pears, but it is on record that an amateur who, failing to grow this favorite variety in any other way, succeeded in getting a bushel or two of the most delicious fruit from a dozen trees in tubs in a greenhouse in summer, when the greenhouse flowering plants were ornamenting the grounds. Another evidence of the efficacy of shelter is obtained from trees growing in sheltered city yards, where the finest fruit of the above-mentioned variety is annually produced.

These, with other equally convincing observations, prove beyond doubt that the soil or any application to the soil, so far as is known, will not cause or prevent cracking of fruit on pear trees.

THE SUNFLOWER (*Helianthus annuus*).

This well-known annual plant probably derives its common name from the brilliant color and ray-like appearance of its conspicuous flowers, for although poets have attempted to make the flower turn on its stem in order that it should follow the course of the sun, it persistently refuses to do so.

The sunflower is a native of South America, and grows 6 or more feet in height. It possesses many valuable properties which are applied to useful purposes. The flowers yield a fine yellow dye, which is said to be lasting; they are also a favorite resort for bees, and a superior honey and wax is thus obtained. The seeds are greedily eaten by poultry of all kinds, and are very fattening. They contain 20 per cent of oil, which is yielded by expression; this oil is bland and edible, makes a fine, soft quality of soap, and burns well. The plant is much cultivated in Russia for the sake of the oil, and the resultant cake is considered highly nutritious as food for cattle. The shelled seed is ground into flour, which makes a very good cake and bread. The leaves, manufactured into cigars, have pectoral qualities when smoked. The stalks, when treated like hemp, produce a fine, silky fiber, which is said to be fitted for working up with silk. The ashes of the burnt stalks yield 10 per cent of potash. As a field crop its culture is similar to that for Indian corn. Fifty bushels can be produced on an acre. Sunflower plantations are said to be specially efficacious in destroying malaria, but the assertion is not supported by comparative experiments. All plants are more or less conducive to this end, especially those of rapid growth and possessing ample foliage.

SANITARY EFFECTS OF BURNING SULPHUR.

Sulphurous acid is one of the most effective antiseptics and antiferments, and may be produced by burning sulphur. It is of great value in the fumigation of dairy rooms and cellars, as it destroys all fungoid mycellium which may be present in the atmosphere, and thus destroys all tendency to mildews and molds. But it should never be used to destroy mildew on plants, as it is certain death to vegetation. Many plants have been destroyed by subjecting them to the fumes of burning sulphur for the purpose of killing mildew on their foliage. Glass graperies, employed for the culture of the foreign grape, are frequently the seat of mildew; sulphur sprinkled on the floor of the house or scattered where the sun can shine upon it will emit fumes sufficient to destroy mildew and will not hurt the plants. Sulphur may be sprinkled upon the hot-air flue or hot-water and steam pipes used for greenhouses, and so long as no burning of it takes place it will be a safe remedy, but burning sulphur is sure destruction to vegetation.

SAFFRON.

The saffron of commerce is the stigmas of the flowers of *Crocus sativus*, a small bulbous plant which was formerly largely cultivated in Europe for this product. The bulbs are planted about 700,000 to an acre, and are subjected to careful and clean culture. Each plant has about three flowers; 30,000 flowers yield about 2 pounds of fresh stigmas, which, when dry, weigh about two-fifths of a pound. The stigmas are dried between layers of paper, or upon a close hair sieve, and pressed by a thick board to form the mass into cakes.

Saffron has a bitter taste and a penetrating, aromatic odor. It is used as a flavoring and coloring ingredient in various articles of cookery and confectionery; it is also employed as a coloring matter by painters and dyers. It is sometimes used to mix with cochineal, increasing the intensity of its color.

Saffron affords over 50 per cent of a peculiar extractive matter, named polychroite, from the changes of color it undergoes by the action of reagents. This substance contains a volatile oil, upon which the medicinal value of saffron depends; it was at one time considered highly stimulant and antispasmodic, but its principal use is that of imparting color and flavor to officinal tinctures.

THE CARROT.

The carrot has been cultivated from remote times; as an esculent it was known to the ancients. It is a well-known and esteemed vegetable, entering into the composition of various culinary dishes. It contains from 6 to 8 per cent of sugar. A transverse section of a carrot will show two parts of different colors. The outside rind is usually most highly colored, and is tender and nutritious; the interior, or heart, is more or less fibrous, and insipid in taste; therefore the value of the root depends upon the relative proportions of these parts, and the root with the smallest proportion of center is the most valuable. Further improvement in carrots will tend to increase the external rind and decrease the fibrous center. There are numerous varieties of carrots in cultivation; these are generally divided into two classes, distinguished as long or field carrots, and shorthorn, or garden carrots. The latter are preferred for culinary uses, and the larger or coarser kinds are preferred for live stock. One bushel of carrots and 1 bushel of oats, given in alternate meals, are said to be of equal value with 2 bushels of oats alone. They are also very beneficial to the health of animals, and are more nourishing than turnips. The soil best suited to carrots is a light or sandy loam. It is useless to attempt to grow good carrots unless the soil is deep and well loosened up, so that no resistance may be offered to the downward growth of the roots. The seeds should be sown thinly in shallow drills. They are furnished with hair-like appendages which cause them to adhere and renders them difficult of separation in sowing. This is overcome by first steeping them for a brief time in water and afterwards rubbing them apart in dry sand. The drills may be from 18 inches to 3 feet apart, according to the variety; thinning the plants from 6 inches to 12 inches apart will also depend upon the variety, the larger kinds requiring the most space. They require careful treatment in hoeing and keeping clear of weeds when young, but when they get well supplied with leaves they grow rapidly. The roots can be kept for months in a cool, dry place, especially if they are packed away in dry sand.

BEDDING PLANTS.

Where bedding, so called, is practiced, which means the employment for summer decoration of tender plants which are renewed annually, the ground should be cleaned up after the frosts have destroyed the plants; then give a heavy dressing of barnyard manure, and dig up the ground so as to leave it in the roughest possible state for the action of frosts. The rotation of crops is quite as necessary in the flower garden as it is in the farm. No flowering plant will exemplify this better than the common verbena, which, if planted in the same bed for three successive years, will become diseased and perfectly worthless as a flowering plant. Manures will help the soil to some extent, but nothing short of a change of crops for three or four years will restore its elements so as to fit it again for the growth of verbenas. The same is applicable to roses, although top-dressings of bonedust and stable manure will maintain a rose bed in good condition for five or six years.

Where it is not convenient to change the crops, or where the flower space is confined to a single bed or border, a good expedient is to remove 6 or more inches of the soil and replace it with fresh earth from the field or vegetable garden. Those persons whose flowers do not "grow as they used to do" will find the remedy in a renewal of the soil, or, if that is not available, then change the site of the bed to another part of the grounds, where flowering plants have not recently been grown.

THE MYRTLE.

The common myrtle (*Myrtus communis*) is a classic plant. It is one of the oldest cultivated plants for ornament. It is supposed to be a native of western Asia, although abundant in the South of Europe. The plant was highly prized by the ancients. Athenian magistrates wore wreaths of it as a badge of office, and victors in the Olympic games were decorated with its branches. They also used various parts of the plant in cookery and in the preparation of drinks; a beverage called myrtidanum is made from the berries. The fruits have a sweetish, aromatic taste, and are used both in the fresh and dried condition. A distillation from its flowers, which is called *Eau d'ange*, is used as a water in perfumery compositions. The plant abounds in essential oil and tannin; volatile oil of a greenish-yellow color is distilled from the leaves. The berries and bark, as well as the leaves, contain a very energetic tannin, and in Tuscany and Sardinia what is known as the

Italian process of tanning consists in using a portion of myrtle leaves in the tanning materials.

The berries, in addition, yield a fixed oil, and the plant is said to contain a bitter principle and resinous matters. Finally, the wood is very hard, beautifully mottled or veined, but from its size it is only fit for small turnery purposes.

It is a popular greenhouse plant, requiring but little attention, and is well suited for parlor decoration. It is easily propagated by cuttings of the young branches, and will endure several degrees of frost uninjured.

EVERGREENS.

By the term "evergreens" is commonly understood the family of coniferous trees, because in northern latitudes these are the only trees which retain their foliage throughout the year. The deciduous trees give us shade and shelter through the summer, but during the coldest portion of the year these trees are leafless and afford only partial protection from the cold winds of winter. This consideration should recommend the cultivation of evergreens around farm buildings, for not only is the comfort of man and beast concerned, but also practical economy, as it is well understood by intelligent farmers that the abstraction of animal heat by cold winds must be counterbalanced by an increased supply of food.

Fruit-growers are also aware that a certain amount of shelter and protection to orchards is in some localities a necessity, and evergreen trees are the best suited for this purpose.

The fact that many evergreen trees furnish our most valuable building material, that the native supply is diminishing, and in some kinds the market value advancing, are further reasons for their liberal planting.

KEEPING CUT FLOWERS.

The best arrangement for displaying cut flowers, as well as the most natural and economical, is that of using any low, shallow vessel, either of glass or china, of about the size and depth of a soup plate. If this is filled with clean, fresh green moss from the woods, made up in a slightly mounded form in the center, flowers and ornamental sprays of leaves can be inserted in a free, natural-appearing manner, instead of having that excessively formal appearance they usually have when closely packed in small cups or vases, or when made into bouquets. They also keep fresh for a longer period, owing to the much larger surface exposed immediately under them, the moist moss furnishing a source of vapor which tends to preserve the blossoms. The moss should be well sprinkled with water at each renewal of the flowers.

Very pleasing effects may be produced by procuring small-rooted plants, such as violets, etc., which may be picked up in the woods and meadows, and inserting them in the damp moss, where they will continue to grow and flower for some considerable time. An arrangement of this kind is easily kept fresh and fair by substituting a twig of fern or a flower as others fade and are removed. Trailing plants of suitable growth may be usefully employed in this class of decorations. The *Linaria Cymbalaria*, often called "Kenilworth ivy," the *Tradescantia discolor*, one of the many "Wandering Jews" of our domestic plant nomenclature, and the *Lysimachia Nummularia*, or "moneywort," are some of the plants well fitted for use in this way.

FLOWER GARDEN AND LAWN.

Very much of the beauty of flower beds and borders depends upon keeping them scrupulously clean and neat. The Dutch or scuffle hoe is the best of all tools for hoeing and stirring the ground around the plants. Such plants as dahlias, gladioluses, and hollyhocks require to be staked, but the stakes should be as short as possible and not conspicuous; and tie rather loosely, especially dahlias, so as to allow the stems to expand without being injured. The flowers will come more perfect if the small and weak shoots are removed. The faded flower stems should be removed from roses and scarlet geraniums; it improves their appearance and strengthens the plants. Roses are greatly benefited by an occasional soaking with guano water, especially the ever-blooming varieties. It is a good practice to insert small pieces of brushwood rather thickly among the plants of petunias, verbenas, and Drummond phlox, for the support of their spreading stems; this will prevent them from being beaten to the ground by dashing rains, and give the mass of flowers a more elevated and improved appearance.

It is sometimes asserted that lawns should not be cut close during dry weather, in order that the grass may better shade the roots. We do not think that there is much point in this. Of course, but little of mowing is required when the grass suffers for want of rain, but it is an erroneous idea that moisture is preserved around the roots of plants by the shade of their luxuriant growth; this is a fallacy, as are all methods which propose to mulch with a growing crop. This is well exemplified where efforts are made to secure fine lawns by sowing oats with the grass seeds for the purpose of shading the grass. The oat-plant is the master of the situation and exerts its right by absorbing all the nutriment, and so the grasses perish.

REPORT OF THE STATISTICIAN.

SIR: I have the honor to submit my twenty-fourth annual report as Statistician of the U. S. Department of Agriculture. Entering the Department on the 17th of July, 1862, two weeks after its organization, I was engaged in special statistical investigation before the organization of the Division of Statistics and in editing and writing the annual report of the Department until May 6, 1866, when I was appointed Statistician, *vice* Lewis Bollman, who for over two years had officiated as the original incumbent of that office. It was a small beginning with a single clerical assistant. The monthly report of statistics was published about the 20th of each month, and was for many years the only serial issue of the Department. The annual was then the medium of much statistical and agricultural data, in addition to the annual reports of division officers, and the annual of the Commissioner. The larger part of the annual was, therefore, a miscellaneous agricultural document, planned and written by the editor or, under his direction, by experts or authorities not connected with the Department. The Statistician was then *ex-officio* editor of this annual volume, ordered then, as now, by Congress, and an edition of 120,000 copies printed of the report of 1862. Of that for 1865 there were 185,000 copies ordered, and 223,000 of that of 1867. The number was increased from time to time until 400,000 copies of the report of 1884 was ordered printed, the number annually printed of later issues.

The monthly report was issued until the close of 1876, edited and written mainly by the Statistician, though for five or six years occasional contributions were received from chiefs of other divisions, in accordance with orders of Commissioner Watts of September 15, as follows:

> The Monthly Report is a channel through which the Department communicates agricultural information to the country; to its value and influence the Chemist, Botanist, and Entomologist will hereafter be expected to contribute every month the result of investigations in their several departments.

In the more or less horizontal reductions of appropriations in 1876 the small and inadequate printing fund of the Department was scaled down, so that it became so nearly exhausted that publication of reports was suspended in January, 1877. When the funds of the following year became available it was deemed advisable to commence a series of miscellaneous bulletins, numbered consecutively as prepared by the several divisions of the Department, instead of a monthly report of all work. This continued until the close of 1882, when the "Report of the Statistician, new series," was commenced, followed soon after by similar serials of other divisions.

July 16, 1878, at the close of sixteen years of continuous service in the Department, I resigned the position of Statistician, and was subsequently induced to undertake a temporary agricultural investigation for the Bureau of Statistics of the Treasury Department, and later to accept from Gen. Walker the charge of Statistics of Agriculture of the Tenth Census. In November of 1881, at the solicitation of Commissioner Loring, I assumed again the duties of Statistician of the U. S. Department of Agriculture.

The work of the division, at first very limited in scope and area, now includes, besides organized original investigation in this country and Europe, the collection and coördination of the official and commercial statistics of agriculture of the world. Instead of one clerk, the office force, including compilers, translators, computers, and copyists, now numbers 60, who as a whole take pride in the reputation of constituting a clerical force as busy and effective as any other in Government employ.

The work of the year past, which includes the voluntary service of some 15,000 regular reporters, and of about 125,000 representative farmers, in returns of crop production and area of cultivation, has been in some respects more comprehensive than usual. It has covered nearly every republic, empire, monarchy, and dependency in the world. It is becoming more varied, extensive, and exacting than ever; as the country grows, its industries multiply, and demands for statistical data increase for legislative and business uses. These demands come from legislators, foreign ambassadors, administrative officials, industrial and commercial organizations; and the great mass of farmers recognize the utility and necessity of prompt, full, and accurate information relative to their movements and methods, production and distribution, prices and markets. They oppose the unintelligent and retrogressive view that ignorance is bliss and secrecy their salvation. A synopsis of the crop report is published, an edition of 125,000, for the exclusive benefit of farmers. The regular monthly issue, an edition of 20,000, is required for the regular corps of reporters, for the press, and for official lists. The Statistician's report is a regular monthly issue of miscellaneous statistics, including results of foreign investigation and computation, and the monthly changes in freight rates for transportation of agricultural products. A third series, the miscellaneous, not a monthly publication, contains results of special and occasional investigation, outside of the usual and regular work that appears in the serial issues. Cartographical illustrations of statistics are issued in various forms, as albums, maps, charts, and diagrams, for schools, libraries, farmers' institutes, and other institutions.

The crop-reporting system of this division is the most systematic and extensive known. It would be folly to claim for it perfection; it may be bettered, but it is infinitely easier to impair its efficiency. It is sometimes insisted in current journalism that it should be improved, usually with a proviso of larger appropriations for its service. The truth is scarcely realized, however, that greater skill and judgment in handling returns, or greater expense in obtaining them, can accomplish little in bettering results, while the great drawback to statistical accuracy remains at the very fountain head of such information. The stupendous folly obtains, to a certain extent, of assuming that what is originally reported by individuals is absolutely correct, and has only to be mathematically tabulated and averaged to be accepted as the gospel of statistics. High official authority could be cited of the possibility of getting a practically perfect census of every known production by a careful consolidation of a sufficient number of local guesses. There is so much of this element of estimate in every decennial census enumeration as to seriously invalidate its correctness. Not a fourth of any of our corn crops is ever measured, and the area on which it is grown, as reported to enumerators, is measurably a matter of estimate, to a very limited extent a matter of actual measurement. The amount of production is estimated from six to ten months after it is harvested, and long after it is distributed or consumed. A census may cost millions, but accuracy can not be assured and is not obtained in the absence of enumeration, measurement, and record by the producers themselves. A stream can not rise higher than its source; pure mathematics and immaculate judgment combined can not cure the inaccuracy of erroneous original data. This is to-day the supreme difficulty in obtaining correct statistical results, whether in a census that requires years of time and millions of money, or in any other official or unofficial crop investigations. Yet the superficial thinker or writer on this subject usually ignores utterly this fatal limitation of accuracy, and sees only lack of acumen or skill or industry in consolidation and deduction.

The distinction should be kept in mind that a census is obtained by the addition of all individual items which united produce the aggregate, requiring, in a country like this, a prodigious and expensive labor; while a crop report on the percentage plan is a comparison, by a board of observers of wide observation and large experience, of increase or decrease of crop areas or products within defined boundaries. A thorough census is of course preferable, but it is impracticable for immediate or quick results. A deficient census may fail to report 10 per cent, even 20 per cent, of production, while careful estimates are often within 2 per cent of the real aggregate, sometimes even closer, and scarcely ever so defective as a poor census. The United States Census of 1870 failed to report 17 per cent of the cotton crop, one of the most important in its schedules. Probably no census ever reported a crop in its absolute entirety. There are always failures to return, which may be so few as not to impair appreciably the value of the work, or they may be so many as to render it misleading and practically worthless.

Improvement in all statistical methods and administration is desirable, but this is by no means the main defect to be remedied. Some advance toward greater accuracy can be made in these directions, but the desired degree of perfection can never be obtained until the original returns are made with greater intelligence and appreciation of the importance and necessity of accuracy. This is a vital point, which superficial critics of statistical results do not see, yet it accounts for nearly all the imperfection of current official statistics, whether comparative investigations or comprehensive enumerations.

The following extract of a letter from Hon. W. D. Hoard, late governor of Wisconsin, illustrates the disabilities of popular enumeration in relation to the butter product, as follows:

> However, I wish to say that the census itself is a very unreliable means of getting at the butter production per cow or in the aggregate, for the reason that not one farmer in a hundred can tell you how many pounds of butter he has made in any given year. Had the census marshals been instructed to inquire of each farmer as to whether his cows were devoted to cheese or butter, and, if butter, then figured their product by a certain well-ascertained average, they would have reached much nearer the truth than they did. I was a census taker in 1870, and pursued this plan. In comparing my work with that of those enumerators who depended upon the untrustworthy and haphazard guesses of the farmers, I found I exceeded them greatly in the number of the pounds of butter reported according to the number of cows.

Statistical investigation is young, especially in agriculture. The masses formerly resented statistical inquiry as an impertinence, and regarded with suspicion all governmental investigation. It was feared that taxation was its motive and oppression its object. This was under monarchical rule. Under a republic greater confidence is expected. Nevertheless, there exists in this country a considerable remainder of such suspicion, a prejudice against governmental inquiry into personal affairs, and a serious lack of appreciation of the great advantages of accurate information concerning production and distribution. It has been more apparent in the last two years than in any recent period, and has seriously impaired the work of statistical investigation in this and other Departments of the Government. It is, therefore, not in methods or administration that improvement is needed, so much as in education to cure these disabilities of original returns, that is vital to higher and better results in statistics. Newspapers, which in some instances have encouraged popular prejudice and misconception of the utilities of statistics, should enter this field of education with new zeal and persistence.

The clerical force of the division is ample for current work, except in the section of investigation and compilation. The great volume of statistical records from all parts of the world is constantly accumulating, in all languages, weights and measures, and denominations of money; and in this country statistical data, agricultural and commercial, demand analysis and involve additional research for the several lines of our official publication. The past year has been one of severe clerical labor, especially in connection with statistical effort never before undertaken upon so comprehensive a scale—a work involving all available official statistics of agriculture of the world, including production for a ten-years period, exports and imports, and net supply for consumption of principal products. This labor has been in progress during most of the past year, and for three months past has employed the entire office force not required for imperative routine work. It has been necessary, at certain periods, to extend the hours of service and even to require night work, which has all been cheerfully rendered. I desire to commend, with hearty emphasis, the fidelity, industry, and effectiveness of the clerks of the division, during the past year, as a body, almost without exception. It is due to Mr. Bernard W. Snow, my assistant, to commend especially the successful conduct of routine business assigned to him, and the intelligence and untiring industry which he has brought to my aid in all lines of my especial duties as Statistician.

The *morale* of the division is excellent, and its clerical efficiency high and improving. I take great pleasure in testifying to the zeal, conscientiousness, and high character of the clerical service of the Division of Statistics of the U. S. Department of Agriculture.

Respectfully,

J. R. DODGE,
Statistician.

Hon. J. M. RUSK,
Secretary.

CROPS OF THE YEAR.

METEOROLOGY.

The meteorological records of the season, as compiled from original data gathered by the Weather Bureau, show that during the crop season of 1892, covering the period of crop growth, from April to September, inclusive, there was an excess of rainfall in the principal agricultural districts, accompanied by low temperatures during the early season up to July, and a temperature above the normal during the closing months. The rainfall of the season, although heavy, was not well distributed, the excess of the year having occurred in the early months accompanied by low temperatures, leaving the hot months of August and September with a marked deficiency. A striking example of this general tendency is furnished by the records of the Upper Mississippi Valley district, where there was a seasonal excess of 6.3 inches of rainfall. There was heavy excess in April and May accompanied by low temperature, a small excess in June and July, with but slight variations from normal temperature, and a deficiency in August and September with a temperature higher than the normal.

The record of crop history of the year, which is presented elsewhere in connection with the detailed meteorological data here shown, will serve to strikingly illustrate the intimate relation between meteorology and crop production. As already pointed out, the early season was unusually wet and cold—conditions which tended to seriously hinder the preparation of the soil, planting, and germination of seed. This is reflected in decreased areas of some crops and substitution of others, as well as in the comparatively low returns of condition which were made during the first few months of the growing season. The change in conditions during the latter part of July and in August and September, giving warm dry weather, is likewise manifest in the crop of record.

There was improvement in the returns of condition, a more hopeful feeling becoming apparent as the season progressed and harvesting and threshing results exceeded expectations as a result of unusually favorable weather conditions at that important season.

In order that an extended comparison may be possible the normal temperature in the principal districts of the country for each month from April to September, together with the actual temperature of the month, is presented. The data are from the official publications of the Weather Bureau, the normal being the computed average of a long series of years.

Temperature.

Districts.	April.		May.		June.		July.		August.		September.	
	Normal.	1892.	Normal.	1892.	Normal.	1892.	Normal.	1892.	Normal.	1892.	Normal.	1892.
	°	°	°	°	°	°	°	°	°	°	°	°
New England	43.7	45.2	53.9	53.0	62.8	64.7	68.7	69.2	67.1	68.5	61.0	61.2
Middle Atlantic States	51.6	51.2	62.4	62.4	70.9	74.1	76.3	75.1	73.4	75.7	67.8	66.8
South Atlantic States	61.8	60.9	70.5	70.0	76.9	76.7	80.7	78.3	78.7	79.8	74.3	73.3
Florida Peninsula	...	...	...	...	...	...	...	...	...	...	...	...
Eastern Gulf States	66.5	65.7	73.0	72.2	78.9	78.4	81.5	78.8	79.5	79.2	75.9	74.3
Western Gulf States	66.4	66.5	72.8	72.0	79.4	78.8	82.9	81.5	81.0	80.2	75.5	74.7
Ohio Valley and Tennessee	55.9	55.1	65.7	64.6	73.4	75.9	77.5	76.1	74.5	75.4	68.6	68.7
Lower Lake Region	44.2	44.3	56.3	54.7	65.9	68.9	71.9	71.1	68.4	70.5	62.4	63.4
Upper Lake Region	40.1	39.4	51.4	49.7	61.2	61.5	68.2	69.3	65.2	67.4	58.6	60.7
Extreme Northwest	40.4	37.8	53.5	46.8	63.8	60.4	68.4	68.5	65.6	67.2	55.4	59.6
Upper Mississippi Valley	51.3	48.6	61.5	57.3	70.4	70.9	75.8	74.2	72.1	73.5	64.5	66.1
Missouri Valley	50.5	47.4	61.0	54.0	70.1	68.9	75.7	74.1	72.0	73.2	63.6	66.7
Northern Slope	45.5	40.8	53.7	48.2	63.3	60.7	69.6	68.5	67.8	68.0	58.3	61.9
Middle Slope	51.7	49.6	60.8	55.0	70.5	70.0	76.1	75.2	72.6	74.1	65.2	68.6
Southern Slope	57.2	58.2	64.5	66.2	71.6	73.4	75.8	75.8	73.1	72.4	66.8	68.6
Southern Plateau	61.6	60.0	69.8	67.5	77.7	76.6	82.7	82.3	80.7	81.0	73.9	76.7
Middle Plateau	49.0	45.8	57.2	54.2	65.7	64.1	72.4	72.5	71.4	71.8	61.8	66.0
Northern Plateau	52.2	46.4	59.8	57.0	64.7	64.6	72.1	68.9	71.4	71.0	61.6	63.5
North Pacific Coast Region	49.3	47.0	54.3	54.1	57.9	57.3	61.1	59.6	60.9	61.1	57.4	58.1
Middle Pacific Coast Region	58.7	54.2	63.6	62.3	67.7	65.5	71.3	69.7	71.6	70.9	68.3	67.0
South Pacific Coast Region	59.6	58.2	62.1	61.8	66.5	62.9	69.8	66.4	71.3	69.7	68.8	66.6

The record of normal and actual rainfall for the same districts and for the same period is also presented in similar form.

Precipitation.

Districts.	April.		May.		June.		July.		August.		September.	
	Normal.	1892.	Normal.	1892.	Normal.	1892.	Normal.	1892.	Normal.	1892.	Normal.	1892.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
New England	3.57	1.87	3.60	4.40	3.21	2.71	4.71	2.51	4.11	4.91	3.27	2.47
Middle Atlantic States	3.41	3.81	3.48	4.58	3.72	3.82	4.56	4.76	4.79	3.49	3.99	1.89
South Atlantic States	3.83	1.53	3.87	2.77	5.19	5.89	6.30	6.60	6.61	3.21	5.76	6.86
Florida Peninsula	......	......	......	......	......	......	......	......	......	......	......	......
Eastern Gulf States	5.04	4.44	4.45	1.45	5.42	4.22	5.44	9.34	5.58	8.18	4.61	3.31
Western Gulf States	4.40	4.60	4.66	4.66	4.00	5.00	3.24	1.74	3.57	5.07	4.30	1.60
Ohio Valley and Tennessee	4.02	6.32	3.96	4.86	4.39	4.59	4.09	4.69	3.85	3.25	3.10	2.80
Lower Lake Region	2.34	1.64	3.27	6.67	3.76	7.06	3.34	3.34	3.06	3.96	3.06	2.66
Upper Lake Region	2.40	2.60	3.17	4.87	3.95	5.65	3.24	2.24	3.14	2.74	3.50	2.20
Extreme Northwest	1.71	2.81	2.29	2.39	3.57	2.67	2.82	3.62	2.19	2.79	1.60	0.60
Upper Mississippi Valley	2.80	5.00	4.17	7.37	4.97	6.17	3.75	5.45	3.14	2.44	3.63	2.33
Missouri Valley	3.07	5.47	4.60	7.30	4.69	3.29	4.23	2.83	3.24	3.44	2.74	0.94
Northern Slope	1.46	2.26	2.41	2.81	2.57	3.17	1.96	1.86	1.74	1.44	1.12	0.32
Middle Slope	2.34	1.24	3.56	4.96	2.77	1.97	2.72	1.72	2.87	2.77	1.46	0.56
Southern Slope	2.58	0.98	2.62	3.12	2.30	0.90	2.54	2.14	2.90	2.50	2.58	1.08
Southern Plateau	0.30	0.20	0.26	0.26	0.33	0.23	1.75	0.85	1.71	0.61	0.91	0.11
Middle Plateau	1.65	1.35	1.02	1.42	0.60	0.70	0.43	0.43	0.84	0.14	0.68	0.08
Northern Plateau	1.38	2.18	1.62	1.82	1.68	0.88	0.60	0.80	0.41	0.21	0.83	0.53
North Pacific Coast Region	3.67	6.67	2.85	3.45	2.52	1.52	1.22	1.42	1.19	1.19	3.51	4.61
Middle Pacific Coast Region	2.44	1.84	0.92	2.42	0.39	0.09	T.	T.	T.	T.	0.36	0.16
South Pacific Coast Region	1.32	0.32	0.40	1.60	0.10	0.10	0.00	0.00	0.03	0.03	0.10	T.

From the data of these two statements it is possible to compile a showing of the aggregate rainfall during the period under consideration. This has been done for the principal agricultural districts, presenting both the normal and the actual amount, for the six months in 1891 and 1892. Conditions in the two seasons are quite generally reversed. In 1891 the crop year was dry, in some districts the deficiency being very heavy. In 1892 the season was generally characterized by an excess of moisture. The only important districts in which the supply was deficient were the Atlantic States, where there have been two dry seasons in succession. It appears that during the growing season the heaviest normal rainfall in the leading agricultural districts is in the Eastern Gulf States, where it is almost 31 inches, and the smallest in the North Pacific coast region, nearly 19 inches, although less than 15 appears in the extreme northwest.

The record of aggregate rainfall for the period is as follows·

Aggregate rainfall.

Districts.	1891.			1892.		
	Normal.	For the year.	Departure from the normal.	Normal.	For the year.	Departure from the normal.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
New England	23.03	16.63	− 6.40	22.47	18.87	−3.60
Middle Atlantic States	24.32	22.42	− 1.90	23.95	22.35	−1.60
South Atlantic States	31.45	27.65	− 3.80	31.56	26.86	−4.70
Eastern Gulf States	30.63	17.89	−12.74	30.54	30.94	+0.40
Western Gulf States	23.37	18.08	− 5.29	24.17	22.67	−1.50
Ohio Valley and Tennessee	23.20	18.29	− 4.91	23.41	26.51	+3.10
Lower Lake Region	18.75	12.84	− 5.91	18.83	25.33	+6.50
Upper Lake Region	19.44	14.33	− 5.11	19.40	20.30	+0.90
Extreme Northwest	13.97	16.62	+ 2.65	14.18	14.88	+0.70
Upper Mississippi Valley	22.50	16.93	− 5.57	22.46	28.76	+6.30
Missouri Valley	21.83	18.04	− 3.79	22.57	23.27	+0.70
North Pacific Coast Region	14.61	18.82	+ 4.21	14.96	18.86	+3.90

A knowledge of the seasonal excess or deficiency in rainfall does not necessarily give a clew to the effect of the rain of the season on plant growth. Quite as important as a sufficient supply is a proper distribution. A heavy excess in one month and a deficiency in the others might give a seasonal excess and yet result in ruin of crops by drought. The departures from the normal for both temperature and rainfall, for each district and each month, as compiled from the preceding tables, are presented in the following statement:

Departures of temperature and rainfall from the normal.

Districts.	April.		May.		June.		July.		August.		September.	
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.
	°	In.	°	In.	°	In.	°	In.	°	In.	°	In.
New England	+1.5	—1.7	—0.9	+0.8	+1.9	—0.5	+0.5	—2.2	+1.4	+.08	+0.2	—.08
Middle Atlantic States	—0.4	+0.4	0.0	+1.1	+3.2	+0.1	—1.2	+0.2	+2.3	—1.3	—1.0	—2.1
South Atlantic States	—0.9	—2.3	—0.5	—1.1	—0.2	+0.7	—2.4	+0.3	+1.1	—3.4	—1.0	+1.1
Florida Peninsula	......	......	......	......	......	......	......	......	......	......	......	......
Eastern Gulf States	—0.8	—0.6	—0.8	—3.0	—0.5	—1.2	—2.7	+3.9	—0.3	+2.6	—1.6	—1.3
Western Gulf States	+0.1	+0.2	—0.8	0.0	—0.6	+1.0	—1.4	—1.5	—0.8	+1.5	—0.8	—2.7
Ohio Valley and Tennessee	—0.8	+2.3	—1.1	+0.9	+2.5	+0.2	—1.4	+0.6	+0.9	—0.6	+0.1	—0.3
Lower Lake Region	+0.1	—0.7	—1.6	+3.4	+3.0	+3.3	—0.8	0.0	+2.1	+0.9	+1.0	—0.4
Upper Lake Region	—0.7	+0.2	—1.7	+1.7	+0.3	+1.7	+1.1	—1.0	+2.2	—0.4	+2.1	—1.3
Extreme Northwest	—2.6	+1.1	—6.7	+0.1	—3.4	—0.9	+0.1	+0.8	+1.6	+0.6	+4.2	—1.0
Upper Mississippi Valley	—2.7	+2.2	—4.2	+3.2	+0.5	+1.2	—1.6	+1.7	+1.4	—0.7	+1.6	—1.3
Missouri Valley	—3.1	+2.4	—7.0	+2.7	—1.2	—1.4	—1.6	—1.4	+1.2	+0.2	+3.1	—1.8
Northern Slope	—4.7	+0.8	—5.5	+0.4	—2.6	+0.6	—1.1	—0.1	+0.2	—0.3	+3.6	—0.8
Middle Slope	—2.1	—1.1	—5.8	+1.4	—0.5	—0.8	—0.9	—1.0	+1.5	—0.1	+3.4	—0.9
Southern Slope	+1.0	—1.6	+1.7	+0.5	+1.8	—1.4	0.0	—0.4	—0.7	—0.4	+1.8	—1.5
Southern Plateau	—1.6	—0.1	—2.3	0.0	—1.1	—0.1	—0.4	—0.9	+0.3	—1.1	+2.8	—0.8
Middle Plateau	—3.2	—0.3	—3.0	+0.4	—1.6	+0.1	+0.1	0.0	+0.4	—0.7	+4.2	—0.6
Northern Plateau	—5.8	+0.8	—2.8	+0,2	—0.1	—0.8	—3.2	+0.2	—0.4	—0.2	+1.9	—0.3
North Pacific Coast Region	—2.3	+3.0	—0.2	+0.6	—0.6	—1.0	—1.5	+0.2	+0.2	0.0	+0.7	+1.1
Middle Pacific Coast Region	—4.5	—0.6	—1.3	+1.5	—2.2	—0.3	—1.6	0.0	—0.7	0.0	—1.3	—0.2
South Pacific Coast Region	—1.4	—1.0	—0.3	+1.2	—3.6	0.0	—3.4	0.0	—1.6	0.0	—2.2	—0.1

CROP HISTORY OF THE YEAR.

The seeding of winter grain, the initiation of the work of crop production, precedes the year of principal growth and of harvest, and is dependent on conditions prevailing throughout the autumn months. These crops of the present year were therefore prepared for and germinated during the last four months of 1891. Their wide geographical range and consequent climatic differences, and the physical variations of the soils occupied, not to mention the pressure of other agricultural labor at this period of the year, conspire to extend over several months the time of seeding. Another cause of so wide a range of the autumn planting is the doubt in the mind of the grower whether early seeding and growth, with the liability to injury by the weevil, may be preferable to later growth, even with a feeble root development, and to exemption from insect ravages. The seeding of the crop of 1892 was later than usual, in the West especially, and in the Southwest later than on the Atlantic coast. The unfavorable conditions were drought, difficult plowing, lumpy soil, slow germination, and an imperfect stand. A late and slow growth followed, and the plants were generally small when winter set in, and apparently (perhaps not really) of weak vitality. The December average of condition was 85.3.

Winter protection by snow was quite general in New York from January till late in March. In Pennsylvania the covering was less continuous or general, but was enjoyed when most needed. In Michigan there was a fair degree of protection, especially in the severest weather. In Ohio, Indiana, and Illinois the snow covering was not continuous or heavy; in some places very light and partial, in others better than for years. In Missouri and Kansas there was still less snow, but there was some protection at the time of the March freezes. The winter was not very severe, and was in many sections mild. Winter-killing was exceptional, or limited to flat and wet areas. It was claimed that the lumpy condition of the surface modified the injury by freezing. There is always some appearance of damage in March, but the first of April found the larger portion of the area in about the same condition as in December. Still the bare spots and patches of brown tended to lower the average, which was reported at 81.2. It was evident that the roots were generally sound and healthy, as improvement was promptly indicated during the favorable weather of April, so that the May report recorded 84 as the average, which was advanced to 88.3 on the 1st of June and to 89.6 in July. This indicated a crop somewhat above the average, which has been 85 for a series of ten years. Though the September report of appearance at harvest was a little lower, 87.6, the result of thrashing showed a rate of yield warranted by the higher return of July.

Spring wheat gained in breadth in the Northwestern States, though there was a decline in North Dakota as a result of a continuously cold and wet spring, which rendered the seeding of the breadth intended practically impossible. Excessive rains in Wisconsin caused a reduction of condition during the month of June, and hot and dry weather in Nebraska were injurious, and in the latter part of June a drought in Washington and Oregon reduced condition. There was a slight decline in the average condition of spring wheat during the month of July. In Wisconsin prevailing weather conditions caused more or less rust, and in Minnesota heavy growths lodged, and rust appeared in many fields. The condition of winter wheat at the time of harvest was reported at 81.2, indicating a scarcely medium yield.

Condition of winter wheat.

	April.	May.	June.	July.	September.
1891	96.9	97.9	96.6	96.2	96.7
1892	81.2	84.0	88.3	89.6	87.6

A heavy reduction in the breadth of maize occurred in the central corn belt, caused by the soaked condition of the soil at the planting season, which not only made the crop late, but seriously reduced the area. The same cause affected condition as reported on the 1st of July, 81.1, the lowest July percentage ever reported in an official record of twenty-five years. This was a bad beginning which by no means presaged a good ending, yet during the month some advance occurred, placing condition at 83.5, while in August of 1890 the average was 73.3, against 93.1 the month before. No serious decline occurred in the latter part of the season, as is frequently the case, especially in seasons of local drought of some severity. This is strikingly shown by the September records, which make the percentage 60 in 1881, 70.1 in 1890, 72.3 in 1887, and 76.6 in 1886.

In July there was some improvement in the States north of the Ohio River, and a greater advance in the region west of the Mississippi, except in Kansas and Nebraska. Condition was high on the Atlantic coast and along the Gulf coast. At the close of August improvement was noted in central Ohio, with some decline in the southern counties. A decided advance occurred in Indiana, and injuries from drought were quite general in Illinois and Kansas, and in less degree in Iowa and Missouri. Up to this time no damage from frost was reported. September weather was favorable for maturing the crop, which was late and had been in danger of probable frost. The crop ripened well in the Eastern States; in some sections it did not ear well, though heavy in fodder. In New Jersey maize was somewhat reduced in condition by prolonged dry weather, but when planted in moist situations the product was well grown and matured. In Virginia and North Carolina the yield was materially shortened by drought. A fair crop of good quality was harvested in Georgia. Heavy rains in July and August affected maize unfavorably in Mississippi and Louisiana. A heavy yield of good quality is reported in Texas. Late corn in Arkansas suffered considerably from drought. Corn was not much injured by drought in Tennessee. As a whole the crop of the country is somewhat under average in quantity, but generally well matured, notwithstanding its average lateness, only the late planted lacking in development and maturity.

The reported condition of the crops of 1891 and 1892 is thus compared:

	July.	August.	September.	October.
1891	92.8	90.8	91.1	92.5
1892	81.1	82.5	79.6	79.8

A further comparison of the reported condition in principal States will furnish a suggestion of the history of maize production in the two years:

States.	July.		August.		September.		October.	
	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.
New York	92	90	91	90	92	89	95	87
Virginia	94	96	95	90	95	78	97	76
Georgia	95	95	95	97	97	98	99	95
Texas	95	95	93	94	92	93	91	93
Tennessee	96	92	96	92	98	92	97	89
Kentucky	95	93	95	90	97	83	98	81
Ohio	93	80	93	81	95	79	97	80
Indiana	95	72	88	74	90	75	94	77
Illinois	96	70	88	73	88	70	92	71
Iowa	94	75	90	79	90	78	95	79
Missouri	88	75	87	83	88	82	86	82
Kansas	82	81	88	81	82	70	83	70
Nebraska	90	84	89	80	89	76	93	78

The area in oats would have been larger but for the fact that the season for sowing was distinctively unfavorable in many States, especially those of the Ohio Valley, where a contemplated increase was prevented by excessive moisture. In the Eastern States generally, and in the

Southern States without exception, there was considerable enlargement of the breadth. The same marked tendency to increased importance of the crop is noted in every State lying between the Missouri and the Pacific Ocean. The rate of yield, as foretold by the season's records of condition, was materially less than in the previous year—less in the central prairie regions than in the Eastern States. The unfavorable condition was caused by unpropitious weather for seeding and too much rain in the period of growth. The quality is generally poor. In portions of the West oats weighing not more than 24 pounds to the bushel are reported.

A comparison of condition of this year's oats crop with that of 1891 is as follows:

	June.	July.	August.	September.*
1891	85.1	87.6	89.5	90.7
1892	88.5	87.2	86.2	78.9

* Or time of harvesting.

The same general conditions which affected wheat operated to deteriorate the rye crop. Condition at harvesting was 88.5, which was higher than in 1885, 1887, and 1890. It was especially low in Ohio, Illinois, and Missouri. It was relatively higher in States where it was planted as a spring crop.

There has been a heavy increase in barley in the past two years. The crop of 1891 was the largest ever harvested. Another increase was made last year generally, though there was a slight decrease in New York. The production of barley has increased in ten years nearly 50 per cent, and the volume of importation has decreased materially.

Buckwheat remains the smallest cereal crop, with slight tendency to enlargement. The usual product is about 12,000,000 bushels, of which New York and Pennsylvania produced six-tenths, and Michigan, Wisconsin, and Minnesota about half of the remainder. Very little is grown in the South. The present crop is scarcely a medium one, its condition, which does not usually run so low as wheat, being 89, exceeded by all but three crops in the last twenty years.

One of the poorest crops of potatoes ever reported was garnered in 1892. It was a little better than those of 1881 and 1887. The October report of condition made an average percentage of 67.7, or two-thirds of a normal crop. Planting was interfered with in the central west by heavy rains, and there was some complaint of rotting of the seed on account of the moisture of the seed bed. The potato beetle was present as usual, but was not a large factor in deterioration compared with the heavy rainfall. A further decline was reported in August, which was heaviest in New England and the Middle States. Blight and rot began to threaten the crop. Alternations of wet and dry weather affected it in the East, and in the Ohio Valley and Northwest it was injured by excess of moisture, while in Iowa damage was done by heavy rains in the early season, followed by continued hot weather, which packed the soil and prevented cultivation and growth. The injury in Kansas and Nebraska was mainly the result of drought in the later season. The crop was in fairly good condition in the mountain States, and only moderately so on the Pacific coast. Its quality, as a whole, is quite inferior.

The downward progress of this year's potato crop is well illustrated by comparison of last year's records of condition.

	July.	August.	September.	October.
1891	95.3	96.5	94.8	91.3
1892	90.0	86.8	74.8	67.6

The season was quite favorable for grasses and hay production. Dry weather threatened to reduce the yield in New England, especially in Maine and New Hampshire, but opportune rains late in June and in July greatly improved the prospect. In the Middle States there was some deficiency, though New York had a nearly full yield, and in Maryland and Virginia some deterioration was reported. From North Carolina to Louisiana, inclusive, conditions were highly favorable, and moderately so in Texas, Arkansas, and Tennessee. Condition was high in the Ohio Valley and Northwest, but some loss was caused by lodging and the difficulty of curing the product and garnering on account of the frequency of rains. A large yield was secured in Minnesota and Iowa, but not in the best condition. The harvest did not quite come up to the expectation in Missouri and Kansas. High condition was nearly universal in the mountain region and on the Pacific coast.

The cotton acreage was heavily reduced, from the discouraging effect of low prices, in accordance with the recommendation of this Department and all intelligent friends of cotton-growing. In the Mississippi region a compulsory reduction resulted from overflows of that river and its tributaries. Then the temperature of the planting season was low on the Atlantic coast; rainfall was below normal in this district and in excess in the Mississippi Valley, both conditions coöperating with low temperature to retard growth. In July there was generally too much moisture for cotton, though in South Carolina and Georgia alternations of excessive rainfall and blistering sunshine were conditions equally unfavorable. Some depredations of insects were reported. The boll worm infested the Gulf region, was occasionally seen on the southern Atlantic coast, but was not known in the northern districts. The caterpillar was quite a pest in the Southwest, and was indicated in more eastern localities. Some injury was caused by grasshoppers and hemipterous insects popularly known as sharpshooters. During September there was much complaint of rotting of bolls, most frequent in the Carolinas and Alabama. The weather was more favorable west of the Mississippi, and especially in Texas, where conditions were very favorable for production. The general average of condition in October was five points lower than in 1891, and the lowest of any season since 1884. The crop will be the smallest for several years: first, on account of diminution of area, and in a less degree from low condition.

Tobacco promised fairly well in July, but declined in condition later, and in October the general percentage was 83.5, against 93 at the same date in 1891. A good crop of Connecticut seed leaf was made; the product of New York and Wisconsin was large, while that of Pennsylvania was somewhat reduced. In the districts producing export and domestic manufacturing tobacco the crop was small compared with the return of the previous year. The November return of average yield of tobacco of all kinds was 682 pounds, against 748 last year.

It has been a poor year for the orchard fruits of the temperate zone, except that apples have been abundant in some portions of New

England. New York and Michigan, sources of market supply east and west, have had very meager returns from apples and peaches, the latter especially. Semitropical fruits of our southern coasts and California have been abundant and remunerative.

THE MAIN CEREAL CROPS.

CORN.

The corn crop of 1892 has been exceeded in rate of yield in five of the past ten years, and is considerably below the average of that period. The estimates of breadth, yield, and value are as follows:

Corn, 1892.

States and Territories.	Acres.	Bushels.	Value.
Maine	13, 287	472, 000	$316, 032
New Hampshire	25, 327	957, 000	622, 285
Vermont	43, 229	1, 643, 000	1, 051, 329
Massachusetts	40, 059	1, 550, 000	961, 175
Rhode Island	9, 132	305, 000	192, 156
Connecticut	43, 997	1, 518, 000	941, 096
New York	527, 689	17, 414, 000	10, 448, 242
New Jersey	288, 732	9, 124, 000	5, 291, 880
Pennsylvania	1, 299, 406	39, 632, 000	22, 590, 173
Delaware	201, 893	3, 775, 000	1, 661, 176
Maryland	629, 361	12, 965, 000	5, 834, 177
Virginia	1, 703, 706	26, 067, 000	13, 815, 352
North Carolina	2, 485, 010	25, 347, 000	13, 687, 435
South Carolina	1, 591, 677	16, 713, 000	9, 526, 187
Georgia	2, 945, 708	32, 992, 000	18, 475, 481
Florida	491, 379	4, 422, 000	2, 653, 447
Alabama	2, 513, 621	30, 666, 000	15, 946, 412
Mississippi	1, 990, 684	27, 272, 000	13, 908, 909
Louisiana	1, 071, 568	15, 859, 000	7, 929, 603
Texas	3, 441, 211	73, 642, 000	33, 138, 862
Arkansas	1, 962, 524	34, 344, 000	16, 141, 760
Tennessee	3, 018, 431	61, 274, 000	26, 347, 884
West Virginia	636, 534	14, 322, 000	8, 020, 328
Kentucky	2, 953, 020	68, 805, 000	27, 522, 146
Ohio	2, 852, 157	83, 853, 000	35, 218, 435
Michigan	928, 719	23, 218, 000	10, 680, 269
Indiana	3, 526, 761	103, 334, 000	41, 333, 639
Illinois	6, 310, 202	165, 327, 000	61, 171, 098
Wisconsin	1, 001, 738	27, 347, 000	10, 392, 030
Minnesota	896, 012	24, 192, 000	8, 951, 160
Iowa	7, 074, 930	200, 221, 000	64, 070, 566
Missouri	5, 505, 018	152, 489, 000	54, 896, 040
Kansas	5, 952, 057	145, 825, 000	45, 205, 873
Nebraska	5, 572, 523	157, 145, 000	44, 000, 642
South Dakota	794, 011	17, 706, 000	5, 843, 127
North Dakota	17, 515	375, 000	149, 928
Montana	1, 080	21, 000	14, 364
Wyoming	2, 050	38, 000	23, 134
Colorado	124, 350	2, 773, 000	1, 109, 202
New Mexico	29, 250	585, 000	421, 200
Arizona	4, 650	81, 000	52, 894
Utah	8, 750	158, 000	91, 350
Nevada			
Idaho	1, 550	26, 000	17, 903
Washington	10, 250	185, 000	110, 700
Oregon	13, 400	288, 000	161, 336
California	72, 500	2, 197, 000	1, 208, 213
Total	70, 626, 658	1, 628, 464, 000	642, 146, 630

A heavy reduction in area occurred in the corn belt, and the rate of yield was also low there. The average is 23.1 bushels per acre, which is greater than in 1890, 1887, 1886, or 1883. The average value is 39.3, which is not quite as high as the value of the greater crop of 1891 on the 1st of December, on account of the large surplus of that crop which entered into the supply of this year.

The following table gives the breadths, products, and values of the past thirteen crops:

Year.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	1,717,434,543	62,317,842	$679,714,499	39.6	27.6	$10.91
1881	1,194,916,000	64,262,025	759,482,170	63.6	18.6	11.82
1882	1,617,025,100	65,659,545	783,867,175	48.5	24.6	11.94
1883	1,551,066,895	68,301,889	658,051,485	42.4	22.7	9.63
1884	1,795,528,000	69,683,780	640,735,560	35.7	25.8	9.19
1885	1,936,176,000	73,130,150	335,674,630	32.8	26.5	8.69
1886	1,665,441,000	75,694,208	610,311,000	36.6	22.0	8.06
1887	1,456,161,000	72,392,720	646,106,770	44.4	20.1	8.93
1888	1,987,790,000	75,672,763	677,561,580	34.1	26.3	8.95
1889	2,112,892,000	78,319,651	597,918,829	28.3	27.0	7.63
Total	17,034,430,538	705,434,573	6,689,423,698			
Average for 10 years—1880 to 1889	1,703,443,054	70,543,457	668,942,370	39.3	24.1	9.48
Average for 10 years—1870 to 1879	1,184,486,954	43,741,331	504,571,048	42.6	27.1	11.54
1890	1,489,970,000	71,970,763	754,433,451	50.6	20.7	10.48
1891	2,060,154,000	76,204,515	836,439,228	40.6	27.0	10.98
1892	1,628,464,000	70,626,658	642,146,630	39.4	23.1	9.09
Total	5,178,588,000	218,801,936	2,233,019,309			
Average for 3 years—1890 to 1892	1,726,196,000	72,933,979	744,339,770	43.1	23.7	10.21

Only three crops in ten years have been smaller, though four have a less yield per acre. Five crops have had a lower average value per bushel. The value per acre, $10.18, has been exceeded only twice in ten years. The supply for the past three years averages 1,726,196,000 bushels per annum, against 1,703,443,054 for the preceding period of ten years.

In twenty-two years past the exports of maize (including meal) have averaged only 3.8 per cent of the production. The estimated supply and surplus are thus given:

Years.	Production.	Exports.	Exportation.	Years.	Production.	Exports.	Exportation.
	Bushels.	*Bushels.*	*P. ct.*		*Bushels.*	*Bushels.*	*P. ct.*
1870	1,094,255,000	10,673,553	1.0	1883	1,551,066,895	46,258,606	3.0
1871	991,898,000	35,727,010	3.6	1884	1,795,528,000	52,876,456	2.9
1872	1,092,719,000	40,154,374	3.7	1885	1,936,176,000	64,829,617	3.3
1873	932,274,000	35,985,834	3.9	1886	1,665,441,000	41,368,584	2.5
1874	850,148,500	30,025,036	3.5	1887	1,456,161,000	25,360,869	1.7
1875	1,321,069,000	50,910,532	3.9	1888	1,987,790,000	70,841,673	3.6
1876	1,283,827,500	72,652,611	5.7	1889	2,112,892,000	103,418,709	4.9
1877	1,342,558,000	87,192,110	6.5	1890	1,489,970,000	32,041,529	2.2
1878	1,388,218,750	87,884,892	6.3	1891	2,060,154,000	76,602,277	3.7
1879	1,754,591,676	99,572,329	5.7				
1880	1,717,434,543	93,648,147	5.5	Annual average	1,483,459,726	56,546,413	3.8
1881	1,194,916,000	44,340,683	3.7				
1882	1,617,025,100	41,655,653	2.6				

Returns of individual corn-growers, made by themselves, have been received from nearly 50,000 persons, selected as representative farmers, covering an aggregate of 1,698,081 acres, producing 45,477,652 bushels, or 26.8 bushels per acre. Last year similar returns covering 1,621,284 acres were made, with a product of 46,524,165 bushels, or 28.4 bushels per acre. In 1891 an area of 1,524,280 acres was reported, producing 35,267,889 bushels, or 23.1 bushels per acre. This marked the year as a poor corn season, and our October record of condition indicated such a result by a percentage of 70.6. The October condition in 1891 was 92.5, and last October it was 79.8. These farmers, many of whom are among the most progressive, got larger results than the average; yet last year, one of generally good crops, the official average was only 6 per cent less than the average of these returns. In 1890 the general average was about 11 per cent less than that of these farmers' returns, and this year the difference is 13 per cent. The State averages of the three years, as reported by these growers, are as follows:

States and Territories.	1890.	1891.	1892.	States and Territories.	1890.	1891.	1892.
Maine	38.0	44.6	41.6	Indiana	30.2	39.0	34.7
New Hampshire	44.6	45.7	43.2	Illinois	33.8	40.7	33.0
Vermont	43.0	44.0	42.7	Wisconsin	35.0	29.2	28.3
Massachusetts	43.4	42.9	37.7	Minnesota	25.6	29.3	30.0
Rhode Island	38.4	25.3	36.1	Iowa	27.9	41.0	34.0
Connecticut	42.4	43.0	43.1	Missouri	30.3	32.9	31.2
New York	29.6	38.5	37.9	Kansas	12.8	28.8	26.3
New Jersey	39.3	43.4	48.9	Nebraska	12.5	39.1	33.5
Pennsylvania	36.6	44.3	34.8	South Dakota	10.9	23.5	21.4
Delaware	19.9	30.4	31.3	North Dakota		18.1	23.8
Maryland	35.2	43.6	32.8	Montana	13.6	27.8	31.0
Virginia	23.2	27.7	22.4	Wyoming	28.3	38.0	23.3
North Carolina	19.3	17.2	15.4	Colorado	10.3	23.5	21.7
South Carolina	12.7	12.2	12.9	New Mexico	20.5	20.6	19.3
Georgia	12.5	13.3	12.9	Arizona	14.7	23.4	25.2
Florida	10.0	11.4	11.5	Utah	21.1	19.1	19.5
Alabama	17.3	16.2	12.2	Nevada	11.5	22.5	20.9
Mississippi	15.9	17.2	17.2	Idaho	15.6	22.3	22.2
Louisiana	18.3	20.3	12.5	Washington	20.6	17.9	10.6
Texas	21.4	22.6	23.6	Oregon	22.4	27.5	19.1
Arkansas	19.0	26.1	19.4	California	22.8	36.4	20.5
Tennessee	22.9	29.7	27.1	Oklahoma	....	25.9	27.6
West Virginia	23.3	36.5	31.9	Indian	4.8	43.3	21.6
Kentucky	24.5	34.0	29.5				
Ohio	28.1	34.8	40.3	Average	23.1	28.7	26.8
Michigan	29.2	33.3	42.3				

WHEAT.

The progress of wheat-growing in this country has been a marvel in agricultural production. The Dakotas now produce more than was grown in the United States fifty years ago. The exports of last year were greater than the aggregate product twenty-five years ago. The yield per acre of old lands is increasing, and that of new lands decreasing, and new wheat lands are annually brought into cultivation. Granitic New England in the few fields cultivated obtains more per acre than the richest soils of the West. The yield declines fastest in the newest and richest soils, not because of soil exhaustion, but because of its fatness in stimulating the growth of weeds. The census of 1880 made an average yield of wheat of 13 bushels; that of 1890, when the season was far less favorable and prospects apparently much worse, gives a yield of about 14 bushels per acre. With good cultivation and fertilization it should be increased to 20 bushels. Individual farms in Maine report between 30 and 40 bushels per acre; some in New York report 32 or more; and many in Illinois and North Dakota return between 20 and 30 bushels per acre. The rate of yield could readily be increased one-half; but it is safe to say that it will not be till the virgin soils are scratched over after the prevailing practice misnamed cultivation. The present breadth of wheat, under wise and skillful cultivation, would suffice for double our present population.

The wheat crop of 1892 is slightly above an average one in yield per acre, and in volume has only been exceeded in 1891, though the crops of 1880 and 1889 nearly equaled it. The area is estimated at 38,554,430 acres, producing 515,949,000 bushels, valued on the farm at $322,111,881. The yield per acre is 13.4 bushels, and the value per bushel 62.4 cents. In the revision of acreage changes are made in some States in which the decline of the past twelve years has been heavier than had been reported.

There has also been a considerable enlargement of the breadth the past year in several Western States. The crop is reported in measured bushels. The estimates by States are as follows:

States and Territories.	Acres.	Bushels.	Value.
Maine	4, 500	75, 000	$76, 653
New Hampshire	2, 350	38, 000	38, 305
Vermont	8, 750	151, 000	144, 480
New York	518, 837	8, 405, 000	7, 144, 385
New Jersey	124, 950	1, 787, 000	1, 483, 032
Pennsylvania	1, 324, 063	19. 331, 000	15, 658, 369
Delaware	94, 705	1, 231, 000	923, 374
Maryland	529, 684	6, 992, 000	5, 173, 953
Virginia	799, 069	7, 591, 000	5, 769, 279
North Carolina	716, 942	5, 090, 000	4, 530, 356
South Carolina	144, 316	938, 000	872, 390
Georgia	216, 820	1, 474, 000	1, 326, 938
Alabama	45, 600	306, 000	284, 134
Mississippi	3, 650	25, 000	22, 338
Texas	445, 085	5, 475, 000	4, 105, 910
Arkansas	163, 058	1, 337, 000	1, 069, 661
Tennessee	898, 915	8, 540, 000	5, 806, 991
West Virginia	402, 077	4, 302, 000	3, 226, 668
Kentucky	985, 977	11, 635, 000	7, 795, 134
Ohio	2, 795, 733	38, 022, 000	25, 854, 939
Michigan	1, 622, 737	23, 854, 000	15, 982, 337
Indiana	2, 713, 292	39, 885, 000	25, 526, 651
Illinois	1, 751, 249	28, 370, 000	17, 873, 247
Wisconsin	766, 429	8, 814, 000	5, 464, 639
Minnesota	3, 552, 626	41, 210, 000	25, 138, 382
Iowa	631, 063	7, 257, 000	4, 354, 335
Missouri	1, 986, 686	24, 834, 000	14, 403, 474
Kansas	4, 070, 724	70, 831, 000	36, 831, 911
Nebraska	1, 253, 564	15, 670, 000	7, 834, 775
South Dakota	2, 541, 348	31, 767, 000	16, 201, 094
North Dakota	2, 868, 729	34, 998, 000	18, 199, 217
Montana	41, 761	898, 000	619, 525
Wyoming	5, 775	101, 000	66, 702
Colorado	131, 082	2, 504, 000	1, 452, 126
New Mexico	37, 331	515, 000	412, 134
Arizona	10, 891	170, 000	132, 522
Utah	102, 573	1, 775, 000	1, 100, 198
Nevada	6, 101	117, 000	87, 854
Idaho	76, 951	1, 693, 000	1, 015, 753
Washington	523, 530	9, 005, 000	5, 222, 735
Oregon	622, 850	9, 779, 000	5, 258, 397
California	3, 012, 057	39, 157, 000	26, 626, 584
Total	38, 554, 430	515, 949, 000	322, 111, 881

One of the aids in determining the rate of yield is the return of our special list of farmers. About 50,000 made such a return this year, nearly all reporting corn, but not so many growing wheat, oats, etc. The aggregate represented 1,473,500 acres of wheat in every State and Territory, producing 23,112,590 bushels, or an average of 15.7 bushels. As a rule these farmers are of the most intelligent and progressive class, who obtain much better results than the average of all, which we this year make 13.4 bushels per acre. Last year a similar series of returns of actual yield made 18 bushels per acre, while our general average of the entire breadth made 15.3 bushels. In 1890, a year when little more than three-fourths of a full crop was indicated by returns of condition, the average of the estimates was 11.1 bushels per acre, while these actual returns of growers averaged 12.6 bushels per acre. The general average is thus 12 per cent less than that of the picked farms, and in 1891 and 1890 14 to 15 per cent less. The difference is of course not quite uniform in the different States, as the State breadths reported vary from 8 acres in Rhode Island (which produces so little that we never attempt to report it) to 203,371 acres in North Dakota; and in these very sparse returns the best lands may not be returned. The estimated averages, however, are lower in almost every case. The following statement gives the State averages of these actual yields, as reported for three years past:

States and Territories.	1890.	1891.	1892.	States and Territories.	1890.	1891.	1892.
Maine	19.0	24.7	23.7	Indiana	12.9	21.4	19.0
New Hampshire	18.3	24.2	20.2	Illinois	12.9	18.3	18.9
Vermont	17.5	25.1	21.7	Wisconsin	15.7	16.7	15.9
Massachusetts	12.0	17.1	18.5	Minnesota	12.7	19.9	12.2
Rhode Island			13.4	Iowa	12.8	17.4	14.6
Connecticut	18.6	24.3	15.5	Missouri	12.9	17.6	14.9
New York	20.1	22.6	18.8	Kansas	12.7	14.6	18.2
New Jersey	15.6	18.5	19.2	Nebraska	8.3	19.4	16.4
Pennsylvania	16.6	20.6	16.9	South Dakota	6.9	14.4	14.2
Delaware	13.9	19.8	19.0	North Dakota		21.2	14.4
Maryland	15.5	20.2	18.6	Montana	22.3	34.9	27.8
Virginia	8.4	12.8	13.8	Wyoming	22.9	25.6	22.1
North Carolina	5.1	7.3	9.2	Colorado	17.9	21.1	20.3
South Carolina	4.4	6.8	7.7	New Mexico	21.0	11.0	13.8
Georgia	3.0	7.5	8.3	Arizona	13.1	16.8	22.4
Florida			10.0	Utah	22.9	22.4	19.7
Alabama	4.6	9.6	7.9	Nevada	24.1	27.3	23.9
Mississippi	2.2	16.9	11.2	Idaho	22.9	21.8	22.9
Louisiana		14.0	22.4	Washington	24.4	21.0	18.9
Texas	7.2	16.5	10.4	Oregon	20.5	24.7	17.5
Arkansas	7.9	10.0	9.0	California	15.9	13.8	15.4
Tennessee	5.8	13.7	13.8	Oklahoma		14.8	20.7
West Virginia	10.5	14.0	8.4	Indian		14.9	25.2
Kentucky	10.4	15.7	17.4				
Ohio	15.4	21.6	16.6	Total	12.6	18.0	15.7
Michigan	16.0	20.6	17.0				

A glance at these figures shows that in 1890, the poor wheat year, the largest rate of yield was 24.4 in Washington; the largest on the Atlantic coast, 20.1 bushels, in New York; the largest in New England, 19 bushels in Maine; the largest in the West, 20 bushels in Michigan. In 1891, the year which produced the greatest national aggregate of all time, the largest rate was 34.9 bushels in Montana; Nevada, 27.3; Wyoming, 25.6; Vermont, 25.1; Oregon and Maine, 24.7 bushels. In the Western States the largest rate, 21.6 bushels, was in Ohio. The largest yield of the present year is 27.8 bushels in Montana, on 1,924 acres. The next in order is 25.2 bushels in the Indian Territory. The next lower is 23.9 in Nevada, and Maine averages nearly as much, 23.7 bushels. In the West, the largest rate is 19 bushels in Indiana. It should be understood that these are averages of States, and not of individual farms, some of which are much higher.

The following table is a record of estimates from 1880 to the present time, with averages of the previous decade:

Years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	498, 549, 868	37, 986, 717	$474, 201, 850	95. 1	13. 1	$12. 48
1881	383, 280, 090	37, 709, 020	456, 880, 427	119. 2	10. 2	12. 12
1882	504, 185, 470	37, 067, 194	444, 602, 125	88. 2	13. 6	11. 99
1883	421, 086, 160	36, 455, 593	383, 649, 272	91. 1	11. 6	10. 52
1884	512, 765, 000	39, 475, 885	330, 862, 260	64. 5	13. 0	8. 38
1885	357, 112, 000	34, 189, 246	275, 320, 390	77. 1	10. 4	8. 05
1886	457, 218, 000	36, 806, 184	314, 226, 020	68. 7	12. 4	8. 54
1887	456, 329, 000	37, 641, 783	310, 612, 960	68. 1	12. 1	8. 25
1888	415, 868, 000	37, 336, 138	385, 248, 030	92. 6	11. 1	10. 32
1889	490, 560, 000	38, 123, 859	342, 491, 707	69. 8	12. 9	8. 98
Total	4, 496, 953, 583	372, 791, 619	3, 718, 005, 041			
Average for 10 years—1880 to 1889	449, 695, 359	37, 279, 162	371, 809, 504	82. 7	12. 1	9. 97
Average for 10 years—1870 to 1879	312, 152, 728	25, 187, 414	327, 407, 258	104. 9	12. 4	13. 00
1890	399, 262, 000	36, 087, 154	334, 773, 678	83. 8	11. 1	9. 28
1891	611, 780, 000	39, 916, 897	513, 472, 711	83. 9	15. 3	12. 86
1892	515, 949, 000	38, 554, 430	322, 111, 881	62. 4	13. 4	8. 35
Total	1, 526, 991, 000	114, 558, 481	1, 170, 358, 270			
Average for 3 years—1890 to 1892	508, 997, 000	38, 186, 160	390, 119, 423	76. 6	13. 3	10. 21

The progress of wheat-growing was stimulated greatly by the crop failures of western Europe prior to 1880. Twenty years ago no crop had attained half the values of that of 1891. The average production of the decade between 1870–'79 was 312,152,728 bushels. The average of the next decade was 449,695,359. That of the past three years is 508,997,000 bushels.

The following table stands as a test of the consistency, if not accuracy, of wheat estimates of the past eleven years:

Years.	Production.	For food.	For seed.	Exportation.	Total distributed.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1881	383, 280, 090	243, 000, 000	55, 215, 573	121, 892. 389	420, 107, 962
1882	504, 185, 470	250, 000, 000	52, 770, 312	147, 811, 316	450, 581, 628
1883	421, 086, 160	256, 000, 000	54, 683, 389	111, 534, 182	422, 217, 571
1884	512, 765, 000	261, 000, 000	55, 266, 239	132, 570, 367	448, 836, 606
1885	357, 112, 000	267, 000, 000	51, 474, 906	94, 565, 794	413, 040, 760
1886	457, 218, 000	271, 000, 000	51, 528, 658	153, 804, 970	476, 333, 628
1887	456, 329, 000	277, 000, 000	53, 009, 982	119, 625, 344	449, 635, 326
1888	415, 868, 000	283, 000, 000	54, 012, 702	88, 600, 743	425, 61[illegible], 445
1889	490, 560, 000	289, 000, 000	53, 973, 000	109, 430, 467	452, 403, 4[illegible]7
1890	399, 262, 000	295, 000, 000	56, 582, 000	106, 181, 316	457, 763, 316
1891	611, 780, 000	302, 000, 000	54, 568, 000	225, 665, 812	582, 173, 812
Total	5, 009, 445, 720	2, 994, 000, 000	593, 024, 761	1, 411, 682. 700	4, 998, 707, 461
Average	455, 404, 156	272, 181, 818	53, 911, 342	128, 334, 791	454, 427, 951

This table gives, first, the estimates of production six months before the year's exports are completed and before the records of distribution are made. What do we find as a result? An average production of 455,404,156, and an average distribution of 454,427,951 bushels. This leaves only a million bushels per annum for loss by fire and flood, which is not enough, showing that the estimates are inside of known distribution. But the reader may say that the consumption may not be accurate. True, it is an estimate, but it is on the basis every year of $4\frac{2}{3}$ bushels per capita, a rate fixed upon in 1878, after careful and thorough investigation of the differing consumption of different sections of country, as a fair average. It must be admitted that, if not the true average, it is a marvelous coincidence that it accounts satisfactorily for the estimates of all the years since, every one of them made before the actual facts of distribution could possibly be known. Nor has anyone ever ventured to dispute its reasonableness or make a different figure. But there was a much larger stock on hand, visible and invisible, at the end of this period than at the beginning, showing that the estimates were conservative, underestimates rather than overestimates of current production.

The record of exportation shows a surplus of 128,334,791 bushels annually sent abroad, or 28 per cent of the product. It shows, further, that the exports of the past five years have been greater than those of five years preceding.

OATS.

There has been a material increase in the acreage of oats as compared with that of 1891. A serious reduction in breadth occurred in that and the previous crop, in the latter from destruction by the grain aphis, blights, and other causes, which caused the lowest rate of yield which our records show, and in the former from discouragement produced by the unprofitable outcome of the crop of 1890. The present estimates are as follows:

Oats, 1892.

States and Territories.	Acres.	Bushels.	Value.
Maine	124, 501	4, 009, 000	$1, 804, 019
New Hampshire	28, 223	960, 000	422, 216
Vermont	106, 580	3, 784, 000	1, 626, 944
Massachusetts	15, 129	460, 000	220, 763
Rhode Island	4, 179	123, 000	60, 408
Connecticut	24, 473	619, 000	278, 625
New York	1, 383, 183	38, 729, 000	15, 104, 358
New Jersey	119, 287	3, 066, 000	1, 256, 927
Pennsylvania	1, 177, 146	29, 674, 000	11, 865, 632
Delaware	22, 152	428, 000	162, 463
Maryland	96, 272	1, 829, 000	695, 084
Virginia	488, 539	5, 472, 000	2, 133, 938
North Carolina	549, 717	5, 332, 000	2, 399, 515
South Carolina	350, 679	3, 682, 000	1, 914, 708
Georgia	569, 136	6, 090, 000	3, 166, 673
Florida	47, 222	463, 000	254, 527
Alabama	364, 810	3, 721, 000	1, 897, 742
Mississippi	146, 607	1, 554, 000	777, 017
Louisiana	34, 533	421, 000	210, 652
Texas	619, 456	15, 177, 000	5, 767, 135
Arkansas	317, 690	4, 988, 000	1, 995, 093
Tennessee	553, 035	7, 466, 000	2, 837, 070
West Virginia	164, 034	2, 871, 000	1, 176, 944
Kentucky	596, 557	10, 917, 000	4, 039, 287
Ohio	1, 002, 421	26, 364, 000	9, 227, 285
Michigan	968, 944	27, 809, 000	9, 733, 043
Indiana	1, 100, 932	29, 175, 000	9, 919, 397
Illinois	2, 854, 105	75, 063, 000	23, 269, 518
Wisconsin	1, 674, 568	50, 572, 000	14, 665, 867
Minnesota	1, 596, 090	43, 573, 000	12, 200, 512
Iowa	3, 773, 254	95, 841, 000	24, 918, 570
Missouri	1, 204, 640	24, 093, 000	7, 227, 840
Kansas	1, 547, 175	44, 094, 000	11, 464, 567
Nebraska	1, 615, 393	43, 131, 000	9, 920, 128
South Dakota	702, 369	18, 472, 000	4, 248, 630
North Dakota	472, 080	12, 510, 000	3, 502, 834
Montana	66, 323	1, 910, 000	764, 041
Wyoming	15, 300	438, 000	166, 280
Colorado	98, 811	2, 836, 000	964, 198
New Mexico	11, 104	225, 000	126, 230
Arizona			
Utah	27, 752	735, 000	294, 171
Nevada			
Idaho	24, 634	714, 000	264, 323
Washington	92, 282	3, 184, 000	1, 114, 305
Oregon	244, 689	6, 484, 000	2, 399, 176
California	67, 829	1, 987, 000	794, 956
Total	27, 063, 835	661, 035, 000	209, 253, 611

The following table exhibits the extraordinary increase in the production of oats:

Years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1880	417,885,380	16,187,977	$150,243,565	36.0	25.8	$9.28
1881	416,481,000	16,831,600	193,198,970	46.4	24.7	11.48
1882	488,250,610	18,494,691	182,978,022	37.5	26.4	9.89
1883	571,302,400	20,324,962	187,040,264	32.7	28.1	9.20
1884	583,628,000	21,300,917	161,528,470	27.7	27.4	7.58
1885	629,409,000	22,783,630	179,631,860	28.5	27.6	7.88
1886	624,134,000	23,658,474	186,137,930	29.8	26.4	7.87
1887	659,618,000	25,920,906	200,699,790	30.4	25.4	7.74
1888	701,735,000	26,998,282	195,424,240	27.8	26.0	7.24
1889	751,515,000	27,462,316	171,781,008	22.9	27.4	6.26
Total	5,843,958,390	219,963,755	1,808,664,119			
Average for 10 years—1880 to 1889	584,395,839	21,996,376	180,866,412	30.9	26.6	8.22
Average for 10 years—1870 to 1879	314,441,178	11,076,822	111,075,223	35.3	28.4	10.03
1890	523,621,000	26,431,369	222,048,486	42.4	19.8	8.40
1891	738,394,000	25,581,861	232,312,267	31.5	28.9	9.08
1892	661,035,000	27,063,835	209,253,611	31.7	24.4	7.73
Total	1,923,050,000	79,077,065	663,614,364			
Average for 3 years—1890 to 1891	641,016,667	26,359,022	221,204,788	34.5	24.3	8.39

WINTER WHEAT.

The condition of winter wheat, as reported in December, averages 87.2, which is two points above the last report of condition of the previous crop. The average is lower from late seeding of a considerable portion of the area. With a favorable winter improvement might come in April and May, but with enfeebling effect of hard weather in March would be more liable to succumb to the destructive influence of freezing and thawing and prove less promising in the spring.

In New York high condition is generally reported. In some counties of Pennsylvania a fine prospect is indicated; in others it was sown late and is less promising, while a few report the ravages of the Hessian fly. Maryland has suffered quite as much impairment as Pennsylvania. The returns of Virginia are moderately favorable, as are those of Tennessee. Other Southern States report generally good condition, ranging from 92 to 98.

In the Central States, those of the Ohio Valley, and Missouri and Kansas seeding was late on account of dry weather, which delayed preparation and germination. The early planted in such soils is thin on the ground. The late seeding is more promising. The highest condition in this district is in Missouri. The State percentages generally fall within the eighties, indicating barely medium prospects. The winter wheat of the Pacific coast is looking very well, with percentages considerably above 90.

States.	1892.		States.	1892.	
	Wheat.	Rye.		Wheat.	Rye.
Connecticut	96	99	Kentucky	79	82
New York	97	98	Ohio	86	89
New Jersey	95	96	Michigan	87	94
Pennsylvania	88	93	Indiana	83	85
Delaware	90	92	Illinois	80	80
Maryland	83	89	Wisconsin	96	....
Virginia	88	89	Iowa	83	....
North Carolina	92	94	Missouri	91	93
South Carolina	97	96	Kansas	83	84
Georgia	96	96	Nebraska	93	....
Alabama	98	97	Colorado	96	....
Mississippi	98	90	Washington	99	....
Texas	98	99	Oregon	98	98
Arkansas	95	99	California	98	99
Tennessee	87	91			
West Virginia	86	82	Average	87.4	89.4

FLAXSEED.

This crop is not regularly reported upon by the U. S. Department of Agriculture, but a special investigation has been undertaken to show, approximately at least, the comparative product of the crop of 1892. The resources of the Department will not admit of sufficient local investigation to enable it to report upon all the minor crops, but in the case of this product the regular corps of correspondents are competent to furnish the necessary data.

In 1891, as a result of high prices of seed and especially favorable conditions for seeding, the crop reached the largest proportions ever recorded. There almost seemed indications of a genuine and permanent revival of interest in flax-growing, judging by the sudden increase in the area devoted to the crop in most districts where it is grown. Based as it was, however, on a merely temporary market advance, it was foreseen that it could not be permanent. In a special report upon the crop of the year, presented in the September, 1891, report of this division, it was said "an increased acreage based upon such reasons can not be permanent, and already, with lower offerings on the farm for the seed, there are indications that some portions of the area will be abandoned next year."

That this view was correct was proven by the returns for the present year. The falling off in acreage and production from last year is very heavy and quite generally distributed. Naturally, however, it is less marked in the newer agricultural districts, where flax is essentially a pioneer crop, grown both for its value as a money crop and as a means of subduing the rich virgin soil. The westward movement of the center of production, the result of the tendency to make flax a first crop in the development of agriculture, which has been made apparent at each successive census or special investigation, is continued. In 1880 about 65 per cent of the crop was grown east of the Mississippi River. By the present return it appears that only a little more than 1 per cent now comes from this district.

The estimated acreage and product for the years 1891 and 1892, according to the returns of the correspondents of the Department, are presented:

States.	1891.		1892.	
	Acres.	Bushels.	Acres.	Bushels.
Ohio	18,498	133,912	9,804	64,706
Indiana	3,011	26,349	753	5,271
Illinois	4,438	25,013	1,775	14,200
Wisconsin	6,451	68,909	4,838	45,961
Minnesota	425,089	4,082,981	403,835	3,432,598
Iowa	280,704	2,898,596	266,669	2,133,352
Missouri	66,577	459,848	35,286	215,245
Kansas	360,000	2,600,000	185,000	1,184,000
Nebraska	240,000	1,975,000	168,000	1,260,000
North Dakota	115,000	580,000	35,000	315,000
South Dakota	390,446	2,431,504	351,401	2,284,107
Other	17,079	163,160	15,000	150,000
Total	1,927,293	15,455,272	1,477,361	11,104,440

It will be seen that the crop has been practically abandoned as a farm crop east of the Mississippi River, while west of that stream the production has been concentrated in five States. The crop is now grown practically for seed, the straw and fiber not being utilized under present conditions, and so long as this prevails the crop can not become a general or comparatively important one in American agriculture.

FARM PRICES.

The December returns of prices relate to the value on the farm of the various agricultural products on the first day of that month. The State and national averages which are presented are consolidations of county returns, and represent the actual selling price received by producers for their own crops, either on the farm or in the nearest local or country town or market. These values are necessarily lower than commercial quotations, as a rule, as the latter must include transportation charges, handling, storage, and profits of middlemen. The exceptions, when farm prices equal commercial quotations, are few and occur mainly in those districts where the home-grown product forms but a small part of the supply, and commercial quotations cover mainly the production of other districts shipped in to supplement the home product. An example of this may be frequently noticed in the New England returns, where the home-grown product, comparatively small in volume, commands higher prices than western shipments.

Corn.—The average farm price of corn is returned at 39.3 cents, or 1.3 cents lower than in 1891, despite the fact that the crop of the present year is smaller than that of 1891 by nearly 500,000,000 bushels. This is exactly the average of the ten years 1880 to 1889, when the crop averaged 1,703,000,000 bushels. In 1889 the price was 28.3 cents, but the next year, under the stimulus of a short crop, it rose to 50.6 cents. The present low price, in the face of a short crop, may be attributed to the effect of a large crop of the previous year furnishing a surplus to be added to the present year's production. The range of State quotations is from 67 cents in Maine and 70 in Montana to 28 in Nebraska. The highest returns are from the New England States and the mountain districts, where the production is insufficient for local use, and the lowest naturally from the States which supply commercial corn.

Wheat.—The price of wheat on the farm in December touched the lowest point ever registered since the inauguration of the crop-reporting work of the Department. The average for the country is 62.4 cents, against 64.5 cents in 1884, the lowest previous return. Last year, with a crop nearly 100,000,000 bushels larger than the present one, the price was 83.9, but there was a decline later. The present crop is above the average in volume and, following the enormous production of 1891, has had the natural effect of depressing prices. The falling off in actual and probable foreign demand has also assisted in the reduction. Since 1880 $1 wheat has not been reached, except in the single year 1881. During the decade from 1870 to 1879 the average farm price was $1.049. This comparison illustrates the changes in wheat-growing and emphasizes the impossibility of this country controlling the trade or price for the world. In this connection the declaration of the Secretary of Agriculture, in his report for 1892, is fraught with interest, and can not be too persistently repeated to American wheat-growers. He says:

> The time has arrived when the American farmer must cease his efforts to neutralize the low price of his wheat by producing a larger quantity. He is going from bad to worse, and each effort to extricate himself by that means sinks him deeper in the mire of failure. The only proper course lies in a reduction of acreage and production to meet the demand of domestic consumption and a normal requirement for exportation. * * * But for the unusual conditions which last year produced in Europe, our crop of over 600,000,000 bushels would have precipitated the crisis which is yet impending. So far as our own wheat-growers are concerned the remedy is in their own hands.

Oats.—The course of the price of oats has followed closely that of corn, the grain with which it is to such a large extent used interchangeably, but instead of a small decline it stands at practically the same figure as in 1891. The general average is 31.7 cents, against an average of 30.9 cents for the ten years 1880 to 1889. The crop of the year is 70,000,000 bushels smaller than that of 1891, but is slightly larger than the average of two years past and more than double the average production of the period 1870 to 1879. That consumption is keeping pace with the rapidly increasing production is shown by the fact that there is no glut in distribution and there have been no serious declining values.

Rye.—A heavy decline in the value of rye is apparent, the present return being 54.8 cents, against 77.4 in 1891 and 62.9 in 1890. During the past ten years the price has been lower at four returns, in 1884, 1886, 1887, and 1889, and only materially higher in 1890 and 1891.

Barley.—The price of this grain, while low, does not show so great a fall from that of 1891 as is exhibited in the returns of wheat and rye. The average is 47.2, against 54 cents last year and 42.7 in 1889. During the past three years there has been a material increase in the volume of the crop, and in the face of this enlargement prices have been well maintained.

Buckwheat.—The price of this cereal is but little lower than the return of last year, standing at 53.4 cents, against 57.9 in December, 1881. This is a low range, however, it being the lowest, with one exception (1889), reported during the present decade. The fluctations are less marked than in the case of the more prominent crops. Since 1883, except in 1888, the annual return of value on the farm has ranged between 50 and 60 cents.

Potatoes.—There has been a sharp rise in the value of potatoes, consequent upon the very short crop of the present year. The crop of 1891 was of ample proportions and the price in December was but 37.1 cents, the lowest ever reported by this Department. The present season was unfavorable to the crop, and the comparatively small production is reflected in the present return of price. The consolidated average is 67.3 cents, a figure that has been exceeded but twice in ten years. For the first time in the history of these returns of prices the value of potatoes on the farm is greater per bushel than the value of wheat.

Hay.—The farm value of hay is practically the same as returned last year, $8.49 per ton. This is above the average for a series of years, but considerably below the return for 1887 and 1888.

Cotton.—Last year, in December, the price of cotton was very low, the return being made at a time when the depression of the industry, the result of continued overproduction, was greatest. The crop of the present year is materially reduced, both by intentional reduction of the acreage and reduction of yield from an unfavorable season. The result is a sharp rally in values, the price having advanced 1 cent per pound, now standing at 8.4 cents, a figure about the average of recent years.

PRIMARY PRICES OF FARM PRODUCTS.

In accordance with a request from the Senate Finance Committee, acting under the resolution of March 3, 1891, an investigation of the prices of certain farm products in primary markets was undertaken, covering the period from June, 1889, to September, 1891. Instructions were given to State agents to select points representing each State fairly and direct the correspondents there located to examine the records of sales and report current prices, for the first of each month of the period, of the products of the grade and quality specified. In the larger States some twelve to fifteen localities were selected, and a smaller number in the States of smaller area. In the selection of these points consideration was given to the desirability of representing the various conditions under which farm products are sold. The markets given represent a few of the larger towns where farmers personally dispose of their produce; a considerable number of small county towns, which are local markets for surrounding agricultural territory; and a limited number of points not on lines of railway communication, which perhaps typify those farming districts in which transportation facilities are as yet meager. As local prices are greatly influenced by the relation of local supply to local demand, it seemed important to select points at which consumption exceeds production, as well as those plethoric with excess of production.

The correspondents selected were instructed to give as near as possible the actual price received by farmers disposing of their produce at first hands. They were cautioned against attempting to give average values from memory or the recollection of others, and directed to secure, wherever possible, a record of actual sales during each month of the period. In doing this they examined the books and memoranda of both sellers and purchasers, aiming to get at transactions in which the article dealt in fairly represented the ordinary market grade.

When the returns were received at this office they were carefully examined and revised. All obvious clerical errors and evident misinterpretation of instructions, and all records of changes in prices which were unreasonable on their face or in view of remarks explanatory, were carefully noted and a correspondence with the reporter instituted. The greatest care was taken to secure accuracy and uniformity, and the results were submitted to the committee in the belief that the figures fairly represented the prices at which the farmers in the different localities disposed of their products during the period in question.

In the tables relating to the prices of animals slaughtered the quotations given were not for net weight of meat, but by live weight, gross weight on foot per 100 pounds. In some localities animals for slaughter are sold only by net weight of meat, a fact which caused some confusion of returns, but so careful was the revision and verification by correspondence of the quotations that all errors of this nature, it is believed, were eliminated from the returns.

There are a number of considerations affecting selling values in different sections of the country which may properly be pointed out. Distance from consuming markets and inadequate transportation facilities strongly influence toward lower values, while higher values are apt to rule for productions which are not staple articles of the district in question. Again, comparatively high prices rule in districts where the home market is in part supplied by products produced elsewhere. This tendency is strengthened when there is a preference for the home-grown article, as exemplified in New England, where home-grown grain bears a slightly higher price than the Western produce sold in competition. A number of the products reported upon are sold by the farmers only during a few months of the year. This will account for the comparatively uniform quotation, which is really normal, given for certain periods of each year. Another reason for the uniformity in quotations which sometimes occurs may be found in the fact that the market is local, the supply limited to its regular requirements, and the value determined by custom extending over a long period.

The products selected were only those of which the surplus is largest, and of a well-defined grade. Thus cereals, corn, wheat, oats, and barley, comprise 99 per cent of all, and are quoted in every market. No. 2 grade for wheat and corn was selected, as it usually includes the larger proportion of the crop in each case, and is fairly representative of medium merchantable quality. In butter the average market grade of farm dairy was taken. In eggs quality or size have little consideration in the market, and only current prices were asked. The prices of beeves, lambs, or swine for slaughter in meat production were required per 100 pounds live weight, as the initial movement in meat-making, in which farmers only and not butchers are concerned, thus representing meat on the farm and on foot. In cotton the price is for the "middling" grade.

The interest in these monthly quotations is not so much in the actual values per bushel or pound as in their relation to each other, the object being to show the course of prices, the fluctuations, the changes occurring from month to month. The tabulation and treatment by the statistician of the committee involved the averaging, by States and for all the localities reported, of each separate product. These averages are made for each of the twenty-eight months reported. To show the course of prices, those of June, July, and August, 1889, are combined in an average that is made the basis of comparison with each month of the series, the percentage named relating to this basis of three months, which is expressed by 100.

An examination of the record showing increase or decrease makes an increase in prices of cereals, butter, eggs, mutton, and pork, a decrease in cotton, potatoes, and flaxseed, and an almost inappreciable reduction in beeves and lambs, in each case a fraction of 1 per cent. The change is thus indicated:

Products.	Increase.	Decrease.	Products.	Increase.	Decrease.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Corn	47.27		Sheep	8.61	
Wheat	17.32		Swine	8.68	
Oats	22.09		Butter	24.17	
Barley	28.89		Eggs	31.36	
Potatoes		11.56	Cotton		24.20
Beeves		.12	Flaxseed		18.37
Lambs		.60			

Consolidating the prices of cereals, in accordance with the relative value of each crop (Table 5), a monthly increase is seen during 1890 and until May of 1891, with prices nearly as high in the later months in the face of unusually heavy production. In meats the highest monthly value was attained in May of 1891, the average increase for the nine months of that year being 8 per cent in comparison with the summer months of 1889. The average value of all these products of agriculture taken together began a perceptible rise in January of 1890, and continued to augment monthly till April, 1891, when the increase was 32.11 per cent, declining slightly during the following summer months, and showing in September an average increase of 18.23 per cent over the initial value in 1889. Taking all products together by quarters, a steady quarterly increase is noted to and including the second quarter of 1891, when the average increase over the initial value was 30.66 per cent, and for the third quarter 20.31 per cent.

The results of this investigation of prices of agricultural products are presented in the preliminary report of the Finance Committee. The subcommittee making the investigation of prices consists of the following Senators: Aldrich, of Rhode Island; Allison, of Iowa; Hiscock, of New York; Jones, of Nevada; Harris, of Tennessee; and Carlisle, of Kentucky. Dr. Roland P. Falkner is the statistician of the committee. The following is the analysis of agricultural prices furnished by the Division of Statistics of this Department, as made in this report:

PRICES IN PRIMARY MARKETS.

In the table following are the results of an investigation into the prices of farm products in primary markets which was conducted for the committee by the Statistical Division of the U. S. Department of Agriculture. In a number of localities in various States and Territories, according to the nature of the product, the prices received by farmers for their products have been ascertained and noted for each month during the period from June, 1889, to September, 1891. In making an analysis of the figures here presented, methods similar to those already adopted in the discussion of wages and prices have been followed. In each locality the average price for the three months, June, July, and August, 1889, has been taken as a basis upon which to calculate the increase or depreciation in price in the form of percentage. The series of percentages or ratios obtained for the various localities in a given State have been added and the result divided by the number of localities, and thus a series has been obtained for each State. The various series, by States, for the different articles have then been added, and divided by the number of States in order to obtain a general average for the whole country. The detailed results of this minute calculation can not be presented, but only the general results for each commodity. These series of relative prices for the thirteen articles on the agricultural list are given in Table 1. As heretofore, the points to be considered in the said table are, in the first place, the final results in September, 1891, and, in the second place, the course of prices during the period under consideration.

TABLE 1.—*Prices of agricultural products—relative prices in each month.*

Date.	Barley.	Corn.	Oats.	Wheat.	Potatoes.	Beeves.
Number of States	14	40	41	41	39	44
1889—June	98.77	98.82	101.49	100.75	99.76	102.17
July	100.61	100.24	100.53	100.38	103.10	100.04
August	100.63	100.96	97.99	98.88	97.25	97.80
September	101.41	98.99	93.68	97.33	87.66	95.71
October	101.21	93.24	92.55	97.60	86.08	95.82
November	99.45	90.04	94.58	98.27	87.02	96.04
December	99.14	89.41	96.14	99.22	88.81	97.18
1890—January	103.12	90.65	98.56	100.97	96.49	101.80
February	102.86	91.30	101.44	101.24	101.07	105.17
March	104.85	92.58	103.17	101.66	106.04	107.98
April	102.81	96.33	105.40	103.92	112.74	109.87
May	105.03	102.51	110.35	108.55	118.53	110.45
June	104.15	106.16	113.29	109.10	126.53	105.64
July	106.57	109.63	115.92	105.70	137.94	100.77
August	108.84	119.24	123.04	108.35	135.67	98.10
September	121.57	123.91	127.66	111.81	129.61	95.69
October	126.99	125.09	132.33	112.58	131.04	94.76
November	130.14	126.48	141.30	114.24	135.00	96.13
December	132.08	129.97	146.64	113.50	144.87	98.23
1891—January	134.52	136.08	154.29	114.24	160.71	105.67
February	135.51	139.56	160.22	116.53	168.23	109.17
March	139.48	147.09	166.92	118.53	174.39	114.36
April	145.00	161.80	174.39	122.52	179.62	116.19
May	146.54	165.58	175.07	124.69	178.08	116.41
June	143.32	156.32	163.47	121.44	178.83	112.49
July	137.97	152.76	150.67	116.29	163.88	107.42
August	131.71	153.17	132.81	113.53	104.76	102.26
September	128.89	147.27	122.09	117.32	88.44	99.88

Date.	Meat, lamb.	Meat, sheep.	Meat, swine.	Butter.	Eggs.	Cotton.	Flaxseed.
Number of States	37	41	46	47	47	11	6
1889—June	101.78	101.07	99.95	100.11	98.05	99.25	102.82
July	100.79	99.79	100.31	98.49	99.61	100.08	100.30
August	97.45	99.15	99.76	101.42	102.35	100.70	96.92
September	95.00	98.29	99.46	110.50	114.03	101.36	95.40
October	93.24	98.64	99.32	119.31	130.32	96.38	95.83
November	93.83	99.58	98.83	127.08	145.75	94.02	97.12
December	94.10	101.67	99.30	134.90	163.23	94.25	100.32
1890—January	99.83	106.69	99.42	137.89	157.89	93.78	100.03
February	102.20	109.11	100.58	136.07	143.02	98.66	102.23
March	103.62	111.91	100.66	132.90	127.69	100.48	106.30
April	106.94	113.49	101.40	125.67	115.50	101.87	109.45
May	107.72	111.90	100.67	113.69	105.01	104.41	111.50
June	105.49	108.04	99.03	100.63	104.21	106.51	111.68
July	102.38	106.17	98.37	97.66	102.85	106.75	106.02
August	99.95	104.63	98.31	101.67	108.51	104.52	104.85
September	97.67	103.03	100.02	111.25	119.16	98.56	109.92
October	96.17	102.93	100.08	119.21	232.09	94.42	113.10
November	95.23	103.91	100.73	128.16	150.61	89.84	107.35
December	94.76	106.01	100.17	135.36	169.46	86.17	98.72
1891—January	103.59	110.23	100.27	141.03	170.51	84.92	94.38
February	105.19	112.80	101.00	141.63	158.62	84.20	94.12
March	105.69	115.60	101.98	140.22	138.09	81.01	93.62
April	108.48	117.65	104.73	134.77	123.66	80.07	93.35
May	108.83	116.07	106.20	122.08	113.14	77.77	91.65
June	106.75	111.53	105.50	105.14	113.77	76.19	88.00
July	103.66	108.61	105.55	102.97	114.63	74.43	84.57
August	101.57	109.14	108.10	113.46	120.00	73.10	82.50
September	99.40	108.61	108.68	124.17	131.36	75.80	81.63

If we turn to the consideration of the results in September, 1891, we shall see that as a rule farm prices have increased. The range of variation is much greater than in the case of either retail prices or wages. Of the thirteen articles we find that three—cotton at 75.80, flaxseed at 81.63, potatoes at 88.44—have noticeably declined in price. Two other products, beeves and lambs, show a falling off from the initial figure of less than 1 per cent. The remaining eight articles rise in price, the maximum being corn, which shows, in September, 1891, the relative figure 147.27. It will also be observed that the other articles in the list show a marked increase in price, if not quite so great as in the case of corn.

In the consideration of retail prices and of wages, we observed that the final result for each article or occupation was the resultant of various changes, by no means uniform in character, which had taken place in the several cities where the information had been collected. The prevailing tendency in both of these cases was toward uniformity. If we examine the tendency of farm prices with respect to the different States in which the quotations were obtained, as shown in Table 2, we shall observe that an exceedingly small proportion of the prices remain absolutely uniform. The tendency is to rise or fall. Of 453 quotations there are 328 which show an increased price, 111 a decrease, and 14 only which are uniform. Table 2 shows us that the movement is not the same for the different articles upon the list. While the cereals, together with butter and eggs, show very few cases where prices have fallen in comparison with those where they have risen, this tendency is not observed in the same degree in the case of meat products. On the other hand, cotton has decreased in price in all of the localities where the price was ascertained. With flaxseed and potatoes falling prices predominate. The greater number of changes is found in Table 2 in the extremes of variation, in the prices which rise or fall 10 per cent and more. In the falling prices this group is slightly in excess of the other two, while in the rising prices it is nearly three times as much.

TABLE 2.—*Prices of agricultural products in September, 1891, compared with June, July, and August, 1889.*

Article.	Relative price September, 1891.	Price in September, 1891.							
		Total.	Rise 10 per cent or more.	Rise 5 per cent and less than 10 per cent.	Rise less than 5 per cent.	Uniform.	Fall less than 5 per cent.	Fall 5 per cent and less than 10 per cent.	Fall more than 10 per cent.
Barley	128.89	13	7	1	1		2	2	
Corn	147.27	40	35	2		1	1	1	
Oats	122.19	41	35	1	1	1	1	2	
Wheat	117.32	41	33	2	1	2	1	2	
Potatoes	88.44	39	3	2	3			4	27
Beeves	99.40	44	5	4	12	3	9	3	8
Meat, lamb	99.40	37	6	5	5	2	10	5	4
Meat, sheep	108.61	41	16	7	9	1	5	3	
Meat, swine	108.68	46	18	12	11	2		1	2
Butter	124.17	47	35	6	3	1		1	1
Eggs	131.36	47	42	2	2	1			
Cotton	75.80	11							11
Flaxseed	81.63	6			1				5
Total		453	235	44	49	14	29	24	58

Table 3 indicates for each State or Territory included in the tables the tendency of the prices which are quoted in it. As the number of articles quoted varies considerably in the different States and Territories, we must consider mainly the percentage columns of the table. It will be seen, in the first place, that in but nine States and Territories are there any prices which are uniform. In but two States or Territories—Nevada and Utah—do the decreased prices exceed the increased prices. Elsewhere the contrary is the case, and the proportional excess of increased prices is very large as a rule. Of course it must be remembered that the number of quotations with which we are dealing is comparatively small.

TABLE 3.—*Comparison of farm prices of agricultural products in September, 1891, with those of June, July, August, 1890, in each State.*

States and Territories.	No. of articles.	Prices in September, 1891.			Percentages.			Excess of—	
		Uniform.	Greater.	Less.	Uniform.	Greater	Less.	Increase.	Decrease.
Alabama	11	......	8	3	......	72.73	27.27	45.46	....
Arizona	8	1	4	3	12.50	50.00	12.50	12.50	....
Arkansas	10	......	6	4	......	60.00	40.00	20.00	....
California	10	......	9	1	......	90.00	10.00	80.00	....
Colorado	11	......	8	3	......	72.73	27.27	45.46	....
Connecticut	10	......	8	2	......	80.00	20.00	60.00	....
Delaware	9	1	7	1	11.11	77.78	11.11	66.67	....
Florida	7	2	4	1	28.57	57.14	14.29	42.85	....
Georgia	10	......	7	3	......	70.00	30.00	40.00	....
Idaho	6	......	5	1	......	83.33	16.67	66.66	....
Illinois	10	1	8	1	10.00	80.00	10.00	70.00	....
Indiana	10	......	9	1	......	90.00	10.00	80.00	....
Iowa	12	......	9	3	......	75.00	25.00	50.00	....
Kansas	11	......	9	2	......	81.82	18.18	63.64	....
Kentucky	10	......	8	2	......	80.00	20.00	60.00	....
Louisiana	7	......	5	2	......	71.43	28.57	42.86	....
Maine	8	......	6	2	......	75.00	25.00	50.00	....
Maryland	10	1	6	3	10.00	60.00	30.00	30.00	....
Massachusetts	8	......	6	2	......	75.00	25.00	50.00	....
Michigan	11	......	8	3	......	72.73	27.27	45.46	....
Minnesota	12	......	8	4	......	66.67	33.33	33.34	....
Mississippi	11	1	6	4	9.09	54.55	36.36	18.19	....
Missouri	10	......	9	1	......	90.00	10.00	80.00	....
Montana	5	2	2	1	40.00	40.00	20.00	20.00	....
Nebraska	12	1	9	2	8.33	75.00	16.67	58.83	....
Nevada	5	4	....	1	80.00	....	20.00	....	20.00
New Hampshire	9	......	6	3	......	66.67	33.33	33.34	....
New Jersey	10	......	8	2	......	80.00	20.00	60.00	....
New Mexico	9	......	8	1	......	88.89	11.11	77.78	....
New York	11	......	9	2	......	81.82	18.18	63.64	....
North Carolina	10	......	7	3	......	70.00	30.00	40.00	....
North Dakota	12	......	6	6	......	50.00	50.00	....	....
Ohio	10	......	9	1	......	90.00	10.00	80.00	....
Oregon	11	......	9	2	......	81.82	18.18	63.64	....
Pennsylvania	10	......	8	2	......	80.00	20.00	60.00	....
Rhode Island	9	......	6	3	......	66.67	33.33	33.34	....
South Carolina	10	......	8	2	......	80.00	20.00	60.00	....
South Dakota	12	......	6	6	......	50.00	50.00	....	....
Tennessee	10	......	8	2	......	80.00	20.00	60.00	....
Texas	9	......	8	1	......	88.89	11.00	77.78	....
Utah	7	......	3	4	......	42.86	57.14	....	14.28
Vermont	10	......	7	3	......	70.00	30.00	40.00	....
Virginia	11	......	8	3	......	72.73	27.27	45.46	....
Washington	11	......	7	4	......	63.64	36.36	27.28	....
West Virginia	10	......	8	2	......	80.00	20.00	60.00	....
Wisconsin	11	......	11	....	......	100.00	....	100.00	....
Wyoming	7	......	4	3	......	57.14	42.86	14.28	....

If we seek to ascertain the influence of locality upon the changes which have occurred in these agricultural prices we may make a comparison of the different sections, as found in Table 4. An examination of this table shows that there is no section in which the decreased prices exceed the increased. There are only 3.09 per cent of the prices which remain uniform, 72.41 per cent which increase, and 24.50 per cent which decrease; or an average excess of increased prices over decreased prices as much as 47.91 per cent. Much the same proportions are observed in the different sections. It is to be noted that in the Gulf States, where the general average is naturally depressed by cotton, the proportion of decreased prices is about the same as in the Pacific slope States, but the excess of increased prices over decreased prices is smallest in the last-named group.

TABLE 4.—*Comparison of farm prices of agricultural products in September, 1891, with June, July, and August, 1890, in each State.*

States.	No. of articles.	Prices in September, 1891.			Percentages.			Excess of—	
		Uniform.	Greater.	Less.	Uniform.	Greater.	Less.	Increase.	Decrease.
North Atlantic States	85	......	64	21	......	75.29	24.71	50.58	....
South Atlantic States	67	4	47	16	5.97	70.15	23.88	46.27	....
Northern Central States	123	2	92	29	1.63	74.79	23.58	51.21	....
Southern Central States	50	......	39	11	......	78.00	22.00	56.00	....
Gulf States	38	1	27	10	2.63	71.05	26.32	44.73	....
Pacific slope States	90	7	59	24	7.78	65.56	26.66	38.90	....
Total	453	14	328	111	3.09	72.41	24.50	47.91	....

If we consider now the course of the price variations in the individual articles, as shown in Table 1, we shall observe a much greater range of variation than in prices or wages heretofore considered. Thus, barley varies from 98.77 in June, 1889, to 146.54 in May, 1891; butter, from 97.66 in July, 1890, to 141.53 in February, 1891. Corn shows an even wider range of variation—from 89.41 in December, 1889, to 165.58 in May, 1891. Even in cotton, where the general tendency is to decline, the range of variation is from 106.75 in July, 1889, to 73.10 in August, 1891. A similar wide range is found in the other articles on the table.

In accordance with the plan already followed in regard to prices and wages, an effort has been made to consolidate relative prices, as shown in the table, in such way as to show the relative increase or decrease in the prices paid for farm products throughout the country. The results of this combination are given in Table 5. The first series consists of a simple average of the quotations for the four cereals which have been collected. It is to be compared, as a test of methods, with the second series, in which the cereals are combined according to the importance of each in the crop of the year 1891. The value of the cereal crop was, approximately, $1,651,000,000, to which corn contributed one-half, wheat three-tenths, oats three-twentieths, and barley one-twentieth. These proportions have been used in combining the relative prices of these four cereals in the formation of the second series, in Table 5. A comparison will show that the prices, according to the second series, are somewhat in advance of those in the first series, a result to be attributed to the greater importance which corn plays in the second series. The third series, for meats, is simply an average of the four different kinds quoted. No approximation of their relative importance could be obtained which would have been of any service in giving to each of the four articles an appropriate weight in forming a general statement. The fourth series is a combination for all of the products included in the schedule, except flaxseed, which was in the aggregate value so inconsiderable that it may be disregarded. The value of meat products was placed, approximately, at $900,000,000; that of cotton, at $300,000,000; that of butter and eggs, each, at $200,000,000, and that of potatoes, at $100,000,000. These figures, which do not pretend to be absolutely accurate, are sufficiently near the actual facts for the product of the year 1891 to give proportions which may be properly used in the calculations which we have made.

TABLE 5.—*Agricultural prices—relative prices of various groups in each month.*

Date.	Cereals, simple average	Cereals, average according to importance.	Meats, simple average	All products, except flaxseed, average according to importance.	Date.	Cereals, simple average	Cereals, average according to importance.	Meats, simple average	All products, except flaxseed, average according to importance.
1889.					1890.				
June	99.96	99.84	101.24	100.07	August	114.87	116.02	100.25	109.94
July	100.44	100.35	100.23	100.22	September	121.24	120.73	99.10	112.41
August	99.62	99.88	93.54	99.75	October	124.25	122.52	98.49	114.05
September	97.85	97.82	97.12	99.39	November	128.04	125.21	99.00	116.86
October	96.15	94.84	96.76	98.87	December	130.55	127.64	99.79	119.80
November	95.59	93.66	97.07	99.60	1891.				
December	95.98	93.85	98.06	101.58	January	134.78	132.18	104.94	124.18
1890.					February	137.96	135.55	107.04	125.86
January	98.33	95.56	101.94	103.51	March	143.01	141.12	109.41	127.78
February	99.21	96.38	104.27	104.11	April	150.93	151.07	111.76	132.11
March	100.57	97.51	106.04	104.34	May	152.98	153.79	111.88	131.80
April	102.12	100.29	107.93	105.36	June	146.14	146.28	109.07	126.28
May	106.61	105.63	107.69	106.92	July	139.42	140.77	106.31	122.17
June	108.18	108.01	104.55	106.81	August	132.81	137.15	105.25	119.17
July	109.46	109.24	101.92	106.80	September	128.89	133.59	104.14	118.23

This table shows a general increase in the price of cereals of about 33 per cent, a slight increase in the price of meat products, and in agricultural prices as a whole an increase of something over 18 per cent. If we consider the course of prices as shown by these series we shall observe that the maximum price for cereals is found in the spring of the year 1891, and that the same holds good for the meat products and for agricultural prices as a whole. While in each case the price declined in the summer months of that year, it should be observed that it ranges higher in all three cases than in the corresponding months of the years 1890 and 1889. These facts will be brought out with greater clearness in Table 6, which gives for cereals and for agricultural prices, as a whole, the average price in the last quarter of 1889 and each succeeding quarter. Throughout the year 1891 it will be noticed that prices range considerably higher, both for cereals and agricultural products as a whole, than in the year 1890, and this is especially marked if we compare the different quarters of 1891, which are represented with the corresponding quarters of the year 1890.

TABLE 6.—*Course of agricultural prices by quarter years.*

Period.	Cereals averaged according to importance.	All products except flaxseed averaged according to importance.
Last quarter 1889	94.12	100.10
First quarter 1890	96.48	103.99
Second quarter 1890	104.64	106.35
Third quarter 1890	115.33	110.01
Fourth quarter 1890	125.12	117.46
First quarter 1891	136.28	126.53
Second quarter 1891	150.38	130.66
Third quarter 1891	137.17	120.31
First three quarters 1890	105.48	106.78
First three quarters 1891	141.28	125.80

WHEAT-GROWING IN INDIA.

The cultivation of wheat in India is relatively small, and is not increasing. The English occupancy of the Empire has rendered necessary a supply for the English population, and the wants of Europe have stimulated exportation of a surplus of 10 to 15 per cent of the product. The supply is not sufficient to furnish a bushel to each inhabitant of India. The average production for eight years past has been about 248,000,000 bushels.

India is the third country in rank in wheat production, standing in advance of Russia, which is the fourth in production, though second in exportation. France, second in production, is an importer of wheat. From this it is seen that no country, except the United States and Russia, cuts a very large figure in exportation. While the former stands far in the front in the *quantity* of surplus, the latter is preëminent in *proportion* of crop exported. From this it may be correctly inferred that the rule of nations is a full bread supply, with only two or three prominent exceptions of surplus, and scarcely more of extreme deficiency. It is a good rule, which the United States will follow more closely by and by.

The following figures are derived from the "Final Memoranda on the Wheat Crop of India," issued by the "Revenue and Agricultural Department" of India:

Years.	Area.	Product.	
	Acres.	*Tons.*	*Bushels of 60 lbs.*
1881-'85	27,820,223	8,013,096	299,155,584
1885-'86	27,405,742	6,919,222	258,317,622
1886-'87	26,735,484	6,390,695	238,585,947
1887-'88	26,854,882	7,148,628	266,882,112
1888-'89	25,911,700	6,362,200	237,522,133
1889-'90	24,773,000	6,123,000	228,592,000
1890-'91	26,424,000	6,842,000	235,434,667
	26,560,719	....	254,927,152

Twenty, even forty years ago, estimates of highest authority made the normal area of wheat 26,000,000 acres. After the reserves began to be exported, and railway extension had progressed in the wheat-growing districts, there was some increase of area, which culminated in 1884-'85 in a breadth of 27,820,223 acres, as officially reported. In 1885 a slight decline was manifest, and in five years a fall of 3,047,223 acres was indicated, the area being 24,773,000 acres. This area, as well as that of the preceding year, was abnormal, however, the result of drought and impacted soils, which prevented seeding. The following year the breadth rose to 26,424,000 acres, very near to the average of seven years, 26,560,719 acres. Thus we see that under the impetus of the world's demand, which was so urgent just prior to 1880, there was an extension of about 2,000,000 acres, which began to contract immediately as prices declined, until the average since the highest point was reached is only a fraction of a million acres above the normal area of a quarter of a century ago.

The commercial papers, during that short period of extension of wheat culture in India, were full of predictions of continued enlargement of area and destructive competition with wheat-growers of this country. The Statistician saw precisely the cause and source of this disturbance of India's agricultural conservatism, and predicted a prompt decline in the breadth of wheat, which followed at once, as seen above. The average product of seven years, since 1884, is only 254,927,152 bushels, and the crop of last year was 203,168,000 bushels, making the average of eight years past only 248,457,258 bushels. Only twice in this period, in 1888 and 1891, has the steadily downward tendency of production been checked since its culmination in 1884-'85.

Our exports of the fiscal year ended in June, 1892, were greater than the crop of India the same year.

THE GRAIN SURPLUS.

There are some considerations relative to the grain surplus that have an important bearing upon the future of American agriculture. In fifty years, a period of remarkable advance in population, in which the increase has been from 17,069,453, in 1840, to 62,622,250 in 1890, the per capita supply has been doubled, and the country placed far in the lead of the nearest national competition. Indeed, the crop of 1891 was much larger than the average production of both France and India together.

Will the present rate of supply of wheat be kept up? It is very probable that the supply per unit of population will not very long be maintained; not because there is not land enough unbroken, or skill enough, under sufficient inducement, to increase the rate of yield of old lands, but because it would produce a surplus that would depress the market and make its cultivation impracticable. The increased productivity of the wheat breadth of 1891 made up the deficiency elsewhere, and advanced the aggregate of the world somewhat beyond the average. As an economic policy, under normal conditions, the exportation of grain in bulk is not to be advised, especially in a country of advanced industrial progress, skill, and intelligence. Such a people can do better than to export fertility and deplete the soil, expending a large fraction of the initial value of every bushel in its transportation. The practice arises from peculiar circumstances, and is a temporary expedient. The wheat lands of the Western prairies and more distant plains were taken for their future value as an investment, only incidentally as a home, and they were cultivated extensively because of the need of money for land and buildings and implements, and in wheat because of the little labor required in a shallow breaking of the thin sod, and in harvesting the crop by machinery. The practice will continue while cheap lands remain unbroken, and will be succeeded by rural diversification, as it has been lately in eastern Minnesota by dairying and stock-growing, and earlier in Wisconsin and Illinois.

The practical sense of the people is gradually working toward the abandonment of the exportation of grain in its primitive form. Secondary products are gradually increasing in proportion of foreign shipments. Fifty years ago, when railway mileage was small, and transportation difficult and expensive, wheat was sent abroad mostly in the form of flour, and not until after 1860 did grain in bulk exceed the exports in the form of flour, simply from necessity, from sudden and heavy increase of demand, lack of milling facilities and increase of the flour trade. The introduction of the roller mill improvements has pushed American milling to a high point, if not to the very apex of milling development, and the trade has become so advanced that in the first half of the present fiscal year within a fraction of 40,000,000 bushels of wheat, or 38 per cent of the exports, represent the proportion shipped after manufacture. The enterprise of the millers will doubtless enlarge this proportion. It would be wise to manufacture all wheat exported, to keep the valuable offal in the country for feeding purposes in the increase of meat supplies and fertilizers. At present there is a sharp contention between domestic and foreign millers for the emoluments of this important industry.

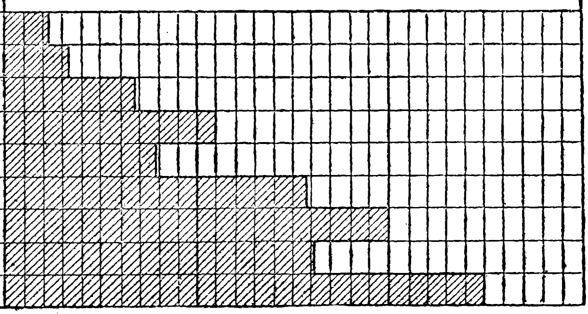
In connection with this question of surplus comes the necessity of regarding the statistical position of wheat—the production and stocks of the world. The idea has been inculcated of late, in behalf of wheat-growers, that prices can be put up by the fiat of imperious will, in defiance of the law of supply and demand; and hence arose an organized effort, last year, in the face of the largest product ever grown in any country to delay distribution under the advice, "hold your wheat." It was believed by some that it might be possible by such means to force prices to $2 per bushel. It was believed by many, who paid for their credulity in heavy losses. Wheat was held back, and from the nooks and corners of the earth, including the remnants of reserves in unheard of places, came forth grain to supply the assumed deficiency, which was really a surplus, as the loss in Europe was more than made good by the gain in America. Some of these advisers attested their honesty and atoned for their miscalculation by suffering with other producers. This office gave the necessary information, which was disregarded, while distribution was checked until supplies from other sources began to reduce prices, and then came a rush to unload farmers' reserves, elevators were crammed, and wheat trains side-tracked, depressing prices still further, until the lowest rates ever known were quoted in Liverpool, and still lower prices in vogue here. The disastrous result extended into the present year, the surplus helping to swell the crop of 1892 and make visible stocks larger than ever before.

The fatal error of suppressing crop statistics, or manipulating or misinterpreting them as a price tonic, has had an expensive object lesson. Farmers can only deceive themselves by attempting to deceive the commercial world in the matter of crop production. They need to know the truth and can not be harmed by its proclamation, but usually will be by its suppression.

The gradual enlargement of our surplus of wheat is shown by the following diagram representing, in periods of five years ended on the 30th of June of the year named, the exports of wheat, including that shipped in the form of flour:

Period ended	Average Annual Export Bushels.
1855	16,438,909.
1860	23,539,983.
1865	47,456,015.
1870	77,816,458.
1875	61,601,559.
1880	109,262,964.
1885	140,025,954.
1890	113,205,463.
1893	174,826,242.

Scale: one-tenth inch equals 7,000,000 bushels



The last line of the diagram represents two years and a half instead of five, from July 1, 1890, to January 1, 1893, the figures showing the annual average. It is seen that the progress of exportation has been steadily onward, with a decline in only two periods—that ended in 1875 and that ended in 1890. It would require a reduction for the other half of this quinquennial (ended in 1895) of much more than 50 per cent to displace the rank as the largest five years' surplus in the history of the foreign wheat trade. A decline in exportation may occur, but the fact does not foreshadow its early extinction.

FARM ANIMALS.

NUMBERS.

The interest in horse-breeding continues, and numbers are increasing. The competition of the West is not so much felt in the Atlantic States in horse-raising as in cattle-growing. It is claimed by our State agent in New York that the soil, grass, and water of New York produce horses of stronger bone, sounder feet, and harder muscle than the alkaline soil on which so many Western horses are reared; and that attention is given to the breeding of a finer class of horses for road and carriage purposes. This claim, however, is not admitted by those interested in horse-breeding in the West. Improvement in numbers and quality of horses is reported in Virginia. The introduction of Hambletonian and other strains of thoroughbred blood has been of great advantage in North Carolina. In the cotton States, especially the Gulf States east of Texas, the rule has been to purchase from Tennessee or Kentucky, in preference to raising horses, but there are signs of some change in this respect.

It is gratifying to note the reported tendency in Texas to improvement through better breeds. Kentucky shows no tendency to reduction of numbers, though prices are not satisfactory. Throughout the Ohio Valley there is little change in numbers of horses. Horse-raising in Iowa is less absorbing as a rural enterprise than it has been, except as to trotting stock. There is ready sale for well-bred horses in Missouri, at a good price, and increasing tendency to improvement in quality. In Kansas the supply is greater than the demand, except for desirable draft horses. A strong tendency to increase the stock of horses is apparent on the Pacific coast, and especially in California.

There appears but little change in numbers of milch cows, a slight decline being reported in some States and a small increase in others, especially in the districts of enlarging population in the distant West. There is less fluctuation in this class of farm animals than in any other, as the milk supply must be kept up and ample provision made for the relatively uniform requirements of butter and cheese factories. A steady increase has been apparent in the past, which will continue as population advances.

There is a decrease in the number of store cattle. The scarcity of feed in Virginia induced farmers to sell off feeding bullocks closely. The no-fence law in some of the Southern States has caused a reduction of numbers, the more worthless of the old stock having been sacrifieed to the manifest improvement of the existing herds. The low price of cattle in the ranch regions, and the discouragement after long waiting for a rise, has tended to reduce the numbers of cattle. In some States there has been a reduction made, after investigation covering the changes of recent years, from the estimates of last year. It was hoped that the results of the national census of 1890 would be available in the comparison and revision of data collected, but up to the date of issue of this report it is not at hand, nothing having been received, excepting a statement of farm animals on ranges, which is not an enumeration, but the result of local estimates, and therefore differing little from our own substitute for a true census.

The increase in numbers of sheep continues, as a result of a progressive advance in prices for four years past, being, as estimated, 2,335,188 in the past year. There has been an increase in Virginia and South

Carolina, and in the Western States, as a rule. There is a tendency to enlargement of the proportion of mutton sheep east of the Missouri River.

The increase of numbers of swine in 1891 was followed by a heavy misfortune in the reduction of the proportion of young pigs raised. The excessively wet weather of spring caused the loss of an unusual proportion of the natural increase. It was early seen that numbers would be considerably reduced. In September our report showed a decrease in the number of fattening swine, though the earlier spring pigs were forced into fattening to supply the deficiency, and many of the breeders were sacrificed to meet the growing demands of the packing trade. These animals are so prolific, and their average term of life so short, that extreme fluctuations are liable to occur; but while the decline has been sudden and heavy, the recuperation may be equally rapid under the influence of increased values.

The numbers at present are thus compared with those of last year:

Stock.	1892.	1893.	Increase or decrease.
Horses	15,498,140	16,206,802	+ 708,662
Mules	2,314,699	2,331,128	+ 16,429
Milch cows	16,416,351	16,424,087	+ 7,736
Oxen and other cattle	37,651,239	35,954,196	—1,697,043
Sheep	44,938,365	47,273,553	+2,335,188
Swine	52,398,019	46,094,807	—6,303,212

The heavy reduction in the numbers of swine makes the grand aggregate of farm animals less than last year. Except as to swine there is increase in the aggregate of more than a million animals. In many cases the growers of cattle have transferred their interest to horses. A tendency to improvement in quality is active, increasing intrinsic value and possibilities of future success.

VALUES.

The increase in the supply of horses has been attended by a reduction in their average price of $3.75 per head, while the decline in the value of mules has been $4.87. All other farm animals have advanced in value, store cattle least and hogs most. In the case of cattle it seems to be the beginning of an advance, which promises still higher values for growers, in sympathy with the rise in prices of beeves ready for slaughter. The average farm value of sheep has advanced 39 per cent since 1889. The increase in the value of swine has been 39 per cent in a single year, the result of a change from apparent plethora to absolute scarcity.

The average value per head for all ages of all classes of animals, as compared with values of 1892, with the increase or decrease, is thus presented:

Stock.	1892.	1893.	Increase or decrease.
Horses	$65.01	$61.22	—$3.79
Mules	75.55	70.68	— 4.87
Milch cows	21.40	21.73	+ .33
Oxen and other cattle	15.16	15.24	+ 08
Sheep	2.58	2.66	+ .08
Swine	4.60	6.41	+ 1.81

The aggregate value of farm animals is greater than a year ago, notwithstanding the reduced numbers, being $2,483,083,249 instead of $2,461,755,678, an increase of $21,327,571. Notwithstanding a reduction in number of swine of 12 per cent, the aggregate value is increased $9,787,994. This is in accordance with the usual rule by which values increase as scarcity is intensified in disproportionate ratio. Often a small crop brings more money than a large one. The following statement gives a comparison of aggregate values of two enumerations:

Stock.	1892.	1893.	Increase or decrease.
Horses	$1,007,593,636	$992,225,185	—$15,368,451
Mules	174,882,070	164,763,751	— 10,118,319
Milch cows	351,378,132	356,876,353	+ 5,498,221
Oxen and other cattle	570,749,155	547,882,204	— 22,866,951
Sheep	116,121,270	125,909,264	+ 9,787,994
Swine	241,031,415	295,426,492	+ 54,395,077
Total	2,461,755,678	2,483,083,249	+ 21,327,571

The advance in beeves for slaughter occurred in 1891, which has been sustained during the past year, as seen by the following figures for Chicago market prices in the first week in January, given in connection with those of sheep and swine:

Price per 100 pounds.

Species and grades.	1892.		1893.	
Cattle:				
Choice shipping	$5.30 to	$6.00	$5.30 to	$6.00
Fair to good	3.75	4.40	3.90	4.60
Sheep:				
Native	3.75	5.40	3.20	5.40
Westerns	3.75	5.10	3.00	5.25
Hogs:				
Rough packing	3.75	3.90	7.00	7.20
Heavy packing	3.95	4.15	7.25	7.55

The increase in swine is very heavy, and is more fully indicated in the following detailed statement, by classes:

Swine.	Jan. 6, 1893.		Jan. 5, 1892.		Feb. 9, 1893.	
Pigs	$5.90 to	$7.10	$3.10 to	$3.75	$5.90 to	$7.75
Light	6.95	7.35	3.70	4.00	7.65	8.25
Rough packing	7.00	7.20	3.70	3.85	8.05	8.25
Mixed	7.05	7.45	3.80	4.00	7.95	8.50
Heavy	7.25	7.55	3.90	4.10	8.30	8.70

Estimated prices of animals on farms and ranches in January, 1893.

States and Territories.	Horses.				Mules.				Milch cows.
	Under 1 year old.	Between 1 and 2 years old.	Between 2 and 3 years old.	Over 3 years old.	Under 1 year old.	Between 1 and 2 years old.	Between 2 and 3 years old.	Over 3 years old.	
Maine	$30.00	$47.50	$69.00	$95.50	....	....	....	....	$24.50
New Hampshire	29.00	45.00	65.60	92.00	....	....	....	....	25.70
Vermont	26.50	42.00	61.00	87.00	....	....	....	....	23.63
Massachusetts	38.00	58.75	86.25	110.00	....	....	....	....	33.00
Rhode Island	38.00	60.75	88.00	108.00	....	....	....	....	30.00
Connecticut	39.50	63.50	90.00	110.00	....	....	....	....	28.00
New York	32.50	55.00	77.50	99.00	$35.00	$50.00	$75.00	$101.00	26.36
New Jersey	42.50	66.00	88.00	108.00	43.00	63.00	91.00	115.00	35.50
Pennsylvania	33.00	55.00	74.07	97.39	35.83	56.00	82.00	106.08	25.75
Delaware	31.00	44.17	65.00	95.00	33.00	50.00	79.00	107.00	24.17
Maryland	30.78	48.31	72.00	95.00	35.50	59.00	87.92	115.00	26.15
Virginia	28.41	45.00	66.00	85.50	33.23	52.01	79.04	97.00	20.00
North Carolina	31.43	49.11	71.90	90.86	36.42	56.21	82.00	102.32	16.50
South Carolina	32.20	52.00	72.64	95.00	36.00	55.44	84.38	105.00	20.00
Georgia	30.61	48.11	73.11	95.93	33.75	52.46	84.00	105.00	18.10
Florida	25.00	36.00	55.00	82.00	27.00	46.00	71.00	104.00	16.00
Alabama	27.00	41.00	58,00	78.00	32.05	48.00	72.00	92.00	14.25
Mississippi	22.00	32.50	47.00	70.00	26.04	42.00	60.00	85.00	13.50
Louisiana	17.00	24.00	40.00	65.00	24.00	40.00	57.00	90.00	18.00
Texas	13.00	19.03	27.22	37.48	21.60	33.00	44.14	62.00	14.50
Arkansas	21.00	30.00	44.41	65.00	28.47	40.92	59.87	77.77	11.50
Tennessee	32.00	48.00	64.00	80.00	35.42	52.00	70.00	87.27	16.15
West Virginia	26.00	39.00	59.00	79.00	29.64	48.00	66.00	88.00	20.25
Kentucky	33.02	50.00	68.00	87.50	36.00	52.00	73.00	91.00	21.50
Ohio	30.00	47.00	69.00	88.00	33.00	49.00	70.00	90.00	25.95
Michigan	31.58	49.44	72.41	96.82	32.00	50.00	71.00	95.00	27.50
Indiana	32.00	47.00	70.00	90.00	35.00	50.00	71.00	88.00	24.50
Illinois	28.68	45.00	65.00	85.00	32.72	46.77	66.75	86.00	23.00
Wisconsin	29.06	45.86	65.20	93.88	29.31	42.50	65.10	92.00	22.91
Minnesota	29.43	45.24	66.66	95.00	31.00	47.94	72.53	95.00	19.50
Iowa	26.00	39.00	55.00	80.00	27.52	40.73	59.00	81.74	21.00
Missouri	24.52	35.67	49.00	67.00	31.19	44.34	61.00	78.58	17.00
Kansas	23.77	34.88	49.38	68.00	28.47	41.77	57.54	79.16	18.50
Nebraska	22.00	33.50	50.00	72.50	27.38	40.39	61.18	82.48	18.50
South Dakota	27.00	40.00	58.00	83.00	30.44	44.17	61.00	85.00	17.75
North Dakota	29.00	44.42	62.00	90.00	33.75	47.00	69.00	98.00	20.50
Montana	16.00	22.00	31.00	43.42	18.33	26.67	45.00	63.75	28.50
Wyoming	14.00	20.00	30.00	41.00	22.00	35.00	50.00	72.00	30.00
Colorado	16.60	25.07	37.00	55.00	23.00	35.00	52.00	76.00	25.50
New Mexico	9.00	15.00	21.00	30.00	13.00	23.50	34.00	47.50	20.00
Arizona	12.50	20.50	31.00	42.50	10.00	18.00	26.00	35.00	20.10
Utah	14,00	22.00	34.00	48.00	17.00	27.00	40.00	65.00	24.00
Nevada	15.00	23.00	34.00	55.00	15.00	31.67	45.00	75.00	30.00
Idaho	14.00	22.00	32.33	41.17	20.50	28.00	40.00	53.00	25.00
Washington	26.50	38.57	60.00	77.06	24.00	36.00	56.00	75.00	33.00
Oregon	20.00	30.00	42.00	65.00	21.46	32.00	50.00	73.00	24.00
California	21.00	32.00	48.00	75.00	26.00	40.00	60.00	87.00	27.25
General average	25.98	39.58	56.80	78.62	31.20	46.00	65.64	87.40	21.75

Estimated prices of animals on farms and ranches in January, 1893—Continued.

States and Territories.	Oxen and other cattle.				Sheep.		Hogs.	
	Under 1 year old.	Between 1 and 2 years old.	Between 2 and 3 years old.	Over 3 years old.	Under 1 year old.	Over 1 year old.	Under 1 year old.	Over 1 year old.
Maine	$8.25	$13.00	$18.75	$32.00	$2.40	$2.89	$8.50	$16.75
New Hampshire	7.50	12.00	18.20	30.50	2.50	3.10	8.31	16.00
Vermont	7.00	11.50	17.50	30.00	3.07	3.86	8.00	16.25
Massachusetts	9.50	15.00	23.00	35.00	3.60	4.50	8.75	17.00
Rhode Island	9.00	14.50	22.50	33.50	3.58	4.42	8.50	15.75
Connecticut	10.79	16.57	25.29	36.86	3.35	4.25	8.50	16.75
New York	9.00	15.29	24.37	34.42	3.25	4.00	7.00	13.50
New Jersey	12.00	18.00	28.18	37.09	3.60	4.40	9.21	15.82
Pennsylvania	8.84	14.85	22.20	31.65	3.15	3.95	7.03	13.45
Delaware	7.75	13.00	20.00	27.50	3.25	3.75	6.00	11.00
Maryland	8.50	14.00	20.88	30.50	3.50	4.15	5.25	10.77
Virginia	6.50	10.81	16.61	22.88	2.50	3.20	3.07	6.50
North Carolina	4.50	7.38	11.61	15.36	1.20	1.80	2.75	6.25
South Carolina	5.75	8.00	12.02	17.00	1.55	2.05	3.14	7.00
Georgia	4.29	6.59	9.65	13.24	1.30	1.95	2.59	5.17
Florida	4.21	5.90	8.85	12.50	1.35	2.10	1.75	3.85
Alabama	4.00	5.83	8.55	12.19	1.10	1.70	2.28	4.93
Mississippi	3.14	4.63	7.23	10.80	1.10	1.65	2.20	4.70
Louisiana	4.69	6.92	9.55	14.21	1.09	1.75	2.18	5.19
Texas	4.50	6.51	9.36	12.71	1.08	1.83	2.70	5.60
Arkansas	3.50	4.90	7.75	12.00	1.15	1.68	2.00	4.50
Tennessee	4.25	7.06	11.21	15.88	1.81	2.50	3.63	7.43
West Virginia	7.75	13.75	22.50	31.90	2.40	3.30	4.22	8.53
Kentucky	7.00	12.08	19.23	27.43	2.70	3.60	4.15	9.00
Ohio	8.97	15.68	24.61	33.41	2.50	3.45	6.00	11.92
Michigan	7.77	14.17	22.12	31.32	2.70	3.70	6.00	11.50
Indiana	8.50	14.02	22.01	30.00	3.10	4.20	6.00	12.00
Illinois	8.00	14.00	22.19	30.00	2.95	4.00	6.25	13.00
Wisconsin	7.00	11.88	18.26	26.00	2.40	3.30	6.30	13.00
Minnesota	6.50	10.49	16.00	25.48	2.25	3.20	5.80	11.87
Iowa	7.81	13.72	21.58	29.00	2.75	4.00	7.00	13.40
Missouri	6.52	11.03	18.00	24.35	2.21	3.09	4.50	9.05
Kansas	6.76	11.82	18.00	24.27	1.85	2.82	6.39	12.00
Nebraska	6.82	11.86	17.92	23.71	1.95	3.00	6.35	11.90
South Dakota	6.45	10.88	17.25	24.25	2.50	3.60	6.20	12.85
North Dakota	7.50	12.00	20.52	27.50	2.38	3.25	5.70	11.46
Montana	8.82	13.73	19.27	26.00	2.10	2.82	7.60	13.75
Wyoming	8.50	12.00	17.00	24.00	2.15	3.00	7.50	12.00
Colorado	6.98	11.00	16.00	24.00	1.80	2.75	6.00	11.00
New Mexico	4.75	8.00	11.00	15.00	1.00	1.75	4.25	9.75
Arizona	5.00	8.00	13.00	16.00	1.50	2.25	4.50	8.25
Utah	5.81	10.25	16.00	21.00	1.87	2.64	7.00	13.00
Nevada	7.67	13.00	17.50	22.00	1.83	2.67	4.60	10.25
Idaho	6.33	11.00	16.00	21.00	2.01	2.50	5.00	10.00
Washington	11.17	17.11	23.00	31.00	2.10	3.20	5.75	11.00
Oregon	6.79	10.59	15.53	22.55	1.70	2.75	3.15	6.60
California	7.48	11.84	19.00	25.00	1.69	2.55	4.50	9.00
General average	6.46	10.81	16.67	22.17	2.07	2.93	5.04	9.51

Estimated number of animals on farms and ranches, total value of each kind, and average price, January, 1893.

States and Territories.	Horses.			Mules.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	111, 051	$79. 84	$8, 865, 781			
New Hampshire	54, 039	77. 73	4, 200, 328			
Vermont	92, 966	68. 33	6, 352, 390			
Massachusetts	65, 109	102, 18	6, 652, 559			
Rhode Island	10, 340	100. 74	1, 041, 622			
Connecticut	45, 313	100. 25	4, 542, 619			
New York	669, 353	84. 26	56, 403, 020	4, 819	$91. 13	$439, 174
New Jersey	87, 706	95. 71	8, 393, 915	8, 380	110. 32	924, 464
Pennsylvania	628, 080	78. 48	49, 289, 469	29, 210	93. 75	2, 738, 294
Delaware	25, 553	80. 22	2, 049, 814	4, 826	101. 85	491, 549
Maryland	133, 685	75. 56	10, 101, 585	13, 622	103. 06	1, 403, 879
Virginia	248, 658	68. 91	17, 135, 626	37, 545	82. 81	3, 109, 067
North Carolina	133, 185	77. 67	10, 344, 475	99, 784	86. 49	8, 630, 310
South Carolina	60, 811	86. 64	5, 268, 668	87, 267	95. 61	8, 343, 293
Georgia	104, 935	81. 60	8, 562, 298	158, 043	93. 08	14, 710, 547
Florida	32, 816	68. 30	2, 241, 349	10, 456	91. 80	959, 850
Alabama	123, 511	66. 03	8, 155, 435	135, 415	80. 64	10, 920, 434
Mississippi	159, 466	59. 54	9, 495, 396	163, 978	75. 36	12, 357, 840
Louisiana	132, 125	52. 01	6, 871, 827	90, 985	79. 90	7, 269, 699
Texas	1, 246, 205	29. 01	36, 151, 400	241, 751	48. 96	11, 835, 587
Arkansas	190, 820	51. 97	9, 916, 082	137, 139	64. 69	8, 871, 887
Tennessee	321, 546	63. 52	20, 424, 624	220, 190	63. 96	14, 084, 257
West Virginia	158, 555	58. 06	9, 205, 705	7, 239	67. 87	491, 275
Kentucky	410, 420	68. 13	27, 963, 224	153, 291	64. 50	9, 887, 255
Ohio	891, 093	68. 74	61, 253, 716	18, 000	75. 24	1, 354, 320
Michigan	530, 294	76. 67	40, 659, 672	3, 783	87. 92	332, 613
Indiana	747, 014	70. 24	52, 470, 278	56, 557	70. 38	3, 980, 497
Illinois	1, 377, 654	65. 03	89, 582, 790	105, 778	68. 07	7, 200, 699
Wisconsin	480, 479	73. 30	35, 219, 199	5, 289	79. 66	421, 324
Minnesota	475, 021	76. 32	36, 255, 007	9, 757	84. 98	829, 130
Iowa	1, 353, 791	61. 34	83, 041, 533	40, 208	66. 90	2, 689, 972
Missouri	988, 589	50. 72	50, 140, 250	249, 348	57. 45	14, 324, 516
Kansas	1, 000, 594	55. 59	55, 626, 845	92, 399	66. 95	6, 186, 220
Nebraska	687, 822	57. 83	39, 776, 734	46, 474	70. 63	3, 282, 531
South Dakota	293, 800	63. 41	18, 629, 858	8, 200	76. 77	629, 546
North Dakota	161, 880	68. 75	11, 128, 775	7, 840	88. 03	690, 137
Montana	206, 862	34. 98	7, 236, 244	1, 243	47. 10	58, 545
Wyoming	97, 087	30. 49	2, 960, 175	1, 368	65. 02	88, 942
Colorado	185, 458	44. 05	8, 169, 880	5, 236	71. 29	373, 250
New Mexico	91, 140	23. 31	2, 124, 474	3, 638	40. 68	147, 976
Arizona	52, 175	30. 00	1, 565, 250	1, 340	50. 00	67, 000
Utah	76, 791	31. 24	2, 398, 948	1, 825	48. 08	87, 748
Nevada	60, 645	40. 00	2, 425, 782	1, 688	52. 93	89, 354
Idaho	192, 917	36. 00	6, 945, 012	1, 053	40. 00	42, 120
Washington	196, 115	59. 58	11, 683, 903	1, 378	67. 50	93, 017
Oregon	294, 509	45. 77	13, 479, 667	4, 755	52. 47	249, 503
California	518, 824	57. 48	29, 821, 982	60, 031	67. 90	4, 076, 130
Total	16, 206, 802	61. 22	992, 225, 185	2, 331, 128	70. 68	164, 763, 751

Estimated number of animals on farms and ranches, etc.—Continued.

States and Territories.	Milch cows.			Oxen and other cattle.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	174,120	$24.50	$4,265,940	145,031	$22.07	$3,201,192
New Hampshire	109,306	25.70	2,809,164	109,292	21.57	2,357,205
Vermont	238,856	23.63	5,644,167	160,717	20.82	3,346,122
Massachusetts	181,770	33.00	5,998,410	92,927	24.66	2,292,036
Rhode Island	24,279	30.00	728,370	11,831	26.85	317,651
Connecticut	134,884	28.00	3,776,752	96,107	28.66	2,754,830
New York	1,556,874	26.36	41,039,199	768,040	26.57	20,410,650
New Jersey	188,846	35.50	6,704,033	61,930	28.64	1,773,961
Pennsylvania	938,382	25.75	24,163,337	793,461	22.05	17,491,915
Delaware	31,330	24.17	757,246	27,941	22.38	625,396
Maryland	149,016	26.15	3,896,768	119,834	21.39	2,562,652
Virginia	279,411	20.00	5,588,220	406,937	16.10	6,551,606
North Carolina	272,073	16.50	4,489,205	382,637	11.14	4,262,191
South Carolina	157,024	20.00	3,140,480	202,085	12.28	2,481,604
Georgia	347,491	18.10	6,289,587	552,124	9.44	5,210,890
Florida	57,166	16.00	914,656	537,115	8.62	4,631,815
Alabama	314,892	14.25	4,487,211	436,107	8.58	3,741,453
Mississippi	309,142	13.50	4,173,417	411,547	7.51	3,092,697
Louisiana	177,560	18.00	3,196,080	289,727	10.09	2,922,217
Texas	816,682	14.50	11,841,889	6,462,536	9.05	58,512,448
Arkansas	338,863	11.50	3,896,925	711,278	8.13	5,782,338
Tennessee	369,999	16.15	5,975,484	460,165	9.76	4,493,008
West Virginia	184,106	20.25	3,728,147	283,501	17.64	5,000,807
Kentucky	313,859	21.50	6,747,969	443,707	17.19	7,628,335
Ohio	767,735	25.95	19,922,723	845,512	22.20	18,767,498
Michigan	464,070	27.50	12,761,925	463,134	20.53	9,506,289
Indiana	663,618	24.50	16,258,641	1,063,531	20.16	21,436,952
Illinois	1,093,812	23.00	25,157,676	1,538,003	19.92	30,639,795
Wisconsin	715,809	22.91	16,399,184	820,236	17.79	14,594,293
Minnesota	571,481	19.50	11,143,880	648,365	16.31	10,393,683
Iowa	1,291,142	21.00	27,113,982	2,704,342	19.34	52,313,344
Missouri	834,937	17.00	14,193,929	1,831,856	15.55	28,479,321
Kansas	727,080	18.50	13,450,980	1,958,735	16.22	31,772,640
Nebraska	525,035	18.50	9,713,148	1,566,236	16.17	25,328,073
South Dakota	223,500	17.75	3,967,125	389,500	16.27	6,335,725
North Dakota	117,250	20.50	2,403,625	255,680	18.59	4,752,725
Montana	36,419	28.50	1,037,942	1,036,227	17.42	18,049,013
Wyoming	17,815	30.00	534,450	774,943	15.40	11,934,118
Colorado	63,437	25.50	1,617,644	830,251	16.90	14,027,924
New Mexico	18,400	20.00	368,000	1,249,537	10.03	12,529,733
Arizona	16,907	21.00	355,047	822,154	15.10	12,414,525
Utah	55,042	24.00	1,321,008	390,649	15.58	5,305,016
Nevada	16,393	30.00	491,790	253,998	15.59	3,960,034
Idaho	30,419	25.00	760,475	417,424	15.50	6,470,072
Washington	101,435	33.00	3,347,355	429,782	22.10	9,496,673
Oregon	107,183	24.00	2,572,392	781,110	15.67	12,238,899
California	299,237	27.25	8,154,208	916,414	17.12	15,690,840
Total	16,424,087	21.75	357,299,785	35,954,196	15.24	547,882,204

Estimated number of animals on farms and ranches, etc.—Continued.

States and Territories.	Sheep.			Hogs.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	398,704	$2.77	$1,103,413	76,918	$10.15	$780,721
New Hampshire	135,848	2.92	396,676	51,147	10.23	523,364
Vermont	329,612	3.64	1,199,392	74,047	10.14	751,205
Massachusetts	53,032	4.28	226,712	65,871	10.73	706,796
Rhode Island	12,260	4.21	51,615	13,617	9.95	135,486
Connecticut	42,479	4.04	171,743	54,329	10.15	551,442
New York	1,492,528	3.81	5,690,263	645,691	8.88	5,736,962
New Jersey	61,246	4.19	256,743	181,020	11.52	2,085,984
Pennsylvania	1,637,216	3.69	6,047,876	1,076,580	8.89	9,572,733
Delaware	13,551	3.62	48,987	52,167	7.00	365,167
Maryland	151,506	3.95	598,222	325,477	7.18	2,337,576
Virginia	498,400	3.00	1,497,194	920,228	4.10	3,772,013
North Carolina	396,115	1.62	641,707	1,259,402	4.05	5,094,282
South Carolina	78,384	1.90	148,929	697,746	4.53	3,160,512
Georgia	432,809	1.77	765,206	1,674,362	3.52	5,891,744
Florida	106,495	1.92	204,471	388,074	2.50	972,514
Alabama	358,158	1.51	542,251	1,484,558	3.21	4,761,719
Mississippi	447,156	1.49	664,027	1,371,485	3.05	4,183,030
Louisiana	191,951	1.55	296,641	767,779	3.38	2,598,165
Texas	4,334,551	1.60	6,924,445	2,344,458	3.86	9,049,608
Arkansas	240,326	1.51	361,714	1,563,322	3.00	4,689,967
Tennessee	541,427	2.27	1,230,285	1,989,741	4.69	9,339,843
West Virginia	841,434	2.99	2,519,253	442,765	5.34	2,364,631
Kentucky	1,237,338	3.29	4,075,792	1,994,277	5.41	10,791,033
Ohio	4,378,725	3.17	13,900,263	2,423,544	7.42	17,984,638
Michigan	2,518,544	3.38	8,512,679	713,630	7.43	5,302,272
Indiana	1,080,383	3.84	4,145,430	2,017,376	7.68	15,493,446
Illinois	1,187,329	3.65	4,337,906	3,720,059	8.14	30,281,284
Wisconsin	1,198,175	3.01	3,608,903	921,018	8.31	7,653,657
Minnesota	499,941	2.90	1,447,829	550,453	7.62	4,195,003
Iowa	791,043	3.60	2,847,755	6,181,628	8.79	54,348,874
Missouri	1,099,948	2.80	3,079,414	4,076,392	5.87	23,908,041
Kansas	389,629	2.50	974,033	2,445,341	7.90	19,329,687
Nebraska	272,502	2.65	723,084	2,198,909	6.02	17,624,258
South Dakota	324,000	3.29	1,066,008	239,250	8.19	1,960,654
North Dakota	390,400	3.01	1,173,699	90,250	7.43	670,378
Montana	2,528,098	2.58	6,528,560	38,616	9.44	364,730
Wyoming	1,198,567	2.75	3,300,255	15,834	8.71	137,993
Colorado	1,231,484	2.52	3,105,803	25,511	7.25	184,956
New Mexico	2,730,082	1.50	4,101,948	24,355	6.45	157,090
Arizona	580,879	2.25	1,306,978	19,536	6.25	122,100
Utah	2,117,577	2.38	5,036,022	47,136	8.86	417,624
Nevada	555,181	2.43	1,347,092	11,363	6.86	77,949
Idaho	764,262	2.50	1,910,655	57,015	7.50	427,613
Washington	823,825	2.83	2,328,130	158,230	7.64	1,208,878
Oregon	2,456,077	2.40	5,903,182	204,609	4.46	912,760
California	4,124,376	2.32	9,559,479	399,691	6.12	2,446,110
Total	47,273,553	2.66	125,909,264	46,094,807	6.41	295,426,492

DISTRIBUTION AND CONSUMPTION.

CORN.

This country produces three-fourths of the production of the world, which averaged about 2,300,000,000 bushels for the decade ended in 1890, and the tendency is to increase, in the proportion that acreage is extended faster in the United States than in other countries. Only 1 bushel in 25 is exported, and the higher the domestic price the less is exported, as the amount shipped per annum has been 100,000,000 bushels when prices were lowest, and less than 2,000,000 when prices were highest. In this country the consumption for food amounts to nearly 200,000,000 bushels. Corn is also used for food in Mexico and in southern Europe, but in other parts of Europe almost exclusively for feed of horses and other animals.

The report for March relates to the distribution of corn and wheat and the stocks remaining on farms. It is not a census of individual holdings of growers, but is based on county estimates of the percentage of last year's product remaining, made by a board of correspondents in each county, also by an independent board reporting to the State agent. All grain, including any surplus of previous years, is included. These separate results are scrutinized, obvious errors and inconsistencies corrected, differences harmonized, and ultimate statements tabulated by States to show both percentages and aggregate quantities.

The aggregate amount already consumed or distributed, as thus estimated, is 1,002,000,000 bushels, which is only five-sixths as much as was reported last March for the crop of 2,060,000,000 bushels. It is more, however, than was returned the year before from the smaller crop of 1890. The following statement is a comparison of the distribution of eight months for each of the past ten years:

	Product of previous year.	On hand March 1.	Per cent.	Consumed or distributed.
	Bushels.	*Bushels.*		*Bushels.*
March—				
1884	1,551,000,000	512,000,000	33.0	1,039,000,000
1885	1,795,000,000	675,000,000	37.6	1,120,000,000
1886	1,936,000,000	773,000,000	39.9	1,163,000,000
1887	1,665,000,000	603,000,000	36.2	1,062,000,000
1888	1,456,000,000	508,000,000	34.9	948,000,000
1889	1,988,000,000	787,000,000	39.6	1,201,000,000
1890	2,113,000,000	970,000,000	45.9	1,143,000,000
1891	1,490,000,000	542,000,000	36.4	948,000,000
1892	2,060,000,000	860,000,000	41.8	1,200,000,000
1893	1,628,000,000	627,000,000	38.5	1,002,000,000

The proportion thus distributed in eight months varies with the size of the crop, while the actual quantity consumed is more uniform. The years of large production show the smaller percentages, the surplus being held to swell the crops following. Thus only 54.1 per cent of the largest crop known, that of 1889, was distributed up to March following, while 67 per cent of the crop of 1883 was required in eight months.

Considered by groups of States or grand divisions of territory, the proportion distributed at this date is always smallest in the South. This year the percentage is 55.3. In the West, the proportion required varies from six-tenths to two-thirds of the product. Following the two years of largest production, 1889 and 1891, still less than 60 per cent was disposed of, a large surplus remaining. In this region the feeding season is well advanced by this date. In the South there is far less corn fed for meat, and much more in the spring and early summer for support of plow teams, of horses, mules, and oxen. These proportions for ten years past are as follows:

Section.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
New England	66.2	62.9	61.6	63.3	65.4	66.5	66.4	67.7	63.8	64.0
Middle	68.2	63.4	59.3	61.8	65.6	62.0	59.9	62.3	58.2	64.1
Southern	58.6	58.6	54.6	58.1	55.5	55.7	53.5	56.0	54.1	55.3
Western	69.3	63.3	61.6	65.7	60.3	61.5	53.8	66.3	59.3	63.2
Mountain region	70.8	68.1	64.5	66.7	72.0	72.5	75.1	74.5	65.5	66.9
Pacific	70.7	60.7	68.6	70.5	78.2	75.1	71.4	73.5	69.7	70.6
Average	67.0	63.4	60.1	63.8	65.1	60.4	54.1	63.6	58.2	61.5

The record of stocks still remaining in farmers' granaries makes an aggregage of 626,847,370 bushels, or 38.5 per cent of the product of last year. Seven-tenths of this amount is found in the Western States 435,731,850 bushels, or 36.8 per cent of the production of that section. The amount and percentage for each of the last four crops at this date by geographical divisions is seen in the following statement:

Section.	1890.		1891.		1892.		1893.	
	Bushels.	Per cent.	Bushels.	Per cent.	Bushels.	Per cent.	Bushels.	Per cent.
New England	2,873,780	33.6	2,709,930	32.3	3,362,910	36.2	2,319,400	36.0
Middle	30,603,350	40.1	26,566,520	37.7	36,007,800	41.8	25,111,000	35.9
Southern	199,408,040	46.5	164,036,740	44.0	199,486,710	45.9	161,678,910	44.7
Western	735,018,380	46.2	346,977,230	33.7	618,851,680	40.7	435,731,850	36.8
Mountain region	713,680	24.9	669,960	25.5	916,240	34.5	1,220,000	33.1
Pacific	1,321,250	28.6	1,212,870	26.5	1,768,610	30.3	786,120	29.4
Total	969,938,480	45.9	542,173,250	36.4	860,393,950	41.8	626,847,370	38.5

But this statement does not make a sufficiently definite showing for commercial purposes, as only seven of the Western States have any material surplus for commercial distribution. These States appear to have about 380,000,000 bushels on hand, against 546,000,000 last year and 667,000,000 three years ago, though two years ago, after a smaller crop than the last, only 290,000,000 bushels remained on hand on the 1st of March. It seems that the largest proportion, 44 per cent, is in Nebraska, with 42 per cent in Iowa. The other States differ little in proportion. The statement, with comparison of four years past, is as follows:

States.	1890.		1891.		1892.		1893.	
	Bushels.	Per cent.	Bushels.	Per cent.	Bushels.	Per cent.	Bushels.	Per cent.
Ohio	37,360,260	42	19,104,040	29	37,636,800	40	29,348,550	35
Indiana	47,995,200	45	24,927,000	28	49,448,800	40	36,166,900	35
Illinois	124,380,000	48	63,731,640	34	100,998,400	43	61,170,990	37
Iowa	167,983,680	48	86,002,430	37	164,912,660	47	84,092,820	42
Missouri	102,855,270	47	63,124,200	36	69,091,400	34	51,846,260	34
Kansas	117,848,920	49	15,475,320	28	45,405,760	32	48,122,250	33
Nebraska	68,789,780	46	17,699,200	32	78,796,440	47	69,143,800	44
Total	667,213,110	47.2	290,063,830	33.7	546,290,260	41.5	379,891,570	37.7

The crop of 1892, together with the stock on hand on the 1st of March and the proportion of the total crop consumed or shipped out of the county for each State, is presented herewith. A striking point in this showing is the relatively small proportion of each crop which ever crosses county lines. The great bulk of our corn, whether the crop be large or small, is used on the farm where grown. The statement is as follows:

States and Territories.	Crop of 1892.	Stock on hand March 1, 1893.		Consumed in county where grown.		Shipped out of county where grown.	
	Bushels.	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
Maine	472, 000	165, 200	35	472, 000	100	....	.....
New Hampshire	957, 000	315, 810	33	957, 000	100	....	.....
Vermont	1, 643, 000	657, 200	40	1, 643, 000	100	....	.....
Massachusetts	1, 550, 000	573, 500	37	1, 550, 000	100	....	.....
Rhode Island	305, 000	106, 750	35	298, 900	98	6, 100	2
Connecticut	1, 518, 000	500, 940	33	1, 502, 820	99	15, 180	1
New York	17, 414, 000	6, 269, 040	36	17, 239, 860	99	174, 140	1
New Jersey	9, 124, 000	3, 649, 600	40	8, 211, 600	90	912, 400	10
Pennsylvania	39, 632, 000	13, 871, 200	35	36, 461, 440	92	3, 170, 560	8
Delaware	3, 775, 000	1, 321, 250	35	2, 378, 250	63	1, 396, 750	37
Maryland	12, 965, 000	4, 797, 050	37	8, 945, 850	69	4, 019, 150	31
Virginia	26, 067, 000	10, 948, 140	42	22, 938, 960	88	3, 128, 040	12
North Carolina	25, 347, 000	11, 913, 090	47	23, 572, 710	93	1, 774, 290	7
South Carolina	16, 713, 000	8, 356, 500	50	16, 044, 480	96	668, 520	4
Georgia	32, 992, 000	17, 155, 840	52	31, 342, 400	95	1, 649, 600	5
Florida	4, 422, 000	2, 211, 000	50	4, 068, 240	92	353, 760	8
Alabama	30, 666, 000	15, 026, 340	49	28, 826, 040	94	1, 839, 960	6
Mississippi	27, 272, 000	13, 636, 000	50	26, 726, 560	98	545, 440	2
Louisiana	15, 859, 000	7, 136, 550	45	15, 541, 820	98	317, 180	2
Texas	73, 642, 000	29, 456, 800	40	67, 014, 220	91	6, 627, 780	9
Arkansas	34, 344, 000	14, 081, 040	41	32, 970, 240	96	1, 373, 760	4
Tennessee	61, 274, 000	26, 960, 560	44	50, 244, 680	82	11, 029, 320	18
West Virginia	14, 322, 000	5, 012, 700	35	13, 462, 680	94	859, 320	6
Kentucky	68, 805, 000	23, 393, 700	34	63, 988, 650	93	4, 816, 350	7
Ohio	83, 853, 000	29, 348, 550	35	67, 082, 400	80	16, 770, 600	20
Michigan	23, 218, 000	6, 036, 680	26	22, 753, 640	98	464, 360	2
Indiana	103, 334, 000	36, 166, 900	35	80, 600, 520	78	22, 733, 480	22
Illinois	165, 327, 000	61, 170, 990	37	127, 301, 790	77	38, 025, 210	23
Wisconsin	27, 347, 000	8, 204, 100	30	26, 800, 060	98	546, 940	2
Minnesota	24, 192, 000	7, 983, 360	33	23, 224, 320	96	967, 680	4
Iowa	200, 221, 000	84, 092, 820	42	162, 179, 010	81	48, 041, 990	19
Missouri	152, 489, 000	51, 846, 260	34	137, 240, 100	90	15, 248, 900	10
Kansas	145, 825, 000	48, 122, 250	33	113, 743, 500	78	32, 081, 500	22
Nebraska	157, 145, 000	69, 143, 800	44	91, 144, 100	58	66, 000, 900	42
South Dakota	17, 706, 000	5, 134, 740	29	16, 643, 640	94	1, 062, 360	6
North Dakota	375, 000	75, 000	20	371, 250	99	3, 250	1
Montana	21, 000	6, 930	33	21, 000	100	....	.....
Wyoming	38, 000	13, 300	35	37, 240	98	760	2
Colorado	2, 773, 000	970, 550	35	2, 606, 620	94	166, 380	6
New Mexico	585, 000	157, 950	27	585, 000	100	....	.....
Arizona	81, 000	20, 250	25	65, 610	81	15, 390	19
Utah	158, 000	45, 820	29	156, 420	99	1, 580	1
Nevada	....	....	20	....	100	....	.....
Idaho	26, 000	5, 200	20	26, 000	100	....	.....
Washington	185, 000	37, 000	20	175, 750	95	9, 250	5
Oregon	288, 000	46, 080	16	276, 480	96	11, 520	4
California	2, 197, 000	703, 040	32	1, 647, 750	75	549, 250	25
Total	1, 628, 464, 000	626, 847, 370	38. 5	1, 351, 084, 600	83	277, 379, 400	17

The following statement indicates the retention for domestic consumption of 305,000,000 bushels less this year than last. The excess of last year, however, has helped to supply the deficiencies of the present crop:

Section.	1892.				1893.			
	Retained for county consumption.		Distribution beyond county lines.		Retained for county consumption.		Distribution beyond county lines.	
	Bushels.	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*	*Bushels.*	*P. ct.*
New England	9, 262, 560	99. 8	21, 440	. 2	6, 423, 720	99. 7	21, 280	. 3
Middle	78, 073, 860	90. 7	7, 981, 140	9. 3	64, 291, 150	91. 9	5, 653, 850	8. 1
Southern	395, 502, 490	91. 1	38, 756, 510	8. 9	328, 236, 200	90. 8	33, 326, 800	9. 2
Western	1, 166, 504, 550	76. 6	355, 561, 450	23. 4	946, 535, 660	79. 9	237, 623, 340	20. 1
Mountain region	2, 584, 360	97. 2	74, 640	2. 8	3, 497, 890	95. 0	184, 110	5. 0
Pacific	4, 549, 670	78. 0	1, 281, 330	22. 0	2, 099, 980	78. 7	570, 020	21. 3
Total	1, 656, 477, 490	80. 4	403, 676, 510	19. 6	1, 351, 084, 600	83. 0	277, 379, 400	17. 0

The proportion of merchantable corn, 82.6 per cent, is less than last year, and under the average of a series of years. It was not injured by frost, but was late and not so well matured as in some other years. The result since 1883 is as follows:

Year.	Merchantable.		Unmerchantable.	
	Bushels.	Per cent.	Bushels.	Per cent.
1884	1,593,332,101	89.0	202,196,331	11.0
1885	1,583,012,860	78.0	353,163,140	22.0
1886	1,438,446,830	86.0	226,994,170	14.0
1887	1,222,166,360	84.0	233,994,640	16.0
1888	1,637,405,930	82.4	350,384,070	17.6
1889	1,810,557,850	85.7	302,334,150	14.3
1890	1,183,794,720	79.5	306,175,280	20.5
1891	1,822,430,570	88.5	237,223,430	11.5
1892	1,345,444,720	82.6	283,019,280	17.4

The statement by States, for the crop of 1892, is as follows:

States and Territories.	Merchantable.				Unmerchantable.			
	Bushels.	Per cent.	Price per bushel.	Value.	Bushels.	Per cent.	Price per bushel.	Value.
Maine	401,200	85	$0.71	$284,852	70,800	15	$0.38	$26,904
New Hampshire	803,880	84	.70	562,716	153,120	16	.35	53,592
Vermont	1,363,690	83	.68	927,309	279,310	17	.38	106,138
Massachusetts	1,302,000	84	.69	898,380	248,000	16	.37	91,760
Rhode Island	259,250	85	.68	176,290	45,750	15	.39	17,843
Connecticut	1,275,120	84	.65	828,828	242,880	16	.35	85,008
New York	13,931,200	80	.61	8,498,032	3,482,800	20	.33	1,149,324
New Jersey	7,846,640	86	.56	4,394,118	1,277,360	14	.35	447,076
Pennsylvania	33,687,200	85	.58	19,538,576	5,944,800	15	.32	1,902,336
Delaware	3,322,000	88	.48	1,594,560	453,000	12	.30	135,900
Maryland	11,279,550	87	.49	5,526,980	1,685,450	13	.30	505,635
Virginia	21,114,270	81	.56	11,823,991	4,952,730	19	.31	1,535,346
North Carolina	21,544,950	85	.63	13,573,319	3,802,050	15	.33	1,254,677
South Carolina	14,373,180	86	.64	9,198,835	2,339,820	14	.35	818,937
Georgia	28,373,120	86	.62	17,591,334	4,618,880	14	.33	1,524,230
Florida	3,714,480	84	.61	2,265,833	707,520	16	.34	240,557
Alabama	25,452,780	83	.60	15,271,668	5,213,220	17	.32	1,668,230
Mississippi	23,726,640	87	.56	13,286,918	3,545,360	13	.33	1,169,969
Louisiana	13,489,150	85	.53	7,144,480	2,378,850	15	.32	761,232
Texas	64,804,960	88	.50	32,402,480	8,837,040	12	.27	2,386,001
Arkansas	28,848,960	84	.52	15,001,459	5,495,040	16	.28	1,538,611
Tennessee	50,857,420	83	.46	23,394,413	10,416,580	17	.30	3,124,974
West Virginia	11,744,040	82	.58	6,811,543	2,577,960	18	.33	850,727
Kentucky	57,796,200	84	.48	27,742,176	11,008,800	16	.26	2,862,288
Ohio	67,920,930	81	.45	30,564,419	15,932,070	19	.29	4,620,300
Michigan	18,110,040	78	.46	8,330,618	5,107,960	22	.30	1,532,388
Indiana	80,600,520	78	.43	34,658,224	22,733,480	22	.29	6,592,709
Illinois	127,301,790	77	.41	52,193,734	38,025,210	23	.28	10,647,059
Wisconsin	20,510,250	75	.43	8,819,408	6,836,750	25	.30	2,051,025
Minnesota	19,595,520	81	.39	7,642,253	4,596,480	19	.28	1,287,014
Iowa	168,185,640	84	.36	60,546,830	32,035,360	16	.27	8,649,547
Missouri	126,565,870	83	.39	49,360,689	25,923,130	17	.27	6,999,245
Kansas	119,576,500	82	.32	38,264,480	26,248,500	18	.23	6,037,155
Nebraska	135,144,700	86	.29	39,191,963	22,000,300	14	.21	4,620,063
South Dakota	15,050,100	85	.37	5,568,537	2,655,900	15	.22	584,298
North Dakota	315,000	84	.43	135,450	60,000	16	.29	17,400
Montana	16,800	80	.75	12,600	4,200	20	.40	1,680
Wyoming	29,640	78	.60	17,784	8,360	22	.40	2,344
Colorado	2,273,860	82	.51	1,159,669	499,140	18	.45	224,613
New Mexico	438,750	75	.78	342,225	146,250	25	.48	70,200
Arizona	61,560	76	.70	43,092	19,440	34	.44	8,554
Utah	113,760	72	.62	70,531	44,240	28	.40	17,696
Idaho	18,200	70	.72	13,104	7,800	30	.38	2,964
Washington	159,100	86	.60	95,460	25,900	14	.37	9,583
Oregon	241,920	84	.58	140,314	46,080	16	.35	16,128
California	1,911,390	87	.57	1,089,492	285,610	13	.33	94,251
Total	1,345,444,720	82.6	42.9	576,999,966	283,019,280	17.4	27.7	78,344,511

VALUE OF THE CROP.

The aggregate value of the crop, as reported on the 1st of December, was $642,146,630 for 1,628,464,000 bushels, or 39.3 cents per bushel. The value of merchantable corn in March is 42.9 cents per bushel, aggregating $576,999,966; the value of unmerchantable, 27.7 cents, or $78,344,511, making a total value of $655,344,477, showing an increase of over $13,000,000, and making the average farm price at this date 40 cents. The export prices, or average prices at seaports, for several years have been as follows:

Year ending June 30—	Price.	Year ending June 30—	Price.
	Cents.		*Cents.*
1879	47.1	1886	49.8
1880	54.3	1887	48.0
1881	55.2	1888	55.0
1882	66.8	1889	47.4
1883	68.4	1890	41.8
1884	61.1	1891	57.4
1885	54.0	1892	55.1

WHEAT.

The estimated proportion of wheat on hand is 26.2 per cent of the last crop, the smallest percentage in ten years. The quantity on hand aggregates 135,000,000 bushels, 36,000,000 bushels less than last March, and 23,000,000 more than the remnant of the very small crop of 1890. A very large proportion is found in States that do not spare a bushel for commercial distribution; only 34,000,000 in the principal spring wheat States, Minnesota, the Dakotas, Nebraska, and Iowa, more than half of which is required for seed in the spring. Of the winter wheat States only Kansas and California have any considerable surplus available for commercial distribution. In the four States of the Ohio Valley there are only 31,000,000 bushels, scarcely enough for consumption of local mills for home use. It is never realized in the great grain markets that the South, Middle and Eastern States, and mountain areas are buyers and not sellers of grain, and that at least thirty-two States and some Territories, always holding some wheat supplies, never contribute to the needs of other States and other countries, but instead draw upon the stocks of grain markets to eke out the requirements of home consumption. Another fact is not sufficiently considered, that after a full crop the invisible reserves are necessarily larger, more grain is absorbed in almost inappreciable and practically unavailable remnants in farm granaries than after the smaller crops. The result is commercially deceptive, as expected receipts are never immediately realized. Reserves now are all the smaller for the disastrous experience of last year, when grain was systematically withheld, through ill-advised counsel, from a crop the largest ever known in the world's history of wheat-growing, giving opportunity for search in all corners of the earth for required supplies, and insuring precipitate fall of prices on the recurrence and increased momentum of the movement. This season's free movement has naturally followed the heavy losses and bitter experience of last year.

Comparing apparent supply of the past year with distribution, on the basis of former estimates of consumption ($4\frac{2}{3}$ bushels per head) for the average population of twelve months past, say 65,200,000 people, we find that apparent reserves aggregated 728,000,000 bushels, and the distribution and estimated reserves 763,000,000 bushels, an excess of 35,000,000 bushels. The discrepancy heretofore has been so small that some commercial writers have really reached the absurd conclusion that no investigation has been made, but that the farmer's reserves are assumed as the difference between supplies and consumption at a fixed rate per head, including the actual exportation. The discrepancy is either from overestimate of reserves by our correspondents or underestimate of the last two crops, from which these reserves come. It may be partly from both. If from underestimate, it is more largely from the crop of 1891, and means that these two crops were about 3 per cent larger than the estimates, and would afford further proof that our crops are not officially overestimated. Yet the figures are remarkably close, either for estimates or official enumerations, and they furnish strong and satisfactory evidence of the approximate accuracy of the results of our statistical methods.

	Distribution.	Supply.
	Bushels.	*Bushels.*
Visible supply, Mar. 1, 1892		41,000,000
In farmers' hands, Mar. 1, 1892		171,000,000
Crop of 1892		516,000,000
Consumption, twelve months	304,000,000	
Seed, spring and fall	54,000,000	
Exported Mar. 1, 1892, to Mar. 1, 1893	191,000,000	
Visible supply Mar. 1, 1893	79,000,000	
In farmers' hands, Mar. 1, 1893	135,000,000	
Total	763,000,000	728,000,000

The following table shows the quantity and proportion of wheat in the hands of farmers on the 1st of March of each year since 1881:

Year.	Crops of previous years.	In farmers' hands Mar. 1.		Year.	Crops of previous years.	In farmers' hands Mar. 1.	
	Bushels.	*Bushels.*	*Per ct.*		*Bushels.*	*Bushels.*	*Per ct.*
1893	515,949,000	135,000,000	26.2	1887	457,218,000	122,000,000	26.7
1892	611,780,000	171,000,000	28.0	1886	357,112,000	107,600,000	30.1
1891	399,262,000	112,000,000	28.2	1885	512,765,000	169,000,000	33.0
1890	490,560,000	156,000,000	31.9	1884	421,086,160	119,000,000	28.3
1889	415,868,000	112,000,000	26.9	1883	504,185,470	143,000,000	28.4
1888	456,329,000	132,000,000	28.9	1882	383,280,090	98,000,000	25.6

The following table presents a remarkable showing of distribution in comparison with official estimates, made each year months before the sum of exportation could be known. The aggregate of these estimates is 5,009 million bushels. From this has been sent to foreign countries, as grain and flour, about 1,412 million bushels; the seed used has been 593 million bushels, and the consumption, on the basis stated, 2,994 million bushels, making a total of about 4,999 million bushels, accounting for all within a fraction of a million bushels per annum, without including wheat burned or lost on the lakes, or that used for spirits, or the considerable surplus that remained at the end of June, 1892, which must certainly have been as much as 50,000,000 bushels greater than the reduced supply on hand at the beginning of the period, July 1, 1881, showing that the estimates, though close, were less than the wheat actually accounted for.

Year.	Production.	For food.	For seed.	Exportation.	Total distributed.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1881	383, 280, 090	243, 000, 000	55, 215, 573	121, 892, 389	420, 107, 962
1882	504, 185, 470	250, 000, 000	52, 770, 312	147, 811, 316	450, 581, 628
1883	421, 086, 160	256, 000, 000	54, 683, 389	111, 534, 182	422, 217, 571
1884	512, 765, 000	261, 000, 000	55, 266, 239	132, 570, 367	448, 836, 606
1885	357, 112, 000	267, 000, 000	51, 474, 906	94, 565, 794	413, 040, 700
1886	457, 218, 000	271, 000, 000	51, 528, 658	153, 804, 970	476, 333, 628
1887	456, 329, 000	277, 000, 000	53, 009, 982	119, 625, 344	449, 635, 326
1888	415, 868, 000	283, 000, 000	54, 012, 702	88, 600, 743	425, 613, 445
1889	490, 560, 000	289, 000, 000	53, 973, 000	109, 430, 467	452, 403, 467
1890	399, 262, 000	295, 000, 000	56, 582, 000	106, 181, 316	457, 763, 316
1891	611, 780, 000	302, 000, 000	54, 508, 000	225, 665, 812	582, 173, 812
Total	5, 009, 445, 720	2, 994, 000, 000	593, 024, 761	1, 411, 682, 700	4, 998, 707, 461
Average	455, 404, 156	272, 181, 818	53, 911, 342	128, 334, 791	454, 427, 951

The following tables show the distribution, the first by sections, the second by States:

Sections.	Crop of 1892.	Stock on hand Mar. 1, 1893.		Estimated for county consumption.		Distribution beyond county lines.	
	Bushels.	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*
New England	264, 000	102, 190	38. 7	264, 000	100. 0	....	....
Middle	30, 754, 000	9, 539, 300	31. 0	20, 221, 620	65. 8	10, 532, 380	34. 2
Southern	37, 768, 000	9, 214, 590	24. 4	25, 865, 560	68. 5	11, 902, 440	31. 5
Western	381, 449, 000	101, 232, 700	26. 5	154, 197, 040	40. 4	227, 251, 960	59. 6
Mountain region	7, 773, 000	2, 158, 160	27. 8	5, 314, 280	68. 4	2, 458, 720	31. 6
Pacific	57, 941, 000	12, 958, 490	22. 4	15, 651, 810	27. 0	42, 289, 190	73. 0
Total	515, 949, 000	135, 205, 430	26. 2	221, 514, 310	42. 9	294, 434, 690	57. 1

States and Territories.	Crop of 1892.	Stock on hand Mar. 1, 1893.		Consumed in county where grown.		Shipped out of county where grown.	
	Bushels.	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*	*Bushels.*	*Per ct.*
Maine	75, 000	28, 500	38	75, 000	100	....	....
New Hampshire	38, 000	11, 780	31	38, 000	100	....	....
Vermont	151, 000	61, 910	41	151, 000	100	....	....
New York	8, 405, 000	2, 605, 550	31	6, 051, 600	72	2, 353, 400	28
New Jersey	1, 787, 000	571, 840	32	1, 375, 990	77	411, 010	23
Pennsylvania	19, 331, 000	5, 992, 610	31	12, 178, 530	63	7, 152, 470	37
Delaware	1, 231, 000	369, 300	30	615, 500	50	615, 500	50
Maryland	6, 992, 000	1, 608, 160	23	3, 286, 240	47	3, 705, 760	53
Virginia	7, 591, 000	1, 897, 750	25	4, 402, 780	58	3, 188, 220	42
North Carolina	5, 090, 000	1, 425, 200	28	4, 682, 800	92	407, 200	8
South Carolina	938, 000	150, 080	16	891, 100	95	46, 900	5
Georgia	1, 474, 000	339, 020	23	1, 385, 560	94	88, 440	6
Alabama	306, 000	55, 080	18	284, 580	93	21, 420	7
Mississippi	25, 000	4, 250	17	23, 750	95	1, 250	5
Texas	5, 475, 000	1, 095, 000	20	4, 325, 250	79	1, 149, 750	21
Arkansas	1, 337, 000	334, 250	25	1, 203, 300	90	133, 700	10
Tennessee	8, 540, 000	2, 305, 800	27	5, 380, 200	63	3, 159, 806	37
West Virginia	4, 302, 000	1, 204, 560	28	3, 011, 400	70	1, 290, 600	30
Kentucky	11, 635, 000	2, 908, 750	25	6, 631, 950	57	5, 003, 050	43
Ohio	38, 022, 000	9, 885, 720	26	20, 912, 100	55	17, 109, 900	45
Michigan	23, 854, 000	6, 917, 660	29	9, 541, 600	40	14, 312, 400	60
Indiana	39, 885, 000	11, 167, 800	28	17, 549, 400	44	22, 335, 600	56
Illinois	28, 370, 000	7, 659, 900	27	16, 170, 900	57	12, 199, 100	43
Wisconsin	8, 814, 000	3, 084, 900	35	5, 905, 380	67	2, 908, 620	33
Minnesota	41, 210, 000	12, 363, 000	30	16, 484, 000	40	24, 726, 000	60
Iowa	7, 257, 000	2, 685, 090	37	5, 805, 600	80	1, 451, 400	20
Missouri	24, 834, 000	6, 705, 180	27	12, 168, 660	49	12, 665, 340	51
Kansas	70, 831, 000	17, 707, 750	25	19, 124, 370	27	51, 706, 630	73
Nebraska	15, 670, 000	4, 701, 000	30	6, 268, 000	40	9, 402, 000	60
South Dakota	31, 767, 000	7, 941, 750	25	7, 624, 080	24	24, 142, 920	76
North Dakota	34, 998, 000	6, 299, 640	18	6, 999, 600	20	27, 998, 400	80
Montana	898, 000	269, 409	30	628, 600	70	269, 400	30
Wyoming	101, 000	39, 390	39	94, 940	94	6, 060	6
Colorado	2, 504, 000	826, 320	33	1, 377, 200	55	1, 126, 800	45
New Mexico	515, 000	108, 150	21	437, 750	85	77, 250	15
Arizona	170, 000	35, 700	21	147, 900	87	22, 100	13
Utah	1, 775, 000	390, 500	22	1, 189, 250	67	585, 750	33
Nevada	117, 000	31, 590	27	84, 240	72	32, 760	28
Idaho	1, 693, 000	457, 110	27	1, 354, 400	80	338, 600	20
Washington	9, 005, 000	1, 801, 000	20	2, 341, 300	26	6, 663, 700	74
Oregon	9, 779, 000	2, 151, 380	22	2, 738, 120	28	7, 040, 880	72
California	39, 157, 000	9, 006, 110	23	10, 572, 390	27	28, 584, 610	73
Total	515, 949, 000	135, 205, 430	26. 2	221, 514, 310	42. 9	294, 434, 690	57. 1

Average farm prices of wheat for the years 1879–1892.

States.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
Kentucky	$1.08	$0.93	$1.31	$0.90	$0.95	$0.74	$0.95	$0.72	$0.73	$0.96	$0.72	$0.92	$0.90	$0.67
Ohio	1.20	1.02	1.29	.95	.99	.75	.91	.74	.75	.97	.76	.91	.92	.68
Michigan	1.17	.97	1.25	.90	.96	.74	.84	.73	.74	.98	.74	.90	.91	.67
Indiana	1.17	.99	1.27	.90	.95	.67	.86	.70	.72	.94	.71	.88	.86	.64
Illinois	1.07	.95	1.22	.86	.92	.63	.81	.69	.70	.93	.70	.87	.85	.63
Wisconsin	1.04	1.00	1.19	.90	.88	.60	.76	.66	.64	.96	.70	.83	.84	.62
Minnesota	.94	.87	1.06	.82	.80	.50	.70	.61	.59	.92	.71	.81	.78	.61
Iowa	.92	.82	1.06	.70	.80	.55	.67	.60	.61	.85	.63	.80	.81	.60
Missouri	1.01	.89	1.19	.85	.88	.62	.77	.63	.62	.88	.64	.83	.80	.58
Kansas	.89	.70	1.05	.67	.78	.45	.65	.58	.61	.88	.55	.77	.73	.52
Nebraska	.84	.73	.97	.67	.70	.42	.57	.47	.53	.83	.52	.76	.73	.50
South Dakota North Dakota	.....	.....	.....	.80	.72	.46	.63	.52	.52	.91	.60	.70	.72 .70	.51 .52
United States	1.108	.951	1.192	.882	.911	.645	.771	.687	.681	.926	.698	.838	.839	.624

Average export price of wheat.

Year.	Average price.	Year.	Average price.
1876–'77	$1.17	1884–'85	$0.862
1877–'78	1.34	1885–'86	.870
1878–'79	1.07	1886–'87	.890
1879–'80	1.24	1887–'88	.853
1880–'81	1.11	1888–'89	.897
1881–'82	1.19	1889–'90	.832
1882–'83	1.13	1890–'91	.933
1883–'84	1.07	1891–'92	1.03

Weight per bushel.

Year.	Weight per bushel.	Measured bushels.	Weight in pounds.	Bushels of 60 pounds.
1884	58.3	512,763,900	29,912,751,800	498,545,863
1885	57.0	357,112,000	20,369,787,000	339,496,449
1886	58.4	457,218,000	26,686,632,000	444,777,202
1887	58.5	456,329,000	26,702,852,300	445,047,538
1888	56.5	415,868,000	23,485,066,800	391,417,782
1889	57.7	490,560,000	28,287,039,600	471,460,663
1890	57.2	399,262,000	22,854,954,200	380,915,903
1891	58.5	611,780,000	35,758,807,400	495,980,127
1892	57.5	515,949,000	29,661,220,000	494,353,667

Wheat crop of 1892.

States and Territories.	Weight per bushel.	Bushels of crop, 1892.	Weight in pounds.	Bushels of 60 pounds.
Maine	57	75,000	4,275,000	71,250
New Hampshire	56	38,000	2,128,000	35,467
Vermont	56	151,000	8,456,000	140,933
Connecticut	57.5	....	....	....
New York	57.5	8,405,000	483,287,500	8,054,792
New Jersey	58.7	1,787,000	104,896,900	1,748,282
Pennsylvania	58.5	19,331,000	1,130,863,500	18,847,725
Delaware	59	1,231,000	72,629,000	1,210,483
Maryland	59	6,992,000	412,528,000	6,875,467
Virginia	59	7,591,000	447,869,000	7,464,483
North Carolina	58.5	5,090,000	297,765,000	4,962,750
South Carolina	58	938,000	54,404,000	906,733
Georgia	57.8	1,474,000	85,197,200	1,419,953
Alabama	57.5	306,000	17,595,000	293,250
Mississippi	56	25,000	1,400,000	23,333
Texas	56.5	5,475,000	309,337,500	5,155,625

Wheat crop of 1892—Continued.

States and Territories.	Weight per bushel.	Bushels of crop, 1892.	Weight in pounds.	Bushels of 60 pounds.
Arkansas	56. 8	1, 337, 000	75, 941, 600	1, 265, 693
Tennessee	57	8, 540, 000	486, 780, 000	8, 113, 000
West Virginia	59	4, 302, 000	253, 818, 000	4, 230, 300
Kentucky	57	11, 635, 000	663, 195, 000	11, 053, 250
Ohio	57. 3	38, 022, 000	2, 178, 660, 600	36, 311, 010
Michigan	57. 7	23, 854, 000	1, 376, 375, 800	22, 939, 597
Indiana	57	39, 885, 000	2, 273, 445, 000	37, 890, 750
Illinois	57	28, 370, 000	1, 617, 090, 000	26, 951, 500
Wisconsin	56	8, 814, 000	493, 584, 000	8, 226, 400
Minnesota	55. 7	41, 210, 000	2, 295, 397, 000	38, 256, 617
Iowa	56	7, 257, 000	406, 392, 000	6, 773, 200
Missouri	57. 5	24, 834, 000	1, 427, 955, 000	23, 799, 250
Kansas	59	70, 831, 000	4, 179, 029, 000	69, 650, 483
Nebraska	58	15, 670, 000	908, 860, 000	15, 147, 667
South Dakota	56. 2	31, 767, 000	1, 785, 305, 400	29, 755, 090
North Dakota	55. 5	34, 998, 000	1, 942, 389, 000	32, 373, 150
Montana	58	898, 000	52, 084, 000	868, 067
Wyoming	59	101, 000	5, 959, 000	99, 317
Colorado	59. 5	2, 504, 000	148, 988, 000	2, 483, 133
New Mexico	55	515, 000	28, 325, 000	472, 083
Arizona	59	170, 000	10, 030, 000	167, 167
Utah	59	1, 775, 000	104, 725, 000	1, 745, 417
Nevada	56	117, 000	6, 552, 000	109, 200
Idaho	58	1, 693, 000	98, 194, 000	1, 636, 567
Washington	58	9, 005, 000	522, 290, 000	8, 704, 833
Oregon	59	9, 779, 000	576, 961, 000	9, 616, 017
California	59	39, 157, 000	2, 310, 263, 000	38, 504, 383
Total	57. 5	515, 949, 000	29, 661, 220, 000	494, 353, 667

AGRICULTURAL PRODUCTS OF THE WORLD.

The Statistician has been persistent in his efforts, for twenty years, to perfect statistical exchanges with other governments, and has made two investigations in Europe of existing official methods and results in agricultural statistics. The working library of his office is now so complete that ninety-two different governments are represented in Miscellaneous Report No. 5, "Production and Distribution of the Principal Agricultural Products of the World." The difficulties attending the preparation of this work can scarcely be exaggerated. It has involved translations from many languages, reduction of weights and measures nearly as numerous as the countries represented, the collection of consecutive annual statements for a period of ten years, the ascertaining of the average population of each country for the period, and orderly arrangement of hundreds of separate tables, primarily some 1,400 in number.

The necessity for so comprehensive a compilation has long been felt. The fluctuations of annual production, both in area and rate of yield and in trade requirements, are constantly confusing the minds of readers of agricultural statistics, being so wide and abrupt as to render the record of a single year in any country nearly useless for practical deduction. This fact enforces the necessity of a systematic average of a series of years, which, with few exceptions, has not heretofore been found in the statistical records of any country, and never has there been so comprehensive and complete a collection as to extent of geographical area represented and continuity of annual statements. In the compilation there are necessarily gaps in the annual series, many countries failing to make yearly enumerations of products, and in others the requisite trade records have not been published. There is still much incompleteness in such statistics, and though remedial effort is progressing and effective, a state of general efficiency can scarcely be attained for many years. The International Statistical Institute, in its personnel and in its initiatory work of half a dozen years, promises to prove an effective stimulus to original and uniform effort in the line of official national statistics, rendering possible their coördination in international tabulations.

As this work includes only official statistics, except incidentally in the brief analysis of results, its purpose is mainly to give comprehensiveness and lucidity to the disjointed and chaotic mass of such data. It aims to reduce to order and harmony the most valuable official statistics of agricultural exploitation, and confines within narrow limits the commercial quest for normal production of those countries which have no records of production and few if any available facts of distribution. It is a long step in the progress of inquiry as to the actual supply and consumption of each individual country, revealing peculiarities of agricultural possibility, adaptations of climate and soil to the healthful growth of different plants, dietetic tastes and habits of different nations, and many adventitious conditions controlling the development of rural industries and the distribution of their products.

It will be found more useful to the intelligent student of statistics, who desires reliable aid in marshaling the authorized data accessible, than to the superficial inquirer who wants everything, known and unknown, approximate and apocryphal, in one ultimate dictum of authority, which can be quoted and sworn to for personal uses.

In the brief space available in the annual report only an example or two can be given to show its plan, and a selection has been made of the three cereals which together constitute all but 3 per cent of the cereal production of the United States, viz, wheat, corn, and oats. For the annual tables of production, export, and import on which the several national tables of supply are founded, see the full report entitled as above.

WHEAT.

This is the most prominent food grain of the Caucasian race. It is an important crop in almost every country under their domination, and perhaps has a wider habitat than any other prominent product of the soil. Under diverse climates, differing soils, and varied development of agricultural methods it is an important resource in almost every portion of the globe. It forms a large item in the foreign trade of every commercial nation, and either in the form of grain or flour appears in the trade of even the most obscure country.

It is unfortunate that in some of the most important countries no official effort is made to register crop production each year, making it impossible to present a full statement of supply available for consumption. This failure in official effort is offset as far as possible by commercial estimates of wheat production for all countries contributing to the commercial supply, but as the figures presented in this report are all drawn from official sources, there are gaps in the tabulated statements.

In the estimates of production which are presented for Europe the period covered, as far as possible, are the years 1881 to 1890, the average for the term being given. The average aggregate production for the countries for which official data are available is 1,088,281,618 bushels. This practically includes every country of Europe, except Bulgaria, Greece, Norway, Portugal, Servia, Spain, Switzerland, and

Turkey. In order that a complete statement may be presented, commercial estimates for these countries for recent years have been averaged. On this basis the average European wheat crop is:

	Bushels.		Bushels.
Officially estimated	1,088,000,000	Spain	73,000,000
Bulgaria	40,000,000	Switzerland	2,600,000
Greece	6,900,000	Turkey	38,000,000
Portugal	7,800,000		
Norway	300,000		1,264,600,000
Servia	8,000,000		

This compilation shows the general accuracy of the early estimates of European production which appear in the reports of this Department. In the report for April, 1891, a tabulation of these annual estimates was presented covering the years 1886 to 1890, inclusive. The average for the period was 1,220,000,000 bushels, not including Bulgaria or the British Possessions in Europe, for which regular data were not presented. Including the crop of these countries, the statement would have been about 1,262,000,000 bushels. As this early tabulation includes preliminary official estimates, supplemented by commercial estimates, this verification is especially gratifying.

In the annual estimates of the wheat crop of the world which appear from various sources, many countries in which wheat is grown are not included. These are generally countries which do not in any way contribute to the commercial supply, though in the aggregate they must grow and consume an appreciable quantity of the grain. The incompleteness of the statements referred to may be judged by the fact that in the table given below official figures are presented for five countries or colonies, aggregating an average production of more than 15,000,000 bushels, which are not included in commercial statements of the world's crop.

In the annual report of the Statistician for 1891 it was said: "It is not difficult to prove the existence of 2,300,000,000 bushels as an average." This official average, supplemented by averages of commercial estimates in certain other countries, makes an aggregate of 2,280,856,716 bushels, not including several districts known to produce some wheat, and making no account of any grown in the northern provinces of China. An erroneous idea of the magnitude of the "crop of the world," involving an underestimate, has prevailed in consequence of the frequent publication of incomplete lists of wheat-growing countries. This investigation confirms the general accuracy of this estimate. A compilation of the commercial estimates for the years 1888 to 1891 for those countries having no official estimates has been made, using the figures presented each year in the March report of the U. S. Department of Agriculture. The statement is presented as follows:

	Bushels.		Bushels.
South America:		Asia:	
Argentine Republic	28,707,561	Asia Minor	37,339,461
Chile	15,174,537	Persia	22,130,960
Europe:		Syria	12,969,404
Greece	6,969,247	Africa:	
Norway	355,273	Algeria	21,584,298
Portugal	7,777,643	Cape Colony	3,864,810
Servia	8,065,050	Egypt	10,381,269
Spain	73,245,374	Tunis	4,256,250
Switzerland	2,622,479		
Turkey	38,107,715	Total	293,551,331

In addition a commercial estimate of the crop of Bulgaria was 40,022,976 bushels, and a commercial restatement of an official estimate of the crop of the Caucasus, made for the first time, was 74,269,440 bushels. Consolidating these various data, an average crop of the world, so far as is officially or commercially estimated, may be presented in this form:

	Bushels.
Officially estimated	1,873,012,968
Commercial estimates, 1888 to 1891	293,551,331
Bulgaria and Caucasus, 1891	114,292,416
Total	2,280,856,715

It is an easy matter to show the net wheat supply of the principal countries so far as wheat in the grain is concerned, but there is a further uncertain element that renders such a calculation valueless for most countries. A considerable portion of the wheat trade of the world is carried on in the form of flour, and, as in most official records of foreign trade the different kinds of flour are not separately stated, it is impossible to calculate exactly the wheat supply per head of population. As far as such a showing can be made it will be found in the discussion of net supply in the report above mentioned.

The wheat "market of the world," which is open for the surplus production of producing countries, is circumscribed and very small when the general use of wheat as a bread grain is considered. Practically it is all in Europe, and even there limited to the necessities of a few countries. Insular and factory-studded Great Britain, with its small area and its teeming population, and populous little Belgium practically furnish the market for which the wheat-growers of the world are striving in competition. Excluding these two countries Europe is practically self-supporting, the excess in the eastern countries being sufficient to meet the deficiencies in the western nations. To supply the small amount required to meet the European deficiency the fields of America, India, and Australasia are principally relied upon, and the sharp competition between the agriculturists of the rivals for the possession of this "world's market" results in furnishing a cheap food supply for the artisans of the manufacturing nations.

The classification of the principal countries into importing and exporting countries might be made as follows, excluding those in which supply and requirements are closely balanced:

Importing countries.	Net imports.	Exporting countries.	Net exports.
	Bushels.		*Bushels.*
Belgium	19,170,059	Austria-Hungary	5,846,800
France	37,426,407	Bulgaria	5,690,996
Germany	18,767,319	Roumania	19,200,979
Greece	8,975,790	Russia	83,170,011
Italy	19,931,234	Servia	2,236,912
Norway and Sweden	1,909,362	India	30,946,842
Netherlands	8,591,639	United States	83,343,864
Portugal	3,663,852	Argentine Republic	3,747,733
Spain	6,111,449	Canada	2,416,821
Switzerland	10,867,766	Chile	3,924,346
United Kingdom	105,527,648	Australasia	8,178,886
	240,942,525		248,704,190

This statement shows that the United Kingdom absorbs about 43 per cent of the commercial supply of wheat in the grain, and that this country, with Belgium, France, Germany, and Italy, furnishes a market for about 83 per cent. The net importation for all the countries presented below aggregates 243,000,000 bushels, and the net exports 250,000,000, leaving 7,000,000 bushels to find a market in such countries as are not reported.

Wheat.

Countries.	Period.	Production.	Imports.	Exports.	Net supply.
Europe:					
Austria-Hungary—		*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Austria	1881-1890	44, 695, 104	3, 488, 670	9, 335, 470	154, 682, 678
Hungary	1881-1890	115, 834, 374			
Belgium	1881-1890	17, 930, 499	26, 819, 681	7, 649, 622	37, 100, 558
Bulgaria	1881-1890	....	6, 778	5, 697, 774	....
Denmark	1880-1889; 1881-1890	4, 837, 805	2, 118, 916	773, 437	6, 183, 284
France	1881-1890	309, 432, 798	37, 593, 995	167, 588	346, 859, 205
Germany	1881-1890	92, 861, 834	19, 723, 127	955, 808	111, 629, 153
Greece	1889-1890	....	8, 990, 581	14, 791	....
Italy	1884-1891; 1881-1890	122, 283, 127	21, 174, 103	1, 242, 869	142, 214, 361
Norway and Sweden—					
Norway	1881-1890	....	256, 534	10	....
Sweden	1881-1890	3, 673, 392	1, 688, 087	35 249	5, 326, 230
Netherlands	1880-1887; 1881-1890	5, 747, 942	19, 335, 933	10, 744, 294	14, 339, 581
Portugal	1881-1890	....	3, 667, 375	3, 523	....
Roumania	1890-1891; 1880-1890	49, 639, 952	106, 560	19, 307, 539	....
Russia and Poland—					
Russia	1883-1890; 1881-1890	229, 915, 597	210, 253	83, 380, 264	159, 036, 146
Poland	1888-1890	12, 350, 560			
Servia	1888-1890	....	37, 424	2, 274, 336	....
Spain	1880-1890	....	6, 160, 599	49, 150	....
Switzerland	1885-1890	....	10, 879, 267	11, 501	....
United Kingdom	1884-1890; 1881-1890	77, 076, 551	107, 120, 176	1, 592, 528	183, 204, 199
British Possessions—					
Cyprus	1880-1887; 1885-1887	1, 240, 312	83, 091	135, 764	....
Malta	1880-1887	161, 837	....	....	....
Asia:					
British India	1885-1891; 1881-1890	254, 927, 152	165, 782	31, 112, 624	....
Japan	1881-1890; 1883-1890	13, 857, 801	20, 663	360, 481	13, 517, 983
Dutch Possessions—					
Java	1881-1890	....	4, 415	....	....
French Possessions—					
India	1887	....	851	....	....
Tonkin	1888-1889	....	410	....	....
Africa:					
Egypt	1884-1891	....	660, 791	1, 838, 844	....
British Possessions—					
Cape of Good Hope	1881-1890	....	598, 213	....	....
Mauritius	1887-1890	....	41, 155	....	....
Natal	1880-1877	10, 218	....	....	....
French Possessions—					
Réunion	1882-1889	....	57, 359	7, 513	....
America.					
North America—					
Canada	1881-1890	39, 898, 680	3, 896, 402	6, 313, 223	37, 481, 859
Mexico	1888-1890	....	....	17, 478	....
United States	1881-1890	439, 766, 572	388, 311	83, 732, 175	356, 422, 708
South America—					
Argentine Republic	1880-1889	....	60, 316	3, 876, 308	....
Chile	1880-1889	....	15, 389	3, 939, 735	....
Dutch Guiana	1880-1886	6, 034	....	....	....
Paraguay	1885-1887	....	51, 343	....	....
Uruguay	1881-1890	....	253, 080	151, 613	....
Islands—					
Martinique	1882-1888	....	17, 760	....	....
Australasia:					
New South Wales	1881-1890	4, 239, 672	759, 053	119, 111	4, 879, 614
New Zealand	1883-1891	8, 008, 131	4, 203	2, 495, 061	5, 517, 273
Queensland	1881-1890	106, 210	64, 064	15	170, 259
South Australia	1881-1890	11, 390, 544	36, 011	4, 426, 265	7, 000, 290
Tasmania	1882-1891; 1881-1890	759, 479	143, 830	16, 550	886, 759
Victoria	1882-1891; 1881-1890	11, 446, 085	101, 803	2, 240, 146	9, 307, 742
Western Australia	1881-1890; 1885-1890	344, 782	9, 298	....	354, 080
Islands of the Sea:					
French Possessions—					
Tahiti	1884-1889	....	1, 073	....	....

CORN.

The annual production of this American contribution to the food grains of the world exceeds in volume in years of plenty the crop of any other cereal. The great bulk of the crop is grown in the United States, but it is also an important item in rural economy in the European countries along the lower Danube, in Mexico, Argentine Republic, and a scattered crop in most of the countries of the world where climatic conditions are favorable to its growth. Its value as human food is only appreciated in the American countries in which it is grown, its principal use in the Old World being as an animal food. For this reason it does not figure extensively in the foreign trade of the various countries. Being used in competition with the cheaper cereals and root crops the volume of the trade depends upon the price in surplus countries, and this price in turn is set by the requirements there for domestic consumption. The United States is the principal source of supply, and the value in this country is not appreciably affected by the foreign demand.

The average annual net importation of Europe, according to the data presented, is about 64,000,000 bushels. The average net exportation from the United States during the same period is about 57,000,000 bushels, of which Canada takes about 2,000,000 bushels. The remainder required comes from the average exportation of 9,000,000 bushels from Argentine Republic. In Europe only four countries appear as exporters—Bulgaria, Russia, Roumania, and Servia—and of these only Russia and Roumania are important. The former ships more than one-half of her total crop and the latter nearly as large a proportion. The net contribution of the United States to meet the world's requirements is much larger than the net contributions from all other sources combined, and yet the shipments from this country amount to less than 4 per cent of the annual production.

A definite statement of the aggregate corn crop of the world can hardly be compiled. It is grown, to some extent at least, in many countries for which no data of production are available, but it is not difficult to compile a statement which shall present the aggregate production of all countries which contribute to the commercial supply of civilized countries. In the general table below, official estimates are presented for the principal countries, which might be thus summarized:

	Bushels.
Europe	311,820,759
Asia	823,868
Africa	2,904,979
United States	1,680,696,600
Australasia	6,797,791
Islands	30,147
Total (official)	2,003,074,144

This showing may be supplemented by unofficial estimates for a number of producing countries, drawn in the main from Dr. Juraschek's work Übersichten der Weltwirtschaft, as follows:

	Bushels.
Bulgaria and Turkey	21,281,250
Servia	10,782,500
Spain	22,132,500
Egypt	13,336,250
Chile	851,250
Algiers	283,750
Argentine Republic	19,011,250
Canada	6,405,157
Total	94,083,907

Consolidating these estimates of the corn crop of the world, under the limitations already noted, they make an aggregate of 2,097,158,051 bushels, and including a somewhat uncertain allowance for Mexico, about 2,228,000,000 bushels.

The United States produces 80 per cent of the total crop, taking the average of a series of years, and a much larger proportion in years of heavy production. In 1891 the crop of this country almost equaled in volume the average crop of the world, and in such seasons the volume of the world's corn crop exceeds that of any other cereal.

Corn.

Country.	Period.	Production.	Imports.	Exports.	Net supply.
Europe:					
Austria-Hungary—		*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Austria	1881–'90	17, 315, 978	6, 204, 531	1, 506, 927	114, 205, 857
Hungary	1881–'90	92, 192, 275			
Bulgaria	1881–'90	...	1, 591	3, 441, 377	...
Denmark	1881–'90	...	2, 052, 427	166, 509	...
France	1881–'90	26, 563, 111	14, 311, 646	399, 080	40, 475, 677
Germany	1881–'90	...	9, 417, 902	4, 934	...
Italy	1884–'91 1881–'90	80, 722, 264	2, 698, 773	703, 760	82, 716, 277
Norway and Sweden—					
Norway	1881–'90	...	57, 197	208	...
Sweden	1881–'90	...	355, 896	...	...
Netherlands	1890	...	7, 662, 043	1, 062, 319	...
Portugal	1882–'84 1881–'90	14, 458, 806	782, 598	4, 608	...
Roumania	1890–'91 1880–'90	61, 603, 014	86, 349	24, 033, 690	...
Russia and Poland—					
Russia	1885–'90 1881–'90	19, 565, 311	265, 971	10, 298, 713	9, 532, 569
Poland	...	...			
Servia	1888–'90	...	835	222, 360	...
Spain	1880–'90	...	...	2, 419	...
Switzerland	1885–'90	...	1, 149, 950	4, 027	...
United Kingdom	1881–'90	...	61, 396, 419	567, 844	60, 828, 575
Asia:					
Japan	1880–'87	576, 114	43	...	...
French Possessions—					
Cochin China	1885–'89	247, 754	...	...	...
Tonkin	1888–'89	...	7	...	...
Africa:					
Egypt	1884–'91	...	...	1, 005, 351	...
British Possessions—					
Cape of Good Hope	1881–'90	...	161, 504	...	...
Natal	1880–'87	2, 779, 368	...	160, 880	...
French Possessions—					
Mayotte	1885–'89	3, 648	...	...	...
Nossi-Bé	1884–'89	121, 963	...	...	...
Réunion	1884–'89	...	7, 657	1, 016	...
America:					
North America—					
Canada	1881–'90	...	5, 563, 865	3, 339, 709	...
Mexico	1884–'90	...	...	12, 430	...
United States	1881–'90	1, 680, 696, 600	26, 833	57, 256, 957	1, 623, 466, 476
South America—					
Argentine Republic	1881–'90	...	97	9, 282, 934	...
Chile	1880–'89	...	227	8, 555	...
French Guiana	1882–'89	...	3, 429	...	...
Paraguay	1881–'85	...	7, 719	311	...
Uruguay	1881–'90	...	31, 990	311, 325	...
Islands:					
British Possessions—					
Antigua	1880–'87	...	42, 916	...	...
Bermuda	1882–'87	...	25, 473	...	...
Jamaica	1880–'87	...	70, 155	...	...
St. Christopher-Nevis	1882–'87	...	18, 860	...	...
Dutch Possessions—					
Curaçao	1882–'86	4, 403	...	...	...
French Possessions—					
Guadeloupe	1882–'88 1882–'89	10, 544	16, 910	280	...
Martinique	1882–'88	...	34, 374	...	...
St. Pierre and Miquelon	1885–'89	...	3, 836	...	...
Australasia:					
New South Wales	1881–'90	4, 560, 893	177, 780	314, 418	4, 424, 255
New Zealand	1888–'91 1883–'91	242, 327	791	63, 463	279, 655

Corn—Continued.

Country.	Period.	Production.	Imports.	Exports.	Net supply.
Australasia—Continued.		*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Queensland	1881-'90	1,741,492	185,413	33,070	1,893,835
South Australia	1881-'90		7,857	1,673	
Tasmania	1885-'90		978		
Victoria	1881-'90	251,261	136,402	6,233	381,430
Western Australia	1887 / 1885-'90	1,818	6,201		
Islands of the Sea:					
British Possessions—					
Fiji	1881-'87	15,200			

OATS.

The oats crop of the world is practically all grown in Europe and North America, although Australasia furnishes a considerab'e product for her own consumption. The United States leads the world in annual production, followed by Russia, Germany, and France in the order named. The bulk of the trade of the world is confined to exchanges among the countries of Europe, the foreign trade of other countries being comparatively small. The average annual importation of European countries is about 97,000,000 bushels, of which the United Kingdom takes 49,000,000 bushels, and the average annual exports 89,000,000 bushels, Russia furnishing 58,000,000 bushels. This leaves about 8,000,000 bushels per annum to be drawn from other sources of supply, Russia furnishing about 1,000,000 bushels shipped through the Caucasian ports of the Black Sea, United States and Canada nearly 5,000,000 bushels, and Australasia less than 1,000,000 bushels. Eight countries in Europe have a net exportation, but only two (Russia and Sweden) are important as sources of supply. The United Kingdom, France, and Germany are the principal importing countries. Except in the countries named the production is closely regulated to the demands for consumption, and the foreign trade is insignificant.

The European crop for the countries officially reported aggregates 1,592,114,138 bushels. Übersichten der Weltwirtschaft, previously quoted, presents estimates of production for European countries not presented below, as follows:

	Bushels.
Bulgaria and Turkey	9,363,750
Servia	2,270,000
Spain	7,377,500
Switzerland	5,107,500
Finland	9,931,250
Total	34,050,000

With these data an estimate of the production of the world, not attempting to include those countries which in no way affect the commercial supply of the grain, might be thus presented:

	Bushels.
Europe, official estimates	1,592,114,138
Europe, unoffical estimates	34,050,000
United States	594,961,401
Australasia	17,045,346
Canada (estimated)	90,000,000
Total	2,328,170,885

The production of this grain in Australasia is mainly confined to the crop of New Zealand, where climatic conditions are especially favorable, and where the yield per acre is large and the weight of the grain heavy. No other colony except Tasmania produces sufficient to supply its own wants, the deficiency being met by imports from New Zealand.

Oats.

Countries.	Period.	Production.	Imports.	Exports.	Net supply.
Europe:		*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Austra-Hungary—					
Austria	1881–'90	99, 327, 343	2, 065, 196	4, 014, 614	152, 167, 773
Hungary	1881–'90	54, 789, 848			
Belgium	1881–'90	26, 606, 619	....	....	....
Bulgaria	1881–'90	....	....	210, 113	....
Denmark	1880–'89 1881–'90	31, 496, 118	1, 845, 118	310, 865	33, 030, 371
France	1881–'90	246, 060, 733	17, 050, 413	655, 603	262, 464, 543
Germany	1881–'90	299, 556, 143	15, 553, 605	1, 087, 922	314, 021, 826
Italy	1884–'91 1881–'90	17, 290, 307	1, 478, 460	112, 765	18, 656, 002
Norway and Sweden—					
Norway	1875 1881–'90	9, 179, 108	38, 000	314, 963	....
Sweden	1881–'90	53, 497, 474	201, 905	13, 620, 983	40, 078, 336
Netherlands	1880–'87 1881–'90	12, 451, 508	6, 287, 621	7, 636, 823	11, 102, 306
Portugal	1882–'84 1880–'86	993, 514	6, 420	....	....
Roumania	1890–'91 1880–'90	7, 649, 761	9, 791	1, 818, 555	....
Russia and Poland—					
Russia	1883–'90 1881–'90	535, 091, 581	40, 603	58, 022, 565	507, 810, 416
Poland	1888–'90	30, 700, 797			
Servia	1888–'90	....	46, 801	487, 913	....
Spain	....	....	....	....	....
Switzerland	1885–'90	....	2, 967, 043	6, 450	....
United Kingdom	1884–'90 1881–'90	167, 303, 646	49, 180, 525	829, 631	215, 657, 540
British Possessions—					
Cyprus	1880–'87	116, 638	....	....	....
Asia:					
Japan	1883–'90	....	570	....	....
British Possessions—					
India	1881–'90	....	....	279, 450	....
French Possessions—					
Cochin-China	1888–'89	....	247	....	....
Tonkin	1888–'89	....	98	....	....
Africa:					
British Possessions—					
Cape of Good Hope	1881–'90	....	82, 883	....	....
Mauritius	1880–'87	....	339, 918	....	....
America:					
North America—					
Canada	1881–'90	....	272, 091	2, 062, 410	....
United States	1881–'90	594, 961, 401	310, 885	2, 828, 387	592, 443, 899
South America—					
British Guiana	1882–'87	....	98, 658	....	....
French Guiana	1884–'89	....	9, 080	....	....
Islands—					
British Possessions—					
Bermuda	1882–'87	....	51, 005	....	....
St. Christopher-Nevis	1882–'87	....	7, 634	....	....
French Possessions—					
Gaudelupe	1882–'89	....	76, 573	280	....
Martinique	1882–'88	....	22, 720	....	....
St. Pierre and Miquelon	1885–'89	....	3, 289	....	....
Australasia:					
New South Wales	1881–'90	418, 872	1, 190, 883	105, 996	1, 503, 759
New Zealand	1883–'91	11, 209, 071	91	2, 800, 280	8, 408, 882
Queensland	1881–'90	5, 268	200, 018	143	205, 143
South Australia	1880–'90 1881–'90	79, 213	270, 469	54, 476	295, 136
Tasmania	1881–'90	761, 327	39, 307	155, 162	645, 472
Victoria	1881–'90	4, 543, 574	926, 064	89, 862	5, 379, 776
Western Australia	1881–'90 1885–'90	28, 021	75, 361	....	....
Islands of the Sea:					
French Possessions—					
New Caledonia	1887–'89	....	845	....	....
Tahiti	1887–'89	....	167	....	....

THE WOOL OF THE WORLD.

The progress of the United States in wool-growing has been remarkable. While the records of all countries from which statistics are collected do not show an aggregate much exceeding 2,400,000,000 pounds, the product of this country is not much short of 300,000,000 pounds. Including imports of wool, raw and manufactured, we consume over 500,000,000 pounds. Thus it will be seen that less than a twentieth of the population of the world consumes more than a fifth of the wool of the world, and produces one-eighth of it all. No other nation consumes so much, and no other produces so much. The four principal countries manufacture nearly two-thirds of all the wool grown, and the United States has already distanced one and stands very nearly on an equality with the two others. Their production and available supply for 1890 were as follows:

Country.	Net imports.*	Domestic production.	Supply.
	Pounds.	*Pounds.*	*Pounds.*
France	298,395,516	124,803,000	423,198,516
United Kingdom	273,021,515	147,475,000	420,496,515
United States	126,373,603	285,000,000	411,373,603
Germany	263,670,160	54,894,000	318,564,160

* Imports minus exports.

A few of the leading countries of Europe and the United States furnish the final market for the surplus production of wool-growing countries. In Europe, the countries depending to a large extent upon outside sources for their wool supply are, in order of prominence, United Kingdom, France, Germany, and Belgium. The remainder of the continent, with the exception of Austria-Hungary, which has a net importation of about 30,000,000 pounds, practically supplies itself. The total imports recorded for the countries of Europe average 1,419,000,000 pounds per annum, and the total exports 587,000,000 pounds, a net deficiency of about 832,000,000 pounds, which, with the deficiency in the United States, makes the wool market of the world. More than one-half of the exports of Europe are shipments from the United Kingdom, representing the surplus production of her colonies, gathered in her enormous trade and reshipped to the consuming countries.

The wool to supply this demand for nearly 1,000,000,000 pounds is drawn from various sources, mainly from countries where agricultural development is largely along the lines of pastoral industry. The Australasian colonies, Argentine Republic, the British Possessions in Asia and Africa, China, Uruguay, and some other out-of-the-way countries are the sources of supply of commercial wool. The Argentine Republic is the leading exporting country, making an annual shipment of 266,000,000 pounds, with New South Wales second, furnishing nearly 200,000,000 pounds. The aggregate volume of imports for all the countries for which data are presented is 1,612,863,977 pounds, and of exports 1,563,173,196. This leaves an average of slightly more than 50,000,000 pounds each year to be supplied in small amounts by obscure countries whose commerce is not recorded, and by the few South American countries which are not officially reported.

In 1871, after the great reduction in flocks, following the period of low prices which resulted from the glut of wool and woolens all over the world, between 1866 and 1869, the estimated numbers of sheep were scarcely 32,000,000. For thirteen years following we find a healthful expansion of sheep husbandry, resulting in an increase in numbers to over 50,000,000, or 59 per cent. Then follow four years of lower prices and consequent discouragement of growers, with a reduction in numbers of sheep by fully 7,000,000, or 16 per cent, during that period. The average farm values of sheep during this period of reduction and recuperation were as follows:

Years.	Value.	Years.	Value.
1885	$2.14	1889	$2.13
1886	1.91	1890	2.27
1887	2.01	1891	2.50
1888	2.05	1892	2.58

The tendency to increase has been interrupted during the past twenty years only in the short period of discouragement noted. The estimates of numbers made in January of each year, from returns of correspondents, and of wool produced (the spring clip with that of the previous autumn in a few localities, with that of sheep and lambs killed during the year), are thus presented:

Number, average price, and value of sheep, and the number of pounds of wool grown in the United States during the years 1871 to 1893.

Years.	Number.	Average price.	Value.	Pounds of wool.
1871	31,851,000	$2.33	$74,035,837	153,000,000
1872	31,679,300	2.80	88,771,197	150,000,000
1873	33,002,400	2.96	97,922,350	158,000,000
1874	33,938,200	2.61	88,690,569	170,000,000
1875	33,783,600	2.79	94,320,652	181,000,000
1876	35,935,300	2.61	93,666,318	192,000,000
1877	35,804,200	2.26	80,892,683	200,000,000
1878	35,740,500	2.26	80,603,062	208,250,000
1879	38,123,800	2.07	79,023,984	211,000,000
1880	40,765,900	2.21	90,230,537	232,500,000
1881	43,569,899	2.39	104,070,861	240,000,000
1882	45,016,224	2.37	106,595,954	272,000,000
1883	49,237,291	2.53	124,365,835	290,000,000
1884	50,626,626	2.37	119,902,706	300,000,000
1885	50,360,243	2.14	107,960,650	308,000,000
1886	48,322,331	1.91	92,443,867	302,000,000
1887	44,759,314	2.01	89,872,839	285,000,000
1888	43,544,755	2.05	89,279,926	269,000,000
1889	42,599,079	2.13	90,640,369	265,000,000
1890	44,336,072	2.27	100,659,761	276,000,000
1891	43,431,136	2.50	108,397,447	285,000,000
1892	44,938,365	2.58	116,121,270	293,000,000

In these twenty-two years the increase of sheep was 41 per cent, and of wool 26 per cent. This is partially due to increased weight of fleece and in part to increase of animals slaughtered for mutton and lamb. This tendency will increase, and it should be carefully considered in estimates of wool production in future years, which must show a larger amount of wool in proportion to numbers of sheep existing at a given date.

Statement showing the imports and exports of wool from 1870 to 1892, inclusive.

Years.	Imports.		Exports of domestic wool.*	
	Pounds.	Value.	Pounds.	Value.
1870	49, 230, 199	$6, 743, 350	152, 892	$54, 928
1871	68, 058, 028	9, 780, 443	25, 195	8, 762
1872	122, 256, 499	26, 214, 195	140, 515	36, 434
1873	85, 496, 049	20, 433, 938	75, 129	17, 624
1874	42, 939, 541	8, 250, 306	319, 600	72, 169
1875	54, 901, 760	11, 071, 259	178, 034	62, 754
1876	44, 642, 836	8, 247, 617	104, 768	13, 845
1877	42, 171, 192	7, 156, 944	79, 599	26, 446
1878	48, 449, 079	8, 363, 015	347, 854	93, 358
1879	39, 005, 155	5, 034, 545	60, 784	17, 644
1880	128, 131, 747	23, 727, 650	191, 551	71, 987
1881	55, 964, 236	9, 703, 968	71, 455	19, 217
1882	67, 861, 744	11, 096, 050	116, 179	37, 327
1883	70, 575, 478	10, 949, 331	64, 474	22, 114
1884	78, 350, 651	12, 384, 709	10, 393	3, 073
1885	70, 596, 170	8, 879, 923	88, 006	16, 739
1886	129, 084, 958	16, 746, 081	2, 138, 080	476, 274
1887	114, 038, 030	16, 424, 479	257, 940	78, 002
1888	113, 558, 753	15, 887, 217	22, 164	5, 272
1889	126, 487, 729	17, 974, 515	141, 576	23, 065
1890	105, 431, 285	15, 264, 083	231, 042	33, 543
1891	129, 303, 648	18, 231, 372	291, 922	39, 423
1892	148, 670, 652	19, 688, 108	202, 456	30, 664

*Exports of all domestic products to Canada are imperfectly recorded, but a small portion of the shipments by rail being reported.

Imports of raw wool by grades.

Year ending June 30—	Clothing wools.		Combing wools.		Carpet and other similar wools.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1884	21, 175, 228	$4, 807, 636	4, 414, 253	$1, 017, 311	52, 761, 170	$6, 559, 762	78, 350, 651	$12, 384, 709
1885	11, 475, 889	2, 262, 824	2, 780, 751	669, 604	56, 339, 530	5, 947, 495	70, 596, 170	8, 879, 923
1886	40, 968, 537	6, 651, 260	7, 198, 534	1, 608, 764	80, 917, 887	8, 486, 057	129, 084, 958	16, 746, 081
1887	17, 963, 982	3, 431, 567	10, 721, 753	2, 528, 560	85, 352, 295	10, 464, 352	114, 038, 030	16, 424, 479
1888	23, 039, 679	4, 541, 242	5, 639, 528	1, 330, 565	84, 879, 546	10, 015, 410	113, 558, 753	15, 887, 217
1889	29, 224, 522	5, 971, 031	6, 871, 666	1, 586, 294	90, 391, 541	10, 417, 190	126, 487, 729	17, 974, 515
1890	16, 649, 480	3, 894, 760	7, 658, 806	1, 905, 970	81, 122, 999	9, 463, 353	105, 431, 285	15, 264, 083
1891	32, 230, 935	6, 919, 913	6, 667, 023	1, 551, 490	90, 405, 690	9, 759, 969	129, 303, 648	18, 231, 372
1892	50, 262, 796	9, 523, 773	5, 826, 574	1, 368, 654	92, 581, 282	8, 795, 681	148, 670, 652	19, 688, 108

The large proportion of carpet wool, or wool not of English or Merino race, is due to its cheapness and low duty. It has a wide range in quality and values as well as uses, as it enters into the manufacture of a great variety of goods as well as carpets.

Net importations of wool for seven decades.

Periods.	Aggregate.	Annual average.	Average imports per head.
	Pounds.	*Pounds.*	*Pounds.*
1822–'30	16, 936, 307	1, 881, 812	.2
1831–'40	62, 865, 275	6, 286, 528	.4
1841–'50	139, 764, 592	13, 976, 459	.7
1851–'60	230, 106, 287	23, 010, 629	.9
1861–'70	501, 611, 132	50, 161, 113	1.4
1871–'80	640, 916, 638	64, 091, 664	1.5
1881–'90	889, 005, 571	88, 900, 557	1.6
1891–'92 (two years)	272, 328, 614	136, 164, 307	2.1

In connection with these importations the following table of imports and average prices of British imports will show the fluctuations and general reduction of wool values in the largest European market, showing a fall of 33 per cent in six years between 1880 and 1886:

Years.	Pounds.	Value.	Price per pound.
			Cents.
1880	460,960,907	$127,474,610	27.7
1881	447,521,441	124,788,306	27.9
1882	484,930,324	120,423,942	24.8
1883	494,428,802	121,008,627	24.5
1884	518,637,800	126,734,770	24.4
1885	501,130,837	101,965,439	20.3
1886	592,544,221	108,951,338	18.4
1887	573,180,904	117,957,921	20.6
1888	634,943,685	125,798,626	19.8
1889	696,011,487	138,023,040	19.8
1890	629,236,207	131,058,563	20.8
1891	715,470,708	135,563,881	18.9

The following table shows that the wool supply is seven times as large as in 1840, and the supply per head has been more than doubled:

Average per annum of total wool reserves for each decade since 1840.

Periods.	Product.	Imports.	Total supply.	Supply per head.
	Pounds.	Pounds.	Pounds.	Pounds.
1841-'50	46,000,000	13,976,459	59,976,459	3.0
1851-'60	66,000,000	23,010,629	89,010,629	3.3
1861-'70	150,000,000	50,161,113	200,161,113	5.4
1871-'80	185,575,000	64,091,664	249,666,664	5.7
1881-'90	280,700,000	88,900,557	369,600,557	6.6
1891-'92 (two years)	289,000,000	136,164,307	425,164,307	6.5

Value of net importations of manufactures of wool.

	Aggregate.	Annual average.	Average value per head.
1830	$82,900,615	$8,290,062	$0.75
1840	139,507,716	13,950,772	.94
1850	130,058,518	13,005,852	.65
1860	313,332,730	31,333,273	1.16
1870	330,465,214	33,046,521	.94
1880	395,376,936	39,537,694	.90
1890	433,459,813	43,345,981	.77
1891-'92 (two years)	76,153,951	38,076,976	.59

This showing for the wool industry of the country can not be equaled in the history of wool and woolens of the world in the growth of manufacture and in the proportion of domestic wool manufactured.

INCOMPLETE ASSESSORS' RETURNS.

The most defective and misleading agricultural statistics extant are the assessors' returns of States, as published by local authority. It must ever remain so until the people realize more fully the necessity of accurate statistics, enact adequate laws for statistical collection, and promptly execute them. Only the smaller number of the more intelligent agricultural States make any effort to collect such statistics. Some of the most advanced in education and the arts of civilization have little interest in agriculture, and so neglect agricultural statistics. The inaccuracy consists far less in reckless or ill-judged returns than in omission of individual returns. This incompleteness is inherent in all enumerations. The United States Census does not give production in its entirety, though when well done the omissions are so few as to be almost immaterial. The earlier censuses were very incomplete, even as to the principal products. As late as 1870 there was an omission of 18 per cent of the cotton production, and the minor products of the South were even less complete. There were fewer bales (conventional) of 400 pounds reported than were counted commercially of 470 pounds. In 1880 this defect was remedied thoroughly by reënumeration. The minor crops are frequently forgotten or neglected in farmers' information to enumerators.

But the State returns are rarely within 5 to 10 per cent of the census in the principal crops of the most thoroughly reported States; in the scattered crops 10 to 20 per cent short, and 20 to 50 per cent short in States of greater laxity in enforcing the law. Ten years ago a comparison of these State returns with the United States Census showed precisely these results, and similar defectiveness exists at the present time. Apparently, in a few States where the work is more conscientiously done, there is some improvement, a slight reduction in the disparity between assessors and enumerators, but on the whole the progress is not very satisfactory. If these annual returns were full, as well as accurate, the *ad interim* crop indications of this Department and of States and private bureaus would be much more satisfactory, and would furnish, if handled with intelligence and judgment, as accurate information concering crop prospects as could be desired. The first great want of the day in statistics is the education of farmers as to the advantage and necessity of accurate information of the acreage and product of the various crops, backed by stringent legislative requirements, with penalties for neglect. The public press, granges, and alliances, and all commercial organizations, should unite in a crusade of statistical education and legislation, or forever hold their peace, whatever absurdities are promulgated concerning crop areas or prospects or products.

In examining the following table, which shows the differences for 1879 between census enumerations and State statistics, it will be found that in those States in which assessors' returns alone are given, they are almost invariably lower than the United States Census; as, for instance, those east of the Mississippi. In the States west of that river—most of them, at least—the gaps caused by neglect to return are filled up by estimate of State officers, aided by county clerks and private individuals, and in these cases the tendency to booming production is apparent in aggregates above those of the census, especially in products, more rarely in acreage, which is so generally reported by assessors who report at all, that the figures are generally allowed to stand, showing a deficiency like that in the States east of the Mississippi. The figures in Iowa seem to be a matter of estimate. The rate of yield in Minnesota, the Dakotas, Nebraska, and Kansas, reënforced by private estimates, are almost invariably much higher than the census rate, while the acreage is generally lower, conforming to the invariable tendency, proved by all local statistics of the past twenty years, to underestimate acreage and to overestimate yield. The following table is a comparison of census and assessors' returns:

KENTUCKY.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	2,960,382	78,434,847	....	....	69,209,117	....
Wheat	898,694	10,707,462	....	....	8,997,706	....
Barley	5,776	165,959	....	....	97,255	....

OHIO.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	3,189,553	113,892,318	35.71	2,714,571	87,838,192	32.35
Wheat	2,269,585	35,559,208	15.66	2,165,933	31,663,448	14.62
Barley	37,092	1,059,915	28.58	30,838	867,689	28.13

MICHIGAN.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn †	994,597	28,785,579	28.94	873,457	38,834,892	44.46
Wheat	1,501,225	24,771,171	16.50	1,424,502	22,938,057	16.10

INDIANA.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	3,586,190	108,843,094	30.35	3,418,051	106,542,161	31.17
Wheat	2,570,017	37,318,798	14.52	2,773,883	41,541,570	14.98
Barley	10,280	250,200	24.34	19,825	416,325	21

ILLINOIS.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	7,860,917	289,629,705	36.84	6,988,267	247,980,589	35.49
Wheat	2,239,861	37,371,081	16.68	2,052,388	37,201,916	18.13
Barley	41,390	1,197,206	28.92	40,088	1,207,157	30.11

WISCONSIN.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	1,120,341	34,024,216	....	....	29,485,749	....
Wheat	744,080	11,698,922	....	....	9,866,322	....
Barley	474,914	15,225,872	....	....	15,524,757	....

MINNESOTA.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	901,690	24,696,446	27.38	688,622	22,115,769	32.11
Wheat	3,372,627	52,300,247	15.51	2,921,437	46,660,583	15.97
Barley	358,510	9,100,683	25.84	332,017	9,105,209	27.42

IOWA.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	7,585,522	313,130,782	41.28	7,953,000	326,073,000	41.00
Wheat	585,448	8,249,786	14.09	2,028,000	27,318,000	13.47
Barley	518,720	13,406,122	25.84	155,797	4,362,316	28.00

MISSOURI.

Crops.	United States Census. Acres.	United States Census. Bushels.	United States Census. Yield per acre.	State assessors.* Acres.	State assessors.* Bushels.	State assessors.* Yield per acre.
Corn	6,069,638	196,904,915	32.44	6,470,000	213,500,000	33.00
Wheat	1,946,785	30,113,821	15.47	1,556,000	23,350,000	15.00
Barley	1,504	34,863	23.18	8,500	178,500	21.00

*While these official State statistics are generally tabulations of assessors' returns, it is understood that in some of them, notably several of those west of the Mississippi River, assessors' returns are supplemented and reënforced by private estimates, especially as to quantity of product.

† The great discrepancy between Census and assessors is doubtless due to the local habit of reporting bushels of ears, while the Census reports shelled corn.

KANSAS.

Crops.	United States Census.			State assessors.		
	Acres.	Bushels.	Yield per acre.	Acres.	Bushels	Yield per acre.
Corn	7,314,765	259,574,568	35.49	6,820,603	273,888,321	40.16
Wheat	1,582,635	30,399,871	19.21	1,594,285	35,319,851	22.15
Barley	7,201	165,715	23.01	6,373	175,405	27.52

NEBRASKA.

Crops.	Acres.	Bushels.	Yield per acre.	Acres.	Bushels	Yield per acre.
Corn	5,480,279	215,895,996	39.39	4,562,124	198,654,322	43.54
Wheat	798,855	10,571,059	13.23	939,690	13,022,631	13.86
Barley	82,590	1,822,111	22.06	135,776	3,512,056	25.87

DAKOTA.

Crops.	Acres.	Bushels.	Yield per acre.	Acres.	Bushels	Yield per acre.
Corn	765,239	13,335,938	17.41	814,677	22,832,073	28.03
Wheat	4,968,045	42,929,593	8.64	4,269,717	44,009,092	10.31
Barley	206,709	2,271,172	10.99	255,969	4,455,777	17.41

BEET-SUGAR PRODUCTION.

Fifteen years ago there was much excitement, in official and agricultural circles, relative to sorghum-sugar production. The official prophecy was made that in a half dozen years production of sugar would exceed consumption in the United States as a result of the sorghum movement. More than twice six years have passed, and sorghum has not gone beyond the experimental stage, and experiment itself is waning. At the same time the Statistician predicted the ultimate development of beet sugar, which has been in active progress for several years, and the aggregate production has more than doubled during 1892. The following statement from the Commissioner of Internal Revenue, Hon. John W. Mason, shows the quantity of sugar produced respectively in 1891 and 1892:

	Pounds.
UTAH.	
Utah Sugar Company, closed December 19, 1892	1,473,500
CALIFORNIA.	
Alameda Sugar Company, closed December 8, 1892	2,506,860
Western Beet Sugar Company, closed January 27, 1893	11,390,921
Chino Valley Beet Sugar Company, closed October 28, 1892	7,903,541
NEBRASKA.	
Oxnard Beet Sugar Company, closed November 19, 1892	2,110,100
Norfolk Beet Sugar Company, closed November 9, 1892	1,698,400
Total	27,083,322

The total production of sugar last year at these factories was 12,004,838 pounds. The production this season compared with last year is as follows:

	Production in 1891.	Production in 1892.
	Pounds.	*Pounds.*
Utah	1,094,900	1,473,500
California	8,175,438	21,801,322
Nebraska	2,734,500	3,808,500
Total	12,004,838	27,083,322

TRANSPORTATION RATES.

For the first five months of the year the rates from Chicago to New York, and points taking New York rates, remained the same. The returns for June 1 showed a decrease of 5 cents per 100 pounds, carload lots, on flour, grain, hides, lumber, and salt, and 12 cents on wool. A special rate was given on machine-compressed wool of 45 cents per 100 pounds. On July 1 a decrease of 5 cents was reported on packing-house products and live hogs. Flour and grain were increased 2½ cents, or from 20 to 22½ cents. The returns for September 1 gave only one change, *i. e.*, a reduction on wool of 5 cents, or from 45 to 40 cents per 100 pounds. On November 1 the reports showed all the rates—except those on wool—restored to the same basis as January 1 rates.

The following table shows the rates in effect January 1, 1892, upon a few of the more important articles of shipment from Chicago to New York, Baltimore, and Boston, and the changes reported during the year:

[In cents per 100 pounds.]

Articles (car loads).	From Chicago to—														
	New York.					Baltimore.					Boston.				
	Jan. 1.	June 1.	July 1.	Sept. 1.	Nov. 1.	Jan. 1.	June 1.	July 1.	Sept. 1.	Nov. 1.	Jan. 1.	June 1.	July 1.	Sept. 1.	Nov. 1.
Bulk meats	35	....	30	....	35	32	....	27	....	32	40	....	35	34	39
Packing-house products	30	....	25	....	30	27	....	22	....	27	35	....	30	28	33
Flour	25	20	22½	....	25	22	17	19½	....	22	30	25	27½	24½	27
Grain	25	20	22½	....	25	22	17	19½	....	22	30	25	27½	24½	27
Hides, dry (min. wt. 20,000 lbs.)	35	30	....	....	35	32	27	....	....	32	40	35	....	33	39
Hogs, live	30	....	25	....	30	27	....	22	....	27	30	....	25	....	30
Lumber	25	20	25	....	....	22	17	22	....	....	30	25	30	27	....
Salt	25	20	25	....	....	22	17	22	....	....	30	25	30	27	....
Wool, in bales or sacks (min. wt. 10,000 lbs.)	65	53	....	....	....	63	50	....	....	....	71	59	....	....	....
Wool, machine-compressed, in bales (min. wt. 20,000 lbs.)	....	45	....	40	....	....	42	....	37	....	....	50	....	45	....

The average rates for the year were lower than they were for 1891. The average upon corn and wheat, Chicago to New York, shows the decline. For 1891 the average rate on corn and wheat was about 15 cents per bushel, while for 1892 it was about 14¼ cents.

To show the all-rail rate upon corn and wheat from Chicago to New York, and the per cent of increase and decrease for the period of twenty-two years, the following table is given:

All-rail rates, Chicago to New York.

Years.	Chicago to New York.			
	Corn, per bushel.		Wheat, per bushel.	
	Average rate.	Increase or decrease.	Average rate.	Increase or decrease.
	Cents.	*Per cent.*	*Cents.*	*Per cent.*
1870	28.00	....	30.00	....
1871	29.68	*6.0	31.80	*6.0
1872	32.66	*16.6	34.99	*16.6
1873	28.93	*3.3	31.02	*3.4
1874	24.50	12.5	26.25	12.5
1875	22.40	20.0	24.00	20.0
1876	15.74	43.8	16.86	43.8
1877	18.90	32.5	20.50	31.7
1878	16.52	41.0	17.70	41.0
1879	14.56	48.0	17.74	40.9
1880	17.48	37.6	19.80	34.0
1881	13.40	52.1	14.40	52.0
1882	13.50	51.8	14.47	51.8
1883	15.12	46.0	16.20	46.0
1884	12.32	56.0	13.20	56.0
1885	12.32	56.0	13.20	56.0
1886	14.00	50.0	15.00	50.0
1887	14.70	47.5	15.75	47.5
1888	13.54	51.6	14.50	51.7
1889	12.82	54.2	15.00	50.0
1890	†11.31	59.6	†14.37	52.1
1891	†15.00	46.4	†15.00	50.0
1892	†14.25	49.1	†14.25	52.5

*Increase. † Straight average.

LAKE AND CANAL RATES.

The following statement shows the weekly range of the rates upon wheat and corn, Chicago to Buffalo, via lake; Buffalo to New York, via Erie Canal; and the through rates, Chicago to New York, less the transfer charges at Buffalo, for the years 1890, 1891, and 1892:

[In cents per bushel.]

Week ending—	Lake—Chicago to Buffalo.						Erie canal—Buffalo to New York.						Lake and Canal—Chicago to New York.					
	1890.		1891.		1892.		1890.		1891.		1892.		1890.		1891.		1892.	
	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.	Wheat.	Corn.
May 10	1¾	1½	1⅜	1⅛	2	1¾	4	3⅝	2¼	2¼	2⅞	2½	5¾	5⅛	4⅛	3⅜	7⅞	4¼
17	1¾	1½	1¼	1⅛	2	1¾	4	3⅝	2½	1⅞	2¼	2	5¼	5⅛	3¾	3	4¼	3¾
24	1½	1¼	1	1	1¾	1½	4	3⅝	2½	2	2½	2¼	5½	4⅞	3½	3	4¼	3¾
31	1½	1¼	1	1	1½	1¼	3¾	3⅜	3¼	2¾	2½	2¼	5¼	4⅝	4¼	3¾	4	3½
June 7	....	....	1	1	1½	1¼	....	....	3	2½	2¼	2	....	....	4	3½	3¾	3¼
15	....	....	1	1	2	1¾	....	....	3	2½	2¼	2	....	....	4	3½	4¼	3¾
22	....	....	1	1	2	1¾	....	....	2⅞	2¾	2¼	2	....	....	3⅞	3¾	4¼	3¾
30	....	....	1½	1¼	2	1¾	....	....	2¾	2⅜	2¼	2	....	....	4¼	3⅝	4¼	3¾
July 7	2½	2⅛	1½	1⅜	2	1¾	3⅝	3⅛	2¾	2⅜	2¼	2	6⅛	5¼	4¼	3¾	4¼	3¾
14	2¼	2	2	1¾	2	1¾	3⅝	3⅛	2½	2¼	2½	2⅛	5⅞	5⅛	4½	4	4½	3⅞
22	2¼	2	2	1⅞	2	1¾	3⅝	3⅛	2½	2¼	2½	2⅛	5⅞	5⅛	4½	4⅛	4½	3⅞
29	2⅛	1⅞	2¼	2½	2	1¾	3⅝	3⅛	3½	3¼	2¾	2¼	5¼	5	5¾	5½	4¾	4
Aug. 7	1½	1¼	3¼	3	2½	2¼	3¾	3¼	3¼	3⅜	2⅝	2⅞	5¼	4½	7	6⅜	5⅛	4⅝
15	1½	1¼	2¾	2¼	2¼	2	4	3½	3⅞	3⅜	3	2⅝	5½	4¾	6⅝	5⅝	5¼	4⅝
23	1½	1¼	2¾	2½	2¼	2	4	3½	4	3⅝	3⅜	3	5½	4¾	6¾	6⅛	5⅝	5
30	1½	1¼	2½	2¼	2¼	2	4	3½	4	3⅝	3	2⅝	5½	4¾	6½	5⅞	5¼	4⅝
Sept. 7	1¾	1⅜	3¼	3	2¼	2	4	3½	4	3½	4	3½	5¾	4⅞	7¼	6⅓	6¼	5½
15	2	1¾	3½	3¼	2½	2¼	3⅞	3⅜	4¼	3⅞	3⅞	3½	5⅞	5⅛	7¼	7⅛	6⅜	5¾
22	2	1¾	3¾	3½	2½	2¼	3⅞	3⅜	4	3⅜	4	3⅝	5⅞	5⅛	7¾	7½	6½	5⅞
29	2	1¾	3	2¾	2¼	2	3⅞	3⅜	4½	4⅛	4	3⅝	5⅞	5⅛	7½	6⅞	6¼	5⅝
Oct. 7	2¼	2	2	1¾	2½	2¼	3¾	3¼	4½	4⅓	4¼	3⅞	6	5¼	6½	5⅞	6¾	6⅛
14	2⅛	1⅞	2	1¾	2½	2¼	3¾	3¼	4⅜	4	4⅜	4	5⅞	5⅛	6⅜	5¾	6⅞	6¼
22	1½	1¼	2	1¾	2¼	2	4¼	3¾	4¾	4¼	5	4⅝	5¾	5	6¾	6	7¼	6⅝
29	1¾	1½	2½	2¼	2¼	2	4¼	3¾	4½	4	6	5⅝	6	5¼	7	6¼	8¼	7⅝
Nov. 7	1¾	1½	4	3¾	3	2½	4¼	3¾	4¼	3¾	5	4⅝	6	5¼	8¼	7½	8	7⅛
15	2	1¾	4	3¾	2¾	2½	3½	3	3¾	3½	4	3¾	5½	4¾	7¾	7¼	6¾	6¼
22	1¾	1½	4	4	2½	2	3	2½	4	3½	4	3¾	4¾	4	8	7½	6½	5¾
30	3½	3¼	4½	4¼	2½	2½	....	....	4¼	3¾	5	4	....	....	8¾	8	7½	6½

TRANSATLANTIC RATES.

The rates upon ocean freights for the year have been quite generally lower than those of 1891. For the first six months of the year, or until July 1, the rates were higher, but from that time they declined rapidly, making the average for the year about 15 per cent lower than the average for the previous year. A showing of this is found in the following comparative statement of the rates upon a few of the more important articles of export from New York to Liverpool, as compiled from the returns of several of the steamship companies:

Articles.	January.		February.		March.		April.	
	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.
Wheat and corn........per bushel..	$0.06	$0.09	$0.07	0.07\frac{1}{2}$	$0.04	0.07\frac{2}{3}$	$0.04	0.06\frac{1}{4}$
Flour....................per barrel..	.48	.60	.54	.56	.36	.48	.36	.34
Bacon............per 2,240 pounds..	4.80	6.00	6.00	5.20	4.80	4.80	3.60	4.80
Lard ....do....	4.80	5.30	5.40	4.60	4.20	4.80	3.00	4.05
Beef.....................per tierce..	.96	1.08	.96	.92	.72	.80	.60	.78
Pork....................per barrel..	.60	.78	.72	.62	.48	.62	.42	.54
Cotton..................per pound..	.00$\frac{5}{16}$	.00$\frac{35}{64}$	.00$\frac{11}{32}$	.00$\frac{5}{16}$	.00$\frac{1}{4}$	.00$\frac{5}{16}$	.00$\frac{1}{4}$	.00$\frac{9}{32}$
Apples ....per barrel..	.48	.72	.60	.60	.60	.50	.60	.51
Butter ....per 2,240 pounds..	7.20	8.00	8.40	7.20	7.20	7.20	6.00	7.20

Articles.	May.		June.		July.		August.	
	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.
Wheat and corn........per bushel..	$0.04	0.05\frac{1}{3}$	$0.04	0.04\frac{1}{6}$	$0.05	0.04\frac{5}{8}$	$0.06	0.05\frac{1}{4}$
Flour....................per barrel..	.36	.36	.36	.36	.36	.34	.36	.36
Bacon............per 2,240 pounds..	2.40	3.60	2.40	3.60	3.60	3.60	3.60	3.60
Lard ....do....	2.40	3.00	2.40	3.00	3.00	3.00	3.60	2.90
Beef.....................per tierce..	.42	.56	.48	.56	.60	.60	.60	.56
Pork....................per barrel..	.30	.42	.30	.42	.42	.42	.42	.40
Cotton..................per pound..	.00$\frac{3}{16}$	.00$\frac{3}{16}$	.00$\frac{3}{16}$	.00$\frac{1}{4}$	.00$\frac{3}{16}$	.00$\frac{15}{64}$	.00$\frac{3}{16}$	.00$\frac{3}{16}$
Apples ....per barrel..	.60	.52	.60	.48	.60	.56	.60	.60
Butter ....per 2,240 pounds..	6.00	6.00	7.20	7.20	7.20	7.20	8.40	6.80

Articles.	September.		October.		November.		December.	
	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.
Wheat and corn........per bushel..	$0.08	0.03\frac{2}{3}$	$0.10	0.05\frac{1}{3}$	$0.12	0.06\frac{1}{2}$	$0.12	$0.04
Flour....................per barrel..	.48	.34	.60	.29	.72	.45	.72	.36
Bacon............per 2,240 pounds..	4.80	3.00	6.00	3.60	7.20	4.40	8.40	4.20
Lard ....do....	4.80	2.30	6.00	3.20	7.20	4.00	8.40	4.00
Beef.....................per tierce..	.84	.48	.96	.60	1.32	.76	1.44	.64
Pork....................per barrel..	.60	.34	.72	.44	.96	.58	.96	.46
Cotton..................per pound..	.00$\frac{3}{8}$	.00$\frac{9}{64}$	.00$\frac{7}{16}$	.00$\frac{9}{32}$	.00$\frac{7}{16}$	.00$\frac{19}{64}$	.00$\frac{7}{16}$	.00$\frac{15}{64}$
Apples ....per barrel..	.60	.60	.60	.60	.72	.60	.72	.60
Butter ....per 2,240 pounds..	8.40	5.60	8.40	6.00	10.80	6.80	10.80	6.60

To show the yearly average rate upon wheat per bushel from New York to Liverpool for the period of twenty-seven years, the following table is given:

Years.	Steamer rates.		Years.	Steamer rates.	
	Pence.	*Cents.*		*Pence.*	*Cents.*
1866	4.74	9.48	1880	5.88	11.76
1867	5.18	10.36	1881	4.08	8.16
1868	7.18	14.36	1882	3.87	7.74
1869	6.49	12.98	1883	4.54	9.08
1870	5.78	11.56	1884	3.40	6.80
1871	8.16	16.32	1885	3.60	7.20
1872	7.64	15.28	1886	3.46	6.92
1873	10.56	21.12	1887	2.71	5.42
1874	9.08	18.16	1888	2.67	5.34
1875	8.07	16.14	1889	4.06	8.12
1876	8.02	16.04	1890	*2.96	*5.92
1877	6.93	13.86	1891	*3.42	*6.84
1878	7.61	15.22	1892	*2.90	*5.80
1879	6.20	12.40			

* Straight average.

REPORT OF THE CHIEF OF THE SEED DIVISION.

SIR: In submitting my annual report for the fiscal year which ended June 30, 1892, I am gratified to report that great advancement has been made in the method and time of doing the legitimate work of this division. Changes have been made to expedite the work and yet to do it in such a manner as to secure success and a distribution of the seeds by the time the husbandman is ready to put them into the ground.

The Seed Division may be compared to a school into which a great variety of pupils are admitted, frequently the majority of them new ones, who must be taught how to do the work and at the same time carefully watched that no mistakes occur. The time of each employee must be kept, tardiness and days absent, and all grievances adjusted—which I am happy to state are few—in such a manner as to secure the desired object and at the same time give no undue offense.

Owing to delay caused by a death in the family of our purchasing agent, the seeds did not arrive as early last season as usual, being four weeks later than on the previous year; but by the help of a faithful corps of willing assistants, working systematically, the seeds were received by the farmers earlier than ever before since my connection with the division.

The seeds sent out during the last fiscal year have given general satisfaction, only a few complaints having been received, and they were generally from farmers inhabiting the districts that were flooded in the spring. The testing of the seeds has been done thoroughly in every particular, and no seeds have been sent out that were not what they should be.

If on the first test the desired percentage of germination was not obtained, a second trial was given, and if this proved unsatisfactory a third test was made in the soil in the propagating houses of the Department, and in case of failure there the seeds were returned to the party or parties from whom they were purchased.

In sending out seeds on Congressional orders it was customary to send a postal card notifying the person to whom they were addressed that they had been sent by request of a member of Congress, giving his name. Frequently the seeds were received a week or ten days before the notice arrived, and often the recipient of the seeds came to the conclusion that more seeds were on the way, and after waiting a few days would write and ask us why the seeds had not arrived. This would require an answer, which would take time, and thus the former method was annoying to us and misleading to the recipient of the seeds. Now, the member of Congress either puts his name on the frank before sending it to us, or in some cases we do so for him, and so the notice and the seeds go together. This method has been in practice for the last year and has given good satisfaction.

This division is one of great growth. By act of Congress of March 3, 1839, the sum of $1,000 was taken from the Patent Office fund and appropriated for collecting and distributing choice and valuable seeds. From this small beginning has grown the Department of Agriculture of to-day, composed of some twenty divisions, among which the Seed Division has in recent years received from Congress an appropriation of $100,000, which was last year deemed too small, and at the first session of the Fifty-second Congress an additional amount of $30,000 was added, so that during the fiscal year 1892-'93 the sum of $130,000 will be expended for this division alone. This shows an average growth, or increase, of a little over $2,400 per annum since 1839. During the past year 4,542,177 papers of seed have been sent to Senators, Representatives, and Delegates in Congress; 271,873 papers to county statistical correspondents; 72,357 papers to statistical agents, and 1,046,582 papers to agricultural associations, experiment stations, and miscellaneous applicants, making a total of 5,932,989 papers. The seeds sent to the correspondents are sent as partial payment for their labors in furnishing the Department with useful information, such as is indispensable to its growth and well-being.

As the years glide by our farmers are becoming more and more enlightened and enterprising. They are adopting the most improved farming implements, the best methods of cultivation, and are reading and obtaining information from a high class of agricultural papers. This has caused a demand for new and improved varieties of seeds, and it is through this division that the Government has sought to supply this want. Alfalfa, Japan, and Alsike clovers sent out from this division are doing the farmers much good by furnishing them larger crops of grass and hay, while Bermuda grass is in good demand in the Southern States, especially in those having a calcareous or a sandy soil. Two years ago this division distributed some 500 bushels of Japanese buckwheat, which yielded per acre double the number of bushels usually obtained from a seeding of the old sort. This new variety did not blight by the hot sun in the early autumn months as did the old kind, and matured in time to escape the early frosts.

If the old variety paid the farmer for the seed, the use of the land on which it grew, and necessary labor, this new variety paid him a clear profit of 100 per cent. In some of the Northwestern States this variety is now principally used. What is true of this kind of seed is true in in a measure of all good varieties.

The crops of the country now yield a much larger profit than they did a few years ago, which is owing to superior seed, improved machinery, and more scientific methods of cultivation and farming. The law gives two-thirds of all the seeds handled by this division to members of Congress, and it also gives them until the 1st day of July in each year in which to get them from this division.

In all cases when not called for, the seeds have to be carried over. This should not be done, as the longer the seeds are kept the less vitality they possess. In my opinion the 1st of April would give all members plenty of time in which to get their seeds, and what then remained could be sent out to miscellaneous applicants. During the past summer an extra building has been provided, a part of which is used for storing seeds, but with this additional space the division has not sufficient room at its command in which to handle, put up, and store all the seeds; and this want of room adds materially to the cost of each yearly distribution. I hope that all members of Congress who are interested in this division will see that it is provided with more room in the near future.

Respectfully submitted.

J. B. PECK,
Chief.

Hon. J. M. RUSK,
Secretary.

CONDENSED REPORTS FROM CORRESPONDENTS.

ALABAMA.

Beans.—Canadian Wonder—vigorous growth, good producers; Flageolet—very fine and good yield.

Beet.—Early Blood Turnip—grew very large and sweet; Long Smooth Blood—fine crop of best quality, some weighing 10½ pounds.

Cabbage.—Early Winningstadt—fine crop and early.

Sweet Corn.—Black Mexican—fine growth, quality can not be excelled; Evergreen—very successful.

Grass.—The Bermuda—made a fine stand, grew from 1 to 8 inches in height.

Onion.—Giant Rocca—very good; Red Wethersfield—very fine; Yellow Danvers—excellent, grew quite large.

Peas.—Champion of England—were fine, large, and of delicious flavor.

Pepper.—Bull Nose—fine.

Pumpkin.—Sweet Potato—very fine.

Radish.—French Breakfast—very fine.

Squash.—Pike's Peak—very prolific, superior in quality to any ever used.

Tobacco.—Caboni—very superior, grew to height of 8 feet, matured well and was fine in flavor; Improved Oronoko and Gold Finder—were excellent varieties.

Tomato.—Perfection—very successful.

Turnip.—Ruta Baga, White Swede—was satisfactory.

Wheat.—Currell's Prolific—was sown on poor light soil, but matured well, attaining average height of 3½ feet, and producing strong, straight straw, with fine grain.

ARIZONA.

Beans.—German Black Wax—good yield.

Cucumber.—The Boston Pickling—early and very fine.

Peas.—The Abundance—did very well; Horsford's Market Garden—highly satisfactory.

Pumpkin.—Quaker Pie—did finely.

Radish.—Early Scarlet Turnip—very fine and early.

Squash.—Early White Scalloped—grew well without cultivation.

Watermelon.—Georgia Rattlesnake, Green and Gold, and Cuban Queen—were all fine varieties.

ARKANSAS.

Beans.—Dwarf or Bush Refugee—prolific, and good variety; Early Mohawk—very productive and good quality; Improved Valentine—excellent string or bunch bean, fine growers.

Beet.—Dark Red Egyptian—were of good size and flavor; Eclipse Blood—grew very large, were crisp and sweet; Edmand's Blood Turnip—very early, fine flavor, and does not soon get woody; Extra Early Egyptian—a success here; Imperial—did well; Long Smooth Blood Red—fine growth and good for pickling.

Cabbage.—All Seasons—perfectly satisfactory; American Flat Dutch—very satisfactory; Early Summer—did well, about 50 per cent heading; Fottler's Improved Brunswick, "large heads, white; best I ever saw."

Carrot.—Midsummer—were very good in quality.

Corn.—Crosby's Early Sweet—good growth and of excellent quality; Evergreen Sweet—stands heat very well; Potter's Excelsior Sweet—best raised in this locality.

Cotton.—Southern Hope—made good yield, fine staple, grew 2,000 pounds seed cotton per acre.

Cucumber.—Improved Long Green—gave entire satisfaction; White Spine—were very good.

Grass.—Bermuda—just suited to this soil and climate.

Kale.—Green Curled Scotch—very fine, wish for none better; Siberian—very superior quality.

Lettuce.—Black Seeded Simpson—very fine, tender, and sweet, making heads 10 inches across; Early White Cabbage—prolific and of good variety; Golden Stone—did finely; Improved Royal Cabbage—fine, makes head like small cabbage, leaves being very light green, recommend it; Salamander—did finely.

Muskmelon.—Emerald Gem—prolific and very sweet; Netted Gem—prolific, tender, and sweet; Stickney's Long Yellow—very large and fine, finest ever grown in neighborhood.

Mustard.—Southern Giant Curled—was very good.

Onion.—Large Red Wethersfield—grows large and are of excellent flavor; Southport Large Red Globe—very good and grows quite large; Yellow Danvers—remarkable, some weighing 3 pounds; Yellow Globe Danvers—fine results.

Parsnip.—Hollow Crown—were very large, smooth, and nice.

Peas.—Champion—were good, strong growers; Dexter's Extra Early—come up early, large pods full of peas; Extra Early Rural New Yorker—"matured soonest, and are the best have ever had;" First and Best—did extremely well and were of delicious flavor; Premium Gem—made a fine yield and were of good quality; Stratagem—bore well and were of fine quality.

Radish.—Early French Scarlet Turnip—very crisp and tender; Winter Rose—very satisfactory; Yellow Globe—grows quickly, and will stand more hot, dry weather than any other tried here.

Spinach.—Perfection Curled—can not be excelled; Round, Thick-Leaved, grew finely, and were a great table delicacy.

Squash.—Mammoth Chili—grew to perfection.

Tobacco.—Hester—very fine; Improved Oronoko and White Burley—were both satisfactory.

Tomato.—Acme—one of the best varieties; Livingston's Favorite—can not be too highly recommended; Livingston's Perfection—splendid success, fine, smooth, large, stands dry weather, blooming and bearing until frost; Peach—did well.

Turnip.—Early Blood Turnip—was very fine and of excellent quality; Pomeranian White Globe—thrifty growth and very satisfactory.

Watermelon.—Florida Favorite—were of good size and superior in quality; Pride of Georgia—did well and was of delicious flavor.

CALIFORNIA.

Beans.—Dwarf or Bush Scarlet—proved a number one string bean; Rust Proof Golden Wax—very satisfactory.

Beet.—Eclipse—were very early, fine quality, a few weighing over 1 pound; Edmand's Blood Turnip—prolific, very early, very tender, sweet, bright red; Egyptian—"matured quickly, best quality, and largest I ever raised;" Improved Blood Turnip—very good.

Cabbage.—All Seasons—large, solid white, excellent flavor, some weighed 22 pounds; Flat Dutch--good in quality and size; Mammoth Late Drumhead—grew well, some of the heads weighing 25 pounds; Succession—heads were large as a nail keg in diameter, and solid.

Corn.—Early Cory Sweet—strong grower, large ears, eight-rowed, large-grained; Evergreen Sweet—very good variety for this part of the country, prolific, and fodder excellent for stock.

Cucumber.—Early Frame—"finest I ever raised, were 8 inches long."

Lettuce.—Salamander—very fine; Satisfaction—grew large, firm, crisp heads, are tender and sweet; White Seeded Simpson—finest ever grown in northern California, was large as cabbage.

Muskmelon.—Black Paris—Good size, green-meated, very rich and spicy, extra nice; Miller's Cream—good flavor and very productive; Netted Nutmeg—delicious flavor, early, and very nice.

Onion.—Southport Large Red Globe—excellent results; Yellow Globe Danvers—produce large, fine onions that keep well.

Parsnip.—The Sugar or Cup—excellent.

Peas.—Champion of England—attained height of 4 feet and began to ripen in June, peas were large and pods fine; Stratagem—"more prolific than any I have tried, very desirable;" Telephone—long pods filled with immense peas, tender and sweet.

Radish.—Early French Scarlet and White Tipped Scarlet—both early and of fine flavor; French Breakfast—of rapid growth, crisp, and of fine flavor; Ne Plus Ultra—grew large, crisp, and tender.

Spinach.—Long Standing—splendid growth, tender and nice.

Tomato.—Livingston's Beauty—prolific, early, beautiful color, large size; Livingston's Perfection—the very best of all that have been tested; New Jersey—very early and excellent in quality.

Turnip.—White Globe—early and of excellent flavor.

Watermelon.—Improved Kolb Gem—fine size, red flesh, with yellow core and dark seeds.

COLORADO.

Beans.—Dwarf Golden Wax—great success, early and of good quality; Dwarf or Bush—prolific and early; Early Mohawk—early and prolific.

Beet.—Blood Turnip—notwithstanding hail storm and whirlwinds, were very fine; Long Smooth Blood—large size, flesh tender and sweet.

Cabbage.—Bristol Flat Dutch—medium sized heads of a delightful flavor; Early Winningstadt—good for this climate, makes large solid heads.

Carrot.—Midsummer—very good, quick growth, also a good cropper; Yellow Belgian—large, very mild, and of fine flavor.

Cucumber.—Boston Pickling—an abundant bearer and a fine cucumber; Improved Long Green—great bearer and of excellent quality.

Field Corn.—Hickory King—grew to height of 7 feet.

Grass.—Orchard—was sown on both sides of a large dike, grew finely, and when all grasses were frosted was green and luxuriant.

Lettuce.—Improved Royal Cabbage—"grew largest heads I ever saw;" White Chavigne—of rapid growth, a superior variety.

Muskmelon.—Emerald Gem—quick growth, best quality of any tested here; Netted Nutmeg—fine growth and of excellent quality.

Oats.—White Wonder—matured well and gave entire satisfaction.

Onion.—Spanish King—very satisfactory; Yellow Globe Danvers—did finely.

Peas.—Forty Fold—good, thrifty, late pea of fine quality; Stratagem—were early, prolific, and of fine flavor; Telephone—"finest flavored and best bearers I have ever seen."

Radish.—French Breakfast—fine; Scarlet Turnip—early, medium size, sweet and tender.

Spinach.—Long Standing—excellent.

Tomato.—Trophy—"failure with me."

CONNECTICUT.

Asparagus.—Conover's Colossal—came up finely, and by winter had finest heads of one-year old plants seen in this part of the country.

Beans.—Dwarf or bush—excellent quality, both as shell or string bean.

Beet.—Eclipse—good for early market, easily grown.

Cabbage.—Early Summer—"perfect, finest I ever grew, one head weighing 13 pounds."

Sweet Corn.—Evergreen—excellent for table use, a good variety; Pride of the North; field—good size, fine yielder, and is early.

Lettuce.—White Seeded Simpson—very good; was tender late into the season.

Onion.—Large Red Wethersfield—very good flavor for cooking; Yellow Globe Danvers—most excellent, mild flavor and good size.

Pepper.—The Bull Nose—has a large growth; a good yielder.

Turnip.—Purple Top Munich—very good; one weighed 5¼ pounds; seeds germinate well.

Watermelon.—Mammoth Iron-Clad—were magnificent, some weighing 50 pounds.

FLORIDA.

Beet.—Dewing's Early Red—good variety; The Eclipse—excellent and well suited to middle Florida.

Cabbage.—Large Drumhead and Vandergaw—fine.

Lettuce.—Chartier—very crisp and fine.

Muskmelon.—Miller's Cream—very fine.

Onion.—Red Globe—satisfactory; Yellow Globe Danvers—fine variety for Southern market gardens; do exceedingly well here.

Peas.—McLean's Advancer—do well in this climate.

Radish.—French breakfast—satisfactory; Scarlet Turnip White Tipped—grew rapidly and were very tender.

Squash.—Boston Marrow—a superior variety; Pike's Peak or Sibley—fine winter variety; raised one weighing 6 pounds and measuring 20 inches in circumference.

Tobacco.—Missouri Broad Leaf—did very well; Yellow Oronoko—was fine in flavor.

Tomato.—Livingston's Favorite—very fine.

Turnip.—Red Top Strap Leaf—were exceedingly sweet.

GEORGIA.

Beans.—Dwarf Scarlet Wax—admirable; Yellow Six Weeks—"best we ever raised."
Beet.—Edmand's Early Blood Turnip—one of the best.
Cabbage.—Early Express—fine, and two weeks ahead of any others; Early Flat Dutch—very large, solid heads of rich flavor; Early Jersey Wakefield—medium sized heads, but hard and solid; Early Summer—success in every way; Fottler's Brunswick—very large, solid and of excellent quality; Royal White—never saw any better.
Carrot.—Luc Half Long Stump-Rooted—excellent variety and grows large.
Corn.—Portland Hybrid Sweet—very early and made a good yield.
Cotton.—Improved Crossland—very productive, large bolls, five locks.
Cucumber.—Siberian—good early variety.
Lettuce.—All Cream—very good; Hanson—heads large and solid, fine flavor and tender; Black Seeded Simpson—"finest variety I ever saw."
Muskmelon.—Stickney's Long Yellow—"one of the largest ever raised by us."
Onion.—Yellow Globe Danvers—very satisfactory; Red Wethersfield—splendid variety, very productive.
Peas.—Champion of England—very fine, 1 package produced 500 hills of living vines until December 15, from second planting; Yorkshire Hero—very fine variety.
Radish.—White Strasburg—a good variety and of rapid growth.
Tomato.—Livingston's Perfection—large, smooth and prolific; Acme—"finest we ever had;" Trophy—very productive.
Turnip.—White Strap Leaf—was of quick growth and delicious.

IDAHO.

Beet.—Long Smooth Blood—very successful; New Eclipse—very fine.
Cabbage.—Early Summer—very fine; Extra Flat Dutch—excellent both for summer and winter, heads weighing from 20 to 25 pounds per head, good flavor.
Carrot.—White Belgian—good.
Lettuce.—Salamander—very good, large compact heads, stand heat well.
Muskmelon.—Christiana—good variety of excellent sweet flavor; Netted Gem—very fine.
Onion.—Southport Yellow Globe—extra fine.
Peas.—Premium Gem—very prolific, fine, three weeks earlier than any others.
Pepper.—Sweet Mountain—did well.
Radish.—Chartier—did well.
Turnip.—Red Top Strap Leaf—of fine flavor and a good cooking variety.
Watermelon.—Mountain Sprout—did well; Mountain Sweet—very good.
Wheat.—Red Fyfe—1 quart yielded 1 bushel; this produced 30 bushels.

ILLINOIS.

Beans.—Canadian Wonder—did well; Dwarf Yellow Six Weeks—very productive; Early China Red Eye—produced well; Golden Wax—were very productive, pods were large and tender.
Beet.—Early Bassano—was tender and sweet; Dewing's Blood—were tender, sweet, and large; Dewing's Improved Early Turnip—excellent; Early Eclipse—came up well, sweet, fine grained and tender; Edmand's Early Blood Turnip—very fine; Long Smooth Blood—beets weighed from 3 to 5 pounds, smooth and fine.
Buckwheat.—Japanese—2 quarts yielded 4 bushels of finest quality large, plump wheat; averaged 29 pounds to the bushel.
Cabbage.—Bristol Flat Dutch—took premium at the county fair; Early Summer—came up well, good-sized heads and compact; Early York—medium size, very white and crisp; Mammoth Late Drumhead—did well and grew to large solid heads; Marble Head Mammoth—produced large and solid heads; Jersey Wakefield—produced solid pointed heads; Stone Mason and Premium Dutch Cabbage—were hardy and vigorous, heads large and solid.
Carrot.—Danvers Half Long Orange Variety—finest raised in years, both in size and quality; Large Orange—large and smooth, beautiful color, and keep well.
Celery.—Improved White Plume—made vigorous and rapid growth, crisp and delicious.
Corn.—Cory Sweet—of vigorous growth, early and of good quality; Hickox Improved—best ever raised in every respect; Hybrid Sweet—was early and had large, well-filled ears; Mexican Sweet—took first prize at the county fair; Perry's Hybrid—two ears on every stalk, 12 to 14 rows on each ear, very nice and sweet.
Cucumber.—Boston Pickling—"most productive and best pickle I ever raised;" Long Green—large and smooth, a fine bearer; Early Frame—profuse bearers, well

formed and free from bitterness; Improved White Spine—early and very productive; Perfection White Spine—were early, of fine appearance and vigorous.

Field Corn.—The Piasa King—white; one quart produced 12 bushels of fine corn.

Kale.—Dwarf German—was a success.

Lettuce.—Black Seeded Simpson—large heads, measuring 12 to 14 inches across, keep well; California All Heart—splendid; Early Curled Simpson and Hardy Green Winter—both of rapid growth, crisp and well flavored; Hanson—gave entire satisfaction; Royal White Cabbage—was splendid; Satisfaction—well named.

Muskmelon.—Hackensack—attained a large growth; Netted Gem—an abundant bearer.

Oats.—White Wonder—produces tall, stiff straw and fine, plump grain, well suited to this section of the country.

Onion.—Large Red Wethersfield—of fine growth and mild, pleasant flavor; White Bermuda—proved to be excellent; Yellow Danvers Globe—Sweet and well flavored.

Parsnip.—Hollow Crown—was vigorous in growth; Student—of vigorous growth and good quality.

Peas.—Horsford's Market and Champion of England—both did remarkably well; Dexter's Early—profuse bearers and of a fine flavor; Stratagem—"largest and finest in flavor I have ever seen;" Yorkshire Hero—pods 6 inches in length, peas almost as large as Lima beans, do not get tough and are very sweet, splendid.

Pumpkin.—Cashaw—good bearer, splendid for pies; Large Cheese—took premium at the county fair; Small Sugar—splendid, good color, and keep well through the winter.

Radish.—Early French Scarlet—best in quality, crisp and tender; Early Round Dark Red—extra early variety and of a mild flavor.

Salsify.—Large Round Purple—very successful; Mammoth Sandwich Island—good, roots large, straight and well flavored.

Spinach.—Viroflay—was satisfactory.

Squash.—Crook Neck—was very productive; Early Orange Prolific Marrow—good, keep well; Sibley—gave perfect satisfaction.

Tomato.—Extra Early Advance—splendid; Livingston Beauty—ripens early, bright color and very prolific; Livingston's favorite—was a success; New Jersey Variety—large, smooth and sound; Perfection—fine a tomato as one can get; Paragon—of large growth and fine flavor.

Turnip.—Early Red Top Strap Leaf—splendid variety, raised 25 bushels from one small package; White Top Strap Leaf—was early, sweet, and tender; Purple Top Strap Leaf—excellent quality, tender, sweet, and juicy.

INDIANA.

Beans.—Early Mohawk—hardy; Golden Wax—quite productive and very early.

Beet.—Eclipse—had a fine crop of large size; Edmand's Early—were early and well flavored; Long, Smooth Blood Red—very tender and sweet, fair size, and keep well.

Cabbage.—All Seasons—finest, largest heads of all the cabbage raised of six different varieties; Bristol Flat Dutch—fine solid heads, sweet and crisp; Hard Heading—"best variety I have seen;" Improved Savoy—made excellent heads, not subject to worms as other varieties.

Carrot.—Danvers Half Long—more productive than any other.

Cucumber.—Improved Long Green—did well and is a very prolific bearer.

Lettuce.—California All Heart—large solid heads; Salamander—excellent, crisp and tender, did not get bitter, as is the fault of many kinds.

Okra.—Dwarf—excellent growth and enormous yield.

Onion.—Southport Large Red Globe—fine size and keep well; White Globe—prolific, and mild in flavor.

Parsnip.—Improved Guernsey—most excellent result; Sugar or Cup—sweet, and fine size.

Peas.—Blue Peter—very prolific, and finely flavored; Dexter's Early—"finest I ever saw."

Pepper.—Sweet Mountain—had 18 large peppers at one time and 5 dozen during the season from one plant.

Pumpkin.—Small Sugar—best ever cultivated in Indiana, excellent bearer, not watery when cooked.

Radish.—Scarlet Turnip—very fine; Early French Scarlet—early, tender, and of fine flavor.

Squash.—Boston Marrow—proved most excellent; White Pineapple—ripened well and early.

Tomato.—Acme—excellent in quality and very handsome; Early Richmond—great bearer and of excellent quality; Livingston Perfection—extra good yielder and of good flavor; Mikado—received premium at fair, splendid, remains solid when ripe; New Jersey—large, smooth, and of delicious flavor.

Turnip.—Early White Strap Leaf—were fine, sweet, and tender; German Sweet—did well, averaging from 3 to 5 pounds, one 8 pounds; Rutabaga—satisfactory.

Watermelon.—Kolb Gem—ripened almost to rind, large, sweet, and rich.

Wheat.—Currell's Prolific—two quarts yielded 5 pecks, these 5 pecks were again sown on 1½ acres, and produced 53½ bushels of plump grain.

INDIAN TERRITORY.

Beet.—Dewing's Early Red—wonderfully quick grower and fine quality; Eclipse—fine variety, first-class crop.

Cabbage.—All Seasons—excellent, is all its name implies; Jersey Wakefield and Flat Dutch—were very fine, every seed came up.

Carrot.—Early Scarlet Horn, Blunt Rooted—proved very fine, growing to an enormous size.

Cucumber.—Pefection White Spine—best ever planted.

Lettuce.—Black Seeded Simpson—finest ever raised in this part of the country; Hanson—could not be excelled; Salamander—exceedingly fine.

Muskmelon.—Miller's Cream—delicious aroma and taste; Netted Gem—most prolific bearer and delicious.

Onion.—Red Wethersfield—produced well.

Parsnip.—Sugar—the very best.

Peas.—Champion of England—produced well-filled pods, finely flavored; Morning Star—fine, very prolific, and sweet; Stratagem—finest quality and yield out of a dozen varieties; Yorkshire Hero—very productive and of excellent flavor.

Pumpkin.—Sugar—should be in every family, fine table variety; New England Pie—delicious, and a fine bearer.

Radish.—White Globe—solid, crisp, and of good flavor.

Salsify.—Long White French—excellent, tender, and succulent.

Tomato.—Trophy—finest ever planted in this part of the country; Perfection—large and fine flavor, continued to bear until frost.

IOWA.

Beans.—Red Valentine—did finely; Early Rachel—proved hardy and early.

Beet.—Bastian's Blood Turnip—good as ever raised, grows very large, one measured 18 inches in circumference; Dark Red Egyptian—excellent early variety, tender and sweet; Dewing's Early Red—did well, good for stock; Eclipse—satisfactory; Early Blood Turnip—fine quality; Edmand's Turnip Blood—sweet and tender; Improved Early—very good.

Cabbage.—All Seasons—satisfactory in every way; Bristol Flat Dutch—can not be excelled; Early Summer—had large heads, of fine quality; Late Flat Dutch—produced large solid heads; Large Flat Dutch—very fine.

Carrot.—Belgian—germinated well, large fine growth; Half Long Danvers—extra large and of fine quality.

Celery.—Golden Heart—extra fine.

Corn.—Black Mexican, Sweet—early, produced large ears; Early Bonanza Sweet—was large and fine; Early Cory Sweet—fine crop, early, and of good quality; Early Eclipse Yellow, Field—excellent variety, especially for fodder; Hickox Improved Sweet—pronounced the finest in this country; Portland Hybrid Sweet—deserves a prominent place among early varieties.

Cucumber.—Improved Long Green—fine variety.

Endive.—Green Curled Summer—good results.

Field Corn.—Pride of the North—good yield, and exceedingly fine corn.

Grass.—Kentucky Blue—fine, good stand.

Kale.—Dwarf Green Curled—this variety is not liked for table use; Siberian—fine.

Lettuce.—Buttercup—excellent results; California All Heart—good flavor, keeps tender longer than any other kind; Early White Cabbage—a fine variety; Early Simpson—was extra nice; Prize Head—fine, large, crisp, and of delicious flavor; Royal Cabbage—stood drought well, very fine.

Muskmelon.—Delmonico—very large and finely flavored; Christiana—good yield and fine flavor; Netted Gem—very fine; Miller's Cream—"finest I ever ate."

Oats.—White Wonder—very prolific, free from rust, stood heavy, and grain plump and full.

Onion.—Improved Red Bermuda—very nice, good flavor, prolific; Silver King—was exceedingly good; Red Wethersfield—best of all onions for general crop, keeps well; Yellow Danvers—fine in quality, and good producers.

Parsley.—Emerald Gem—fine; Double Curled—good results.

Parsnip.—Hollow Crown—were excellent.

Peas.—American Wonder—both early and late sowing yielded well, good flavor; Blue Beauty—gave good satisfaction; Champion of England—enormous growth, heavy crop, good vegetable; Dexter's Extra Early—were very early and prolific; Forty Fold—began blossoming 1 foot high, continued to blossom and set pods until 5 feet high, never saw peas so prolific, and of such excellent quality; Horsford's Market Garden—excellent variety and an abundant bearer; Morning Star—were a great success; Premium Gem—great success, a fine yielder; Stratagem—perfect success, both in flavor and production; Telephone—excellent variety.

Pepper.—Ruby King—very good variety; Sweet Mountain—good results, but late for this section.

Pumpkin.—Small Sugar—excellent for table use; Quaker Pie—matured early and was a good variety.

Radish.—Chartier—fine a radish as sown in open ground, will repay any trouble taken to raise them; Early French Scarlet Turnip—is crisp, delicious, and of quick growth; Early White Turnip—grew to large size and was very solid; Scarlet Globe—produced well and were of a fine quality; Scarlet Turnip, White Tipped—very tender and excellent.

Spinach.—Round Leaved—good quality.

Squash.—Pike's Peak or Sibley—small but fine, "best I ever ate;" Early Orange Prolific Marrow—early, good size, and excellent in quality.

Tomato.—Acme—good; Livingston's Favorite—good cropper, fine flavor; Livingston's Perfection's—splendid variety and good for table; Perfection—excellent results, very fine tomato; Paragon—prolific and luscious, a few plants supplied a large family; Trophy—very prolific, nice and firm, good for packing.

Turnip.—Purple Top Strap Leaf—fine crop; Rutabaga, Laing's Improved—very good variety for table; White Egg—was early, sweet, and tender; White Globe—were firm and sweet; Red Top Strap Leaf—of rapid growth, large and tender.

Watermelon.—Florida Favorite—grew well and was of excellent flavor; Kolb Gem—splendid, some grew large as a water pail.

KANSAS.

Asparagus.—Conover's Colossal—did very finely.

Beans.—Dwarf or Bush—satisfactory; Dwarf Golden Wax—excellent; Dwarf Black Wax—good yield, and lasted a long time; Early Rachel—early variety and very tender; Golden Wax—satisfactory; New Speckled Wax—productive; Red Valentine—prolific, tender, and good.

Beet.—Bastian—very large, tender, fine flavor; Eclipse—large and of rapid growth; Edmand's Early Blood Turnip—good size and quality; Improved Early Blood—very nice; Long Smooth Blood—tender and rich in flavor; Dewing's Early Blood Turnip—large in size, good flavor and color; Early Eclipse—grew large and was of fine flavor; Mangel-wurzel—very fine, some weighing from 12 to 15 pounds each.

Cabbage.—All Seasons—produced excellent heads; Extra Flat Dutch—large, rapid growth, stood drought well; Large Flat Dutch—very fine; Early Summer—produced large, tender, sweet heads; Jersey Wakefield—produced fine, large heads; Stone Mason—gave good results; Premium Flat Dutch—very good; Winningstadt—small, but solid heads.

Carrot.—Early Scarlet Horn—early and finely flavored; White Belgian—did well.

Corn.—Early Eclipse, Field—best in quality and quantity ever raised here; Evergreen, Sweet—gave good yield, splendid table variety; Portland Hybrid, Sweet—excellent; Asylum, Sweet—did well.

Cucumber.—Chicago Pickling—very fine; Improved Long Green—large, smooth fruit; White Spine—satisfactory.

Field Corn.—New Eclipse—valuable acquisition to southwestern Kansas, matures early, and is noted for standing drought well; yield 50 to 60 bushels per acre, 70 pounds of ears shelled 62 pounds of corn.

Kale.—Dwarf Green Curled—good all seasons, splendid growth.

Lettuce.—All Cream—quick in growth, and tender; Early Curled Simpson and All the Year Round—produced fine crops of beautiful lettuce; Improved Royal Cabbage—fine; Salamander—was fine; St. Louis Market—was very fine; White Cabbage—excellent.

Muskmelon.—Emerald Gem—extra good; Netted Gem—early and of fine flavor; Netted Nutmeg—rich, juicy, good yield, a splendid melon.

Oats.—White Wonder—very satisfactory.

Onion.—Large Red Wethersfield—fine variety, mild and crisp; Southport Red Globe—excellent; Yellow Globe—very good.

Parsnip.—Long White Student—did well, quality fine.

Peas.—Champion of England—very prolific, fine flavor, vines 2 feet high; Dexter's Extra Early—early and prolific; Early May—early and good; Eugenia—did well; Everbearing—very prolific; Abundance—satisfactory in every respect; American Wonder and Premium Gem—very productive and excellent in quality; Rural New Yorker—heavy bearer, extra good quality; Telephone—a success; Yorkshire Hero—hardy and prolific.

Pepper.—Sweet Mountain—very productive.

Pumpkin.—Sugar or Pie—germinated well, fine flavor, and solid; Quaker Pie—proved very good.

Radish.—French Breakfast—splendid; French Half Long Scarlet—matures quickly, crisp, and good color; Chartier—early, crisp, and tender; Large White—large, tender, and white; Long Scarlet—satisfactory; Ne Plus Ultra—quick growth, sweet and tender; Rosy Gem—did well; Scarlet Turnip—did well.

Spinach.—Long Standing—seed germinated well, plants thrifty; Round Thick Leaved—very nice and good.

Squash.—Mammoth—was satisfactory; Mammoth Chili—satisfactory; Sibley—fine in flavor and keep well.

Tobacco.—White Burley and Gold Finder—did well, grew large.

Tomato.—Acme—small, but excellent; Peach—small, but of fine flavor; Trophy—good, heavy bearer.

Turnip.—Red Top Strap Leaf—fine; White Egg—satisfactory; White Globe—productive.

Watermelon.—Cuban Queen—strong grower and a good shipper; Georgia—an excellent variety; Jumbo—grew to perfection and was finely flavored; Kolb's Gem—surpassed 15 varieties before tested.

Wheat.—Velvet Chaff—from one-half bushel raised 11 bushels, and proved a superior variety.

KENTUCKY.

Beans.—Dwarf Golden Wax—pods large and well filled, bore three crops; Early Rachel—very early, and of superior quality; Red Valentine—very prolific and nice.

Beet.—Edmand's Blood Turnip—good grower, produces well, superior to any tested; Egyptian—early and tender.

Cabbage.—Early Jersey Wakefield—very fine; Early Summer—produced good, large heads; Jersey Wakefield—did splendidly.

Carrot.—Danvers Half Long—rich in flavor and smooth.

Corn.—Early Cory Sweet—"earliest I have had, ears large for so early a kind;" Early Hybrid Sweet—did well.

Cucumber.—Improved Long Green—made fine pickles.

Kale.—Dwarf Green (German)—very fine for table use.

Lettuce.—Royal White Cabbage—very productive, delicious flavor, good for market.

Onion.—Large Red Wethersfield—large growth, and fine fruit; Yellow Globe—large and handsome.

Parsnip.—Hollow Crown—prolific, tender, and sweet.

Peas.—First and Best—very good.

Pumpkin.—Sweet or Sugar—large and very productive.

Radish.—Early French Scarlet Turnip—quick growth, tender and crisp; White Tipped—very successful.

Tobacco.—Burley—"pronounced superior to any variety of Burley they had had by the dealers;" Conqueror—very healthy and vigorous in growth.

Tomato.—Acme—several days earlier than others, also larger; Early Puritan and Livingston's Beauty—"superior to any I have ever cultivated."

Turnip.—Early White Strap Leaf—large and excellent in quality; Purple Top Strap Leaf—produced large, fine fruit.

Watermelon.—Light Icing—sweet, rich, and crisp.

LOUISIANA.

Beans.—Early China Red Eye—prolific.

Beet.—Egyptian—very fine, solid, and of good flavor.

Cabbage.—Early Summer—satisfactory.

Carrot.—Early Scarlet Pointed Horn—good size and flavor.

Cotton.—King's Prolific—yield of lint at the gin per 100 pounds was 35 per cent; one quart of seed yielded 150 pounds of seed cotton.

Kale.—Dwarf Green Curled—very fine.

Lettuce.—Black Seeded Simpson—very fine.

Onion.—Red Globe—very good, produced onions 3½ inches in diameter, fine flavor.

Radish.—Early White Turnip—good.

Squash.—Boston Marrow—a most prolific variety.

Tomato.—Perfection—prolific, well shaped and well flavored.

MAINE.

Beans.—Case Knife Pole—hardy and prolific.
Beet.—Edmand's Early Blood Turnip—early, good size, sweet, and tender.
Cabbage.—Early Summer—large compact heads, very early and of good quality; Fottler's Improved Brunswick—large fine heads, and very tender; Large Flat Dutch—made fine heads; Improved Late Drumhead—large, solid heads, excellent in quality and flavor; Premium Dutch—every plant produced large, solid heads, tender, and sweet.
Carrot.—Yellow Belgian—large, long, smooth, and fine in grain.
Celery.—Improved White Plume—early and has a delicate, nutty flavor.
Corn.—Black Mexican Sweet—excellent; Potter Sweet—excellent quality and good yielder; Crosby's Early Sweet—late, but very sweet and of fine quality.
Cucumber.—Boston Pickling—early, prolific, and good size; Extra Long Green Turkey—"best I ever raised;" Improved Long Green—fine.
Peas.—First and Best and Premium Gem—excellent in every respect; Stratagem—excellent quality.
Radish.—Scarlet Turnip White Tipped—early, rich in color.
Tomato.—Telegraph—satisfactory; New Peach—excellent quality and not subject to rot; Trophy—prolific, of fine flavor and large size.
Turnip.—Red Top Strap Leaf—rapid growth and very good quality.

MARYLAND.

Beans.—Early China Red Eye—very tender and stringless.
Peas.—Champion of England—were tender, sweet, and delicious; Early Profusion—very prolific, and well flavored.

MASSACHUSETTS.

Beans.—Dwarf or Bush and Yellow Six Weeks—early, prolific, and good quality.
Beet.—Dewing's Early Red—very tender, sweet, and good; Early Blood Turnip—very finest quality for table use; Egyptian—took first premium at the county fair; Long Smooth Blood Red—grew to the size of 18 inches long by 15 inches in circumference, and are very tender.
Cabbage.—All Seasons—satisfactory; Early Summer—two hundred large fine heads, from one package of seed; Fottler's Improved Brunswick—finest ever raised, some heads weighing 18 pounds, tender and sweet.
Carrot.—Half Long Stump Rooted—took first prize at the county fair; Half Long Danvers—pleased with this variety, very smooth and nice; Yellow Belgian—mild and delicate.
Corn.—Black Mexican Sweet—fine, sweet, and made an excellent yield; Extra Early Sweet—very satisfactory.
Cucumber.—Boston Pickling—yielded abundant crops of fine-shaped pickles; Early Frame—handsome small variety.
Field Corn.—Minnesota King Yellow—very nice in green state; good quality.
Muskmelon.—Extra Early Hackensack—sweet, juicy, and pleasant flavor; Miller's Cream—very productive, sweet, fine flavor.
Onion—Yellow Danvers—grew well and ripened early.
Parsnip.—Student—large, smooth, and fine in flavor.
Peas.—Advancer—"Finest I ever ate;" American Wonder—finely flavored, and full pods; Yorkshire Giant—very prolific.
Radish.—Chartier—very good; Early White Turnip—crisp and strong, more peppery than the Early Dark Red; French Breakfast—early, prolific, smooth, and crisp; White Strasburg—mild, crisp, and juicy.
Tomato.—Livingston's Beauty—fine flavor and productive.
Turnip.—Early Red Top Strap Leaf—all that could be desired for an early turnip; Purple Top Milan—grew quickly, very early, fine grained, and sweet.

MICHIGAN.

Beans.—Dwarf or Bush Early Mohawk—very fine; Six Weeks—very nice.
Beet.—Dewing's Early Blood Turnip—very good and very early; Eclipse—early and excellent; Long Smooth Blood—exceedingly fine.
Cabbage.—All Seasons—grew exceedingly large; American Large Flat Dutch—grew large solid heads; Bridgeport Late—very large and good quality; Surehead—very fine.
Carrot.—Danver's Half Long—quality good, larger than the average carrot; Early Scarlet Horn—very satisfactory; Luc Half Long Stump Rooted—did well and grew large.

Celery.—Dwarf Golden Heart—did well.

Corn.—Alaska Sweet—early, and of fine flavor; Cory Sweet—grew to perfection; Crosby's Early Sweet—splendid, "best we ever had;" Evergreen Sweet—large ears, and extra in quality; Portland Hybrid Sweet—excellent; Stowell's Evergreen Sweet—did well.

Cucumber.—Early White Spine—very prolific, and good size; Siberian—produces well.

Leek.—Broad Flag—Very large and good.

Lettuce.—Marblehead—very fine.

Oats.—White Wonder—one quart sown at rate of 1½ bushels per acre harvested 42 quarts of nice heavy oats.

Onion.—Danvers Yellow Globe—grew to perfection; Red Globe—good variety, nice flavor; Red Wethersfield—one of the best; Southport Red Globe—very fine.

Peas.—American Wonder—excellent in growth and yield; Premium Gem—very prolific; Telephone—very large and very productive.

Radish.—Ne Plus Ultra—were ready for table three weeks after planting, can not be excelled; Scarlet Turnip White Tipped—abundant growth and of most delicious flavor.

Squash.—Golden Summer—finest summer squash grown; White Pineapple—good early variety, vigorous and prolific.

Tomato.—Acme—prolific, and good quality; Livingston's Beauty—earliest grown in this section, prolific, even in size; New Peach—"a wonder to everyone who saw it."

Turnip.—Early Red Top Strap Leaf—good.

Wheat.—Currell's Prolific—did poorly first year, 1 quart seed yielded only one-half bushel, but second year that one-half bushel yielded 10 bushels fine grain, straw grew rank and stood well; Velvet Chaff—"considered by miller in Saginaw the best he ever had."

MISSISSIPPI.

Beans.—Canadian Wonder—a long green pod, very prolific, and fine flavor; Dwarf Black Wax—well adapted to this climate; Dwarf German Wax—"never saw better beans or more prolific;" Dwarf Scarlet—were very good; Early China Red Eye—prolific and of excellent quality; Rust Proof Wax—excellent, long bearer, true to its name; Yellow Wax—prolific, large well-flavored beans.

Beet.—Bastian's—early and of excellent quality; Edmand's Blood Turnip—entirely satisfactory in every respect.

Cabbage.—All Seasons—produced firm, solid heads; Early Deep Head—very successful; Early Jersey Wakefield—produced large, well-flavored heads; Early Winningstadt—very good; Fottler's Improved Brunswick—nice heads, made fine krout; Winningstadt—heads large and of fine flavor.

Carrot.—Danver's Half Long Orange—very satisfactory; Early Scarlet Horn—every seed seemed to germinate.

Corn.—Early Alaska—sweet as sugar, gave entire satisfaction; Piasa King, Field—"splendid, would like to plant entire crop of this."

Cotton.—King's Prolific—very fine and yields well; Improved Crossland—best variety grown for years as a rapid grower, prolific yield; Southern Hope—did well under adverse circumstances, stalks grew over 6 feet, bolls and staple were fine.

Cucumber.—Improved Long Green—highly satisfactory, fine a specimen as ever grew.

Field Corn.—Piasa King—ripened two weeks earlier than any other variety, and was excellent in quality.

Lettuce.—Australian Market—fine, heads hard as cabbage, yet crisp and tender; All Cream—did well; Prize Head—unsurpassed; Salamander—large crisp heads.

Muskmelon.—Christiana—fine crop, good flavor.

Onion.—Oval Yellow Danvers—"a perfect little beauty;" Red Southport—a success; Red Weathersfield—more successful than any other onion seed ever planted.

Peas.—Telephone—"can not say enough in favor of this variety;" Yorkshire Hero—satisfactory.

Pumpkin.—Small Sugar—universally liked, the flavor being very fine.

Radish.—Early White Turnip—large and mild in flavor; French Breakfast—perfectly splendid, smooth, pretty, and of good flavor; St. Louis White Summer—a success, exceedingly well flavored.

Spinach.—Long Standing—fine.

Squash.—Golden Summer—all that could be desired.

Tobacco.—Yellow Oronoko, White Burley, Pure Havana—equal to Virginia leaf for pipe; fine chewing tobacco.

Tomato.—Acme—very fine, bearing until frost; Livingston's Perfection—"best we have had in flavor and yield."

Turnip.—Purple Top Munich—very fine, better sown in fall for a spring tunip; Pomeranian White Globe—attain a large size, are crisp and well flavored; Rutabaga—excellent for table, grew to great size.

MISSOURI.

Beans.—Dwarf Black Wax—abundant yield of very tender beans; Butter Wax—produced a fine crop; Dwarf Bush Scarlet—early, good bearer, fine flavor; Early Rachel—prolific, delicious, two weeks earlier than any other variety; German Wax—prolific and excellent in quality; Rust Proof Black Wax—very prolific, early, tender variety; Yellow Wax—prolific, pods were from 5 to 6 inches in length, and crisp; Yellow Six Weeks—were very good.

Beet.—Bastian's Blood Turnip—tender, good flavor, and keep well; Early Blood Turnip—satisfactory; Edmand's Turnip—large, tender, sweet, and of a beautiful color; Egyptian Dark Red—"finest we have had; large, fine shape, good color;" Long Smooth Blood—did finely, some measured 18 inches in length.

Cabbage.—Early Winningstadt—fine quality, very early; Jersey Wakefield—did well, but early summer was best of all; Large Late Drumhead and Select Late Flat Dutch—both did well and made large, solid heads; Marblehead Mammoth—proved a success; Red Dutch—produced large, solid heads, fine for pickling; Selected Early Jersey Wakefield—best early variety ever raised; Stone Mason—did well, are white and firm; Succession—fine, large, crisp, solid heads; Sugar Loaf—thrifty, and free from insects; Winningstadt—sweet, firm, stands drought, also a good late variety.

Carrot.—Half Long Danvers—grew well, and is a fine variety.

Celery.—Giant White—solid and very fine.

Corn.—Early Minnesota Sweet—produced excellent, well-filled ears; Early Eclipse, Field—soft-cobbed corn, good for cattle-feeding, ears 9 to 10 inches long; Minnesota King, Field—planted May 30, matured from 60 to 64 days, is the quickest maturing corn seen in this State; Piasa King, Field—best ever seen here, ears 11 to 13 inches long; Stowell's Evergreen and Asylum Sweet—were all that could be desired.

Cucumber.—Boston Pickling—good variety and very prolific; Early Frame—very prolific, stood drought well; White Spine—early and thrifty.

Field Corn.—Hickory King—very satisfactory.

Clover.—Alfalfa—made a fine stand.

Kale.—Siberian—"best we have yet had."

Lettuce.—Black Seeded Simpson — abundant growth, tender, the best lettuce raised; Early White Cabbage—splendid variety, heads well, and is crisp and tender; White Seeded Simpson—"best have ever tried, quick growth, tender, sweet, crisp."

Muskmelon.—Banana—late, but very fine.

Onion. — Large Red Wethersfield—very good; New Southport—fine, large, and beautiful in shape; Oval Yellow Danvers—strong growth, and a success; Red Wethersfield—good yield and splendid quality.

Parsley.—Emerald—large, double, finest ever seen in this county.

Parsnip.—Hollow Crown—highly satisfactory.

Peas.—Alaska—early, prolific, and fine in quality; American Wonder—early, prolific, and exceedingly well flavored; Early May—prolific bearer; Yorkshire Hero—well adapted to climate, and very productive.

Radish.—French Breakfast—early, and fine in flavor; Rosy Gem—very delicate and tender.

Salsify.—Mammoth Sandwich Island—all that could be desired.

Spinach.—Perfection Curled—early, and made a fine, rapid growth.

Squash.—Sibley—one vine grew 16 large squashes of extra fine quality.

Tomato.—Livingston's Beauty—"splendid, smooth, good flavor, best we ever had;" Perfection—prolific, fruit smooth and fine in flavor; Trophy—reliable and very prolific.

Turnip.—Purple Top Munich—were exceedingly good; White Egg—very good.

Wheat.—Velvet Chaff—yielded one-third more to the acre than any other variety sown at the same time; one of the best varieties of bearded wheat for old land.

Watermelon.—Kolb's Gem—very productive and well flavored.

MINNESOTA.

Beans.—Black Wax—enormous yield of fine beans, earlier than any other; Dwarf Lima—yielded well and ripened; Early China Red Eye—"excellent, best cropper I ever saw."

Beet.—Eclipse Blood—"best beets I ever had;" Improved Long Blood — good variety, firm, and of fine flavor; Lentz—was the best.

Cabbage.—All Seasons—did wonderfully well, insects and worms did not trouble them; American Flat Dutch—fine, some heads weighed 20 pounds; Bristol Flat Dutch—excellent; Early Deep Head—heads solid, tender, and crisp; Fottler's Drumhead—large, compact heads, good quality, few failed to head; Jersey Wakefield—very fine; Stone Mason—produced fine heads; Winningstadt—large head, some 18 to 20 inches through, fine flavor.

Carrot.—Early Horn—good yield and fine quality; Half Long Danvers—"better than any I have ever had;" Midsummer—8 and 9 inches through, fine flavor.

Celery.—Half Dwarf—was excellent.

Corn.—Black Mexican—yielded magnificently, and was sweetest of all; Minnesota King—grew 12 feet, but did not ripen; Sweet Portland Hybrid—very good and early.

Lettuce.—All Cream—very satisfactory; Hanson and Simpson's Black, Seeded—both best quality, solid heads, some 10 inches in diameter; Salamander—very good; St. Louis Market—rapid growth, could use in three weeks' time, very good; White Cabbage—did well.

Muskmelon.—Christiana—very prolific; Miller's Cream—was excellent; Netted Nutmeg—"very fine, only ones I ever had to ripen here."

Oats.—White Wonder—a success.

Onion.—Large Red Wethersfield—very fine, flavor excellent.

Parsnip.—Hollow Crown—did remarkably well, roots 14 inches, and fine in flavor; Improved Long Smooth—fine crop of good size and well flavored; Long White Student—excellent; grows quickly.

Peas.—Abundance—a fine variety; Blue Beauty—good second early crop, strong grower, and good flavor; Climax—delicious early, variety, and abundant bearer; Champion of England—prolific and very good; Horsford's Market Garden—splendid for so early a pea; McLean's Blue Peter—very prolific; Telephone—largest, most tender, and best.

Pumpkin.—Crook Neck—one of the best, fine and solid; Negro—prolific; seven vines yielded 57 excellent pumpkins.

Radish.—Chartier—good spring, summer, and fall; Early White Turnip—splendid; French Breakfast—early and good; Long White Naples—delicious, grew large, and were sweet and crisp to the last.

Salsify.—Long White French—delicious; Mammoth Sandwich Island—prolific; excellent in quality.

Spinach.—Perfection Curled—good as its name; Prickly or Fall—very productive; beautiful crop.

Squash.—Golden Summer—fine grain and flavor; Hubbard—most satisfactory; Pike's Peak or Sibley—yielded well; very nice squash; Prolific Marrow—heavy yielder of medium quality.

Tomato.—Acme—a great success; General Grant—"great favorite here, have raised bushels before;" Livingston's Perfection—great yield; smooth, large, and pleasant to the palate.

Turnip.—Imperial Swede—productive, and of rapid growth; White Globe—all that could be desired.

Watermelon.—Iron-clad, Scaly-bark, and Rattlesnake—were too late for this latitude.

MONTANA.

Cabbage.—Flat Dutch—was satisfactory.

Carrot.—Danvers Half Long—did very well.

Grass.—Meadow Fescue—fine pasture grass, stood drought well; Meadow Fox Tail—went to seed about the height of 1 foot; can not be beaten for an early grass.

NEBRASKA.

Beans.—Bismarck Butter—exceedingly fine and productive; Dwarf Golden Wax—prolific and of delicious flavor; Golden Wax—prolific, early, most valuable variety; Early Red Valentine—tender, quickly cooked, and altogether excellent; Early Rachel—prolific and well flavored; Early Six Weeks; prolific and quick in growth; Rust Proof Golden Wax—splendid growth and good bearer.

Beet.—Bastian's Blood Turnip—large size and fine flavor; Dark Red Egyptian—did well; Early Blood Turnip—did well, being of fine flavor and extra sweet; Eclipse—did well; Edmand's Early Blood Turnip—produced fine vegetables.

Cabbage.—All Seasons—exceedingly fine; American Flat Dutch—good quality, large size, and sure header; Early Winningstadt—very good; Fottler's Improved Brunswick—"finest cabbage I ever had, heads large, solid, and of fine flavor;" Flat Dutch—from 1 package of seeds made 1,500 good solid heads; Premium Flat Dutch—of good growth and excellent in quality.

Cane Seed.—Folger's Early Variety—produced syrup of fine quality; light, and not strong.

Carrot.—St. Valery—came up well, were large, and excellent in flavor.

Corn.—Cory—excellent, ears good size, sweet, and tender; Early Dwarf Sweet—a fine variety; Mammoth Sweet—excellent for this country, early, fine quality.

Cucumber.—Boston Pickling—good variety, smooth, and fine flavor; Improved Long Green—1 package seed produced a barrel of pickles, besides many given away; Improved White Spine—did well; London Long Green—very fine, large yield; Perfection White Spine—very prolific; Siberian—very good.

Grass.—Alsike (Clover)—did very well; Orchard—reached the height of 10 inches and remained green until late in the season.
Kale.—Green Curled Scotch—good.
Lettuce.—Chartier—did well; Early Curled Simpson—headed well and was tender; Hanson—did well; Improved Royal Cabbage—good and fine yield.
Muskmelon.—Early Prolific Nutmeg—prolific, of fine flavor, sweet, and juicy; Netted Gem—fine a melon as ever grew, perfect and of good flavor; Surprise—productive, of good size, and well flavored.
Oats.—White Wonder—produced well, made a heavy growth of straw, excellent.
Onion.—Red Globe—did well; White Globe—were early and productive; White Bermuda—yield well and large in size; Wethersfield—grew to a good size; Oval Yellow Danvers—good size, fine flavor, and prolific.
Parsley.—Emerald Gem—good.
Parsnip.—Large Sugar or Hollow Crown—very fine variety.
Peas.—American Wonder—were extra early; Champion of England—excellent peas and large yield; First and Best—early and prolific, can not be excelled; Horsford's Market—very prolific and fine in quality; McLean's Little Gem—rapid growth and early, full pods; Stratagem—did well; Telephone—very large, good quality, and very prolific; Yorkshire Hero—"best ever grown here."
Pepper.—Sweet Mountain—fine.
Pumpkin.—Early Crook Neck—did well.
Radish.—Chartier—did extremely well, are large and tender; Early Turnip—yielded tender fruit in abundance; French Breakfast—a great success; St. Louis Summer—grew large, sound, and sweet; Scarlet Turnip—grew very large and of good flavor.
Salsify.—Vegetable Oyster—good crop.
Sweet Corn.—Early Alaska—earlier by twelve days than the Early Minnesota; Stowell's Evergreen—good size and kept green for six weeks.
Tomato.—Acme—did well; General Grant—very fine flavor; Livingston's Perfection—prolific, smooth, excellent quality; Peach—of unusually fine flavor and very sweet; Trophy—very prolific; fruit large and smooth.
Turnip.—White Strap Leaf—large and sweet; Pomeranian White Globe—exceedingly fine; 1 package of seed produced 10 bushels.
Watermelon.—Johnson's Christmas—fine, kept well until Christmas; Mountain Sweet—grew to large size, and has fine, red color; Rattlesnake—excellent in flavor.

NEVADA.

Carrot.—Golden Orange—large, long, and of good flavor.
Corn.—Evergreen Sweet—"splendid, very sweet; best I have raised for years."
Muskmelon.—Netted Gem—prolific and very good.
Turnip.—Early White Top Strap Leaf—tender and sweet.
Watermelon.—Improved Kolb Gem—very fine.

NEW HAMPSHIRE.

Beet.—Early Blood Turnip—very good, nice size and shape; Edmand's Early Blood Turnip—were early, smooth, of fine texture, and good flavor; Egyptian—"best I have ever had; very prolific."
Cabbage.—Early Summer—good; Extra Flat Dutch—good; Jersey Wakefield—gave good results; Large Flat Dutch—produced good heads.
Carrot.—Half Long Danvers—best ever raised both in yield and quality.
Citron.—Gave wonderful results, vines covered with round, smooth melons of large size; deserves a name.
Corn.—Early Crosby—sweet, juicy, and of good quality; Stowell's Evergreen Sweet—made a fine growth.
Cucumber.—Improved Long Green—splendid, very nice, very prolific.
Lettuce.—Black Seeded Simpson—one of the best varieties; White Seeded Simpson—not equal to the Hanson.
Muskmelon.—Delmonico—delicious, and very good yield.
Peas.—Dexter—proved satisfactory; Early Profusion—good; Little Gem Pea—yielded large quantity of nicely flavored peas; Stratagem—very prolific.
Pumpkin.—Small Sugar—splendid, fine-grained, full-meated.
Radish.—White Turnip—was in an edible condition for a long time.
Spinach.—Perfection Curled—good.
Tomato.—Ignotum—thrifty, early, fruit smooth and nice; New Jersey—fine both in quality and yield; Livingston's Favorite—did well; Lorillard—were good, smooth, and solid; Perfection—one of the very best.
Turnip.—Red Top Strap Leaf—yield good, but quality indifferent.

NEW JERSEY.

Carrot.—Danvers Half Long—were excellent.

Field Corn.—Minnesota King—Small, yellow, and very early.

Lettuce.—Early Curled Simpson—was very fine; White Seeded Simpson—was tender and crisp.

Muskmelon.—Osage—was excellent.

Pepper.—Sweet Mountain—profuse yield of large peppers.

Tomato—Acme—did well

NEW YORK.

Beans.—Black Wax—early and very good; Butter Wax—very prolific; Early Rachel—very prolific and of superior quality; King of the Garden Lima—very prolific; Long Podded Black Eyed Wax—were good and made an immense yield.

Beet.—Dewing's Improved Early Turnip—good in quality and form; Eclipse Blood—were early, of fair size and excellent flavor; Edmand's Early Blood Turnip—satisfactory in every respect; Egyptian Dark Red—"good quality, fine grained, earliest have ever seen;" Long Smooth Blood Red—most excellent for table use, yields well.

Cabbage.—Early Summer—excellent quality, fair size, and good header; Extra Flat Dutch—large size, good heads, and firm; Fottler's Improved Brunswick—sure header, not one failed, very fine outside leaves; Jersey Wakefield and Bristol Flat Dutch—were excellent; Marblehead Mammoth and Brunswick Drumhead—grew large and were of superior quality; Premium Late Drumhead—satisfactory in all respects; Stone Mason—produced fine-flavored, medium-sized heads.

Carrot.—Half Long Danvers—good and quite early.

Celery.—Boston Marrow—was very fine.

Corn.—Black Mexican Sweet—best ever had, two ears on every stalk, perfect flavor; Crosby's Early—week earlier than any other, very fine; Early Cory—very tender and sweet, earliest and best planted here; Early Minnesota—very fine; Stowell's Evergreen Sweet—grand success, not one stalk examined had less than three ears, most of them being 12 to 15 inches long.

Cucumber.—Boston Pickling—prolific and healthy; Improved Long Green—prolific bearer, fine quality; Improved White Spine—adapted to this climate, prolific, large, and splendid; Perfection White Spine—very early and most productive.

Kale.—Dwarf German—"vigorous growth, good quality, best of which I know;" Dwarf Curled Green—hardy in growth and productive.

Lettuce.—Denver Market—good quality and good flavor; Salamander—very large, of fine appearance, tender, and keeps well; White Cabbage—compact head and very tender.

Muskmelon.—Citron—was satisfactory; Netted Gem—most prolific ever raised; Osage—very good.

Oats.—White Wonder—strong in growth and made a good yield, 1 quart produced 52 pounds of good oats.

Onion.—Early Red Globe—of good size and flavor; Oval Yellow Danvers—good size and very fine; Red Wethersfield—perfect crop, yielded remarkably well; Spanish King—very fine, stands drought well; White Bermuda—best ever had, excellent quality; Yellow Globe Danvers—satisfactory.

Parsley.—Emerald Green—very fine, pronounced best ever seen by local dealers.

Parsnip.—Hollow Crown—gave good results.

Peas.—American Wonder—made an extraordinary yield; Champion of England—one of the best varieties, prolific, were sweet and tender, attained height of 5 feet; Early Dexter and Morning Star—did well, were early, good in yield and quality; Premium Gem, Extra Early—first class in every particular; Stratagem—prolific and excellent in quality; Yorkshire Hero—prolific, tender, and sweet.

Pepper—Golden Dawn—was a success; Red Cluster—good bearer.

Pumpkin.—Quaker Pie—produced a fine crop; Sweet or Sugar—best flavor ever sampled, good size and good yielder.

Radish.—French Breakfast—very nice and well adapted to this climate; Scarlet Turnip, White Tipped—extra quality, very fine; Rosy Gem—grew large, but were tender; White Strasburg—excellent.

Spinach.—Bloomsdale—great success.

Squash.—Boston Marrow—good variety, fairly large, yellow, and sweet; Golden Marrow—grew well and yielded fine fruit; Hubbard—excellent quality; Improved Orange Marrow—did extremely well; Pike's Peak—first class, dry, sweet, matures early, and superior to the Hubbard in every way; White Pineapple—very prolific and handsome, took first premium at the Onondaga County fair.

Sunflower.—Giant Russia—very large.

Tomato.—Acme—early and prolific; Livingston's Beauty—very early, perfect in shape and taste; Livingston's Favorite—exceedingly prolific, solid, skin thin and dark red; Large Round Yellow—excellent in flavor, meaty, and luscious; Lorillard—yielded excellent fruit; Paragon—splendid, medium size, fine table variety; Telegraph—smooth and well flavored.

Turnip.—Purple Top Strap Leaf—fine grained and sweet; Pomeranian White Globe—attained great size, of extra quality, and fine yield; Red Top Strap Leaf—matures early, yields well; Rutabaga, Laing's Improved—fast grower, sweet and brittle; Rutabaga, Sutton Champion Swede—were very large, weighing from 20 to 25 pounds each; White Egg—grows large and juicy; White Strap Leaf—good quality; Yellow Aberdeen—"grand success, best I have ever seen."

Watermelon.—Georgia Rattlesnake—did not do well; Kolb Gem—one of the best in size and flavor.

NORTH CAROLINA.

Beans.—Canadian Wonder—very fine.

Cabbage.—All Seasons—fine heads, firm and sweet; Extra Flat Dutch—was very good; Stone Mason—proved the pride of the garden.

Corn.—Early Minnesota—planted May 12, had corn for table July 17; Evergreen Sweet—grew well and was fine in flavor.

Cotton.—Southern Hope—Excelled all other varieties in yield and staple.

Lettuce.—Black Seeded Simpson—sweet and tender, very desirable; Salamander—an excellent variety.

Muskmelon.—Netted Gem—perfection.

Tomato.—Mikado—"finest tomato for table use I have ever seen;" Telegraph—grew to perfection.

Watermelon.—Scaly bark—grew to large size and of good quality.

NORTH DAKOTA.

Cabbage.—All Seasons—well adapted to this climate, are early and keep well; Large Flat Dutch—grand success, finest in the country, 300 heads from seed sown; Stone Mason—very fine, sweet, and tender.

Cucumber.—Boston Pickling—hardy, and much earlier than other varieties.

Muskmelon.—Emerald Gem—fine flavor, very prolific.

Parsley.—Emerald Green—very fine.

Parsnip.—Hollow Crown—did finely.

Peas.—Early Profusion—very prolific; Yorkshire Hero—excellent.

Pumpkin.—Sweet or Sugar—"only kind that has matured for me."

OHIO.

Beans.—Dwarf Rust Proof Wax—good, free from strings, and very meaty; Dwarf Golden Wax—best bunch bean ever had, no strings, fine flavor; Early Mohawk Bush—never had its equal, kept on bearing until fall; Valentine—were excellent.

Beet.—Bastian's—one of the best, early, and fine quality; Dewing's Early Red—large, round, and tender; Eclipse—very satisfactory; Edmand's Early Blood Turnip—can not be excelled; Egyptian Red—good for table; Long Smooth Blood—very good.

Cabbage.—All Seasons—great success, large solid heads; Early Winningstadt—produced good-sized solid heads; Large Flat Dutch—one of the best; Mammoth Late Drumhead—good quality and large in growth; Marble Head Mammoth—fine, large heads, tender, and sweet; Winningstadt—surpassed anything tried in early varieties.

Carrot.—Danvers Half Long—produced a fine crop of smooth roots; Improved Danvers—very large, solid and of a rich flaver; Early Scarlet Horn—"prefer this to all others;" Half Long Stump Rooted—"best I have had in quality and yield, which was at the rate of 11 bushels to the acre."

Celery.—Giant Pascal—quality the best.

Corn.—Chicago Market Sweet—made a fine yield; Crosby's Early Sweet—early, a success.

Cucumber.—Early Cluster—very early and good; Improved Long Green—finest ever grown; Perfection White Spine—"finest variety I have had."

Kale.—Dwarf German—very good.

Lettuce.—Black Seeded Simpson—"best I ever raised;" Buttercup—"finest I ever saw, heads larger than a dinner plate;" Royal White Cabbage—did well; St. Louis Market—very fine and a rapid grower; Paragon—of fine quality.

Muskmelon.—Extra Early Hackensack—early and delicious; Netted Nutmeg—very fine flavor; Surprise—excellent in every respect.

Onion.—Red Globe—fine, some measuring 10 inches in circumference; Red Wethersfield—very nice; Southport Red Globe—fine, notwithstanding drought; Yellow Globe—very large and keep well.

Parsnip.—Hollow Crown—an excellent variety.

Peas.—Champion of England—fine in every respect, Extra Early Morning Star—very sweet, full-podded and plentiful; Horsford's Market—good, green. wrinkled peas of fine flavor; Premium Gem--good.

Pepper.—Golden Dawn—very good.

Pumpkin.—Quaker Pie—large and excellent flavor.

Radish.—Golden Globe—large and tender; Early White Turnip—strong grower, good quality, tender, and juicy; Long Scarlet Short Top—immense, quick grower, and rich flavor; Ne Plus Ultra—"earliest and best I have ever grown;" Scarlet Turnip—very fine.

Squash.—Sibley or Pike's Peak—one of the best winter varieties, productive, fine.

Tomato.—Acme--very good; Livingston's Beauty—solid and of fine flavor; Livingston's Perfection—largest and most solid ever raised, grand producer; New Jersey—fine, large, smooth, red, and very early; Trophy—very nice, good size, and sweet.

Turnip.—Red Top Strap Leaf—very fine, good flavor, easily grown.

Watermelon.—Improved Kolb Gem—good melon, of medium size; Florida Favorite—very good.

OKLAHOMA.

Beans.—White Wonder—very prolific, a great acquisition; Red Valentine—unexcelled.

Beet.—Edmand's Turnip Blood—produced an excellent crop of fine flavor; Long Smooth Blood—good variety.

Cabbage.—Bristol Flat Dutch—grew 420 plants from package, some weighing 8 pounds, fine; Jersey Wakefield—grew larger heads than other varieties tested; Large York—fine variety, grew to a large size; Red Dutch—hardy, and heads well.

Corn.—Stowell's Evergreen Sweet—very fine, ears large and good.

Cucumber.—Early Frame and Perfection—both did well; Improved Long Green—did fairly well; Long Green—did well.

Lettuce.—Black Seeded Simpson—thrifty, tender, and finely flavored.

Muskmelon.—Capital Prize—one of the best varieties; very prolific.

Onion.—Oval Yellow Danvers—mild, pleasant; Southport Red Globe—medium size, but exceedingly well flavored; Yellow Danvers—more abundant yield than any others tested.

Parsnip.—Student—very good.

Peas.—Alaska—excellent, very prolific; American Wonder—one of the earliest and best; Extra Early Morning Star—very satisfactory; McLean's Advancer—admirably suited to this climate; Stratagem—did well, were very large; Premium Gem—very prolific; Yorkshire Giant—sweet and good.

Pepper.—Bull Nose—very fine; Sweet Mountain—splendid, very large growth.

Radish.—Chartier—grew very large; Early French Turnip—excellent; Early Scarlet Turnip—very good; Scarlet Turnip—grew to a large size, crisp, and tender.

Spinach.—Round Thick Leaved—good.

Tomato.—Acme—early and very fine; Livingston's Beauty—produced large, smooth fruit, of fine flavor; Livingston's Perfection—were large and well flavored; Trophy—a fine variety.

Turnip.—Pomeranian White Globe—were crisp and tender.

Watermelon.—Mountain Sprout—from 50 to 80 pounds in weight, and delicious in flavor.

OREGON.

Beet.—Eclipse—were prolific; Edmand's Early Blood Turnip—splendid, some weighing 3 pounds; Extra Early Egyptian—early, fast growth, and fine for the table.

Cabbage.—Early Winningstadt—attained fair size; Early Summer—"more than double the size of any I have before had;" Late Drumhead—excellent for late fall and winter; Premium Dutch—grew well and produced solid, crisp heads.

Carrot.—Half Long Danvers—fine lot of carrots.

Corn.—Black Mexican Sweet—good bearer, ears full and large; Chicago Market—very early and productive; Early Cory Sweet—splendid yield, matured in 100 days; Evergreen Sweet—made a fine yield.

Cucumber.—Boston Pickling—great success, prolific; Early Frame—very prolific; London Long Green—very prolific and good flavor.

Field Corn.—Minnesota King—made a vigorous growth of fine large ears, ripening before frost, which is unusual here.

Lettuce.—California All Heart—splendid; Early Curled Simpson—tender, crisp, and kept well; Paris Green Co's Paris green—a success; Royal Cabbage—large heads, tender, and sweet; Salamander—grew well and was exceedingly fine in quality.

Oats.—White Wonder—large growth and heavy yield.

Onion.—Red Wethersfield—satisfactory; Southport Yellow Globe—fine variety and well suited to this climate; Yellow Globe Danvers—largest and finest ever raised.

Parsnip.—Hollow Crown—attained large growth; Improved Guernsey—fine, keep in the ground until spring.

Peas.—American Wonder—very early and bore a second crop; McLean's Little Gem—fine crop of choice peas two months from planting; Morning Star—very early and productive; Stratagem—excellent, good producers.

Pumpkin.—Tennessee Sweet Potato—very productive and sweet.

Squash.—Pike's Peak—did well.

Turnip.—Red Top Strap Leaf—large, tender, and sweet.

Tomato.—Volunteer—were early, large, and of fine flavor.

PENNSYLVANIA.

Beans.—Dwarf or Bush Bismarck Butter Wax—"one of the best producing beans we can get;" Golden Wax—excellent.

Beet.—Dewing's Improved Turnip—early, tender, and fine in flavor; Eclipse—very fine; Erfurt Giant—very large; good for table when young.

Cabbage.—Bridgeport Late—satisfactory in every particular; Large Flat Dutch—compact heads, good flavor and growth; Premium Flat—produced solid heads; Vandergaw Quick Growing Flat Dutch—did well; Winningstadt—fine in flavor and quality.

Celery.—Half Dwarf—splendid.

Corn.—Asylum Sweet—very good, fine in flavor and quality; Stowell's Evergreen—very fine.

Egg Plant.—Large Round Purple—came up well, very nice.

Lettuce.—Improved Royal Cabbage—excellent, good all summer; Marble Head Mammoth—very nice, tender, and sweet; Simpson's Early Curled—excellent.

Muskmelon.—Stickney's Long Yellow—strong grower, bears well, and of fine flavor.

Onion.—Red Globe—very fine; Yellow Danvers—very fine quality.

Parsley.—Double Curled—did very well; Emerald Gem—beautiful, curled, mossy variety.

Peas.—American Wonder—fine yield; Early Advancer—prolific and finely flavored; Horsford's Market—very prolific, medium-sized pods, a good variety; Morning Star—very fine pea, fine flavor and good cropper; Stratagem—best ever tried.

Radish.—Ne Plus Ultra—early, fine flavor; large size for early variety.

Spinach.—Round Leaved—"like the variety very much."

Squash.—Sibley and Improved Orange Marrow—gave entire satisfaction.

Turnip.—Red Top Strap Leaf—can not be excelled.

RHODE ISLAND.

Cabbage.—Early White Flat Dutch—quick in growth and excellent in quality; Stone Mason—firm and delicious in flavor.

Corn.—Early Cory Sweet—very early, surpassed other varieties tested.

Lettuce.—Hanson—good result.

Pumpkin.—Crook Neck—very fine.

Squash.—Pineapple—good.

SOUTH CAROLINA.

Beans.—Canadian Wonder—very prolific; Red Valentine—exceeded any before tested in quantity, good quality.

Beet.—Eclipse—early and of excellent quality; Edmand's Early—early and delicious in flavor; Long Smooth Blood Red—large and sweet.

Cabbage.—Jersey Wakefield—a fine variety; Succession—very productive.

Cotton.—Peterkin—one quart yielded 128 pounds of seed cotton, which ginned 57 pounds of lint.

Lettuce.—Black Seeded Simpson—very productive and exceedingly well flavored; White Seeded Simpson—large fine heads, abundant growth.

Muskmelon.—Netted Gem, prolific and of fine flavor.

Onion.—Yellow Globe Danvers—fine, yielded seed for another year.

Peas.—McLean's Advancer—prolific, sweet, and of good flavor.

Turnip.—Purple Top Strap Leaf—successful.

SOUTH DAKOTA.

Beans.—Canadian Wonder—prolific, fine flavor, large, and mealy; Rust Proof Golden Wax—excellent, made a full crop.

Beet.—Bastian—fine large beets; Eclipse—fine color and flavor; Egyptian Dark Red—"splendid both for stock and the table, best I ever saw;" Long Smooth Blood—did finely; Mangold Erfurt Giant—fine yield, good size and quality.

Cabbage.—All Seasons—firm, medium sized heads; Early Summer—good heads, early and late, firm, tender, and sweet; Improved Late Flat Dutch—did well; Large Flat Dutch—solid heads of good size.

Celery.—Large White—large, crisp, and white.

Corn.—Black Mexican—sweeter than the white variety; Cory Sweet—produced well-filled ears; Early Crosby Sweet—produced well-filled ears of good flavor

Cucumber.—Improved Long Green—very prolific, excellent.

Kale.—German Green—very thrifty.

Lettuce.—Australian Market—superior variety, tender and sweet; Black Seeded Simpson—did very well; California All Heart—"finest lettuce ever saw;" St. Louis Market—splendid, best ever raised.

Muskmelon.—Burpee's Emerald Gem—very satisfactory.

Oats.—White Wonder—stood the drought well.

Onion.—Large Red Wethersfield—best ever raised here; Oval Yellow Danvers—extra fine, keep well; White Portugal—large, silver skinned, and good; Yellow Globe Danvers—grew well.

Parsnip.—Hollow Crown—produced well and was excellent in quality.

Peas.—Yorkshire Hero—delicious in flavor.

Radish.—St. Louis White Summer—did exceedingly well, and were of excellent flavor.

Squash.—Pike's Peak—unexcelled.

Tomato.—Livingston's Beauty—good yield and ripened well.

Turnip.—Purple Top Munich—excellent for summer, produced a heavy crop; Red Top Strap Leaf—exceedingly sweet and juicy, some measured 18 inches.

Watermelon.—Hungarian Honey—satisfactory; Scaly bark—well adapted to this climate.

TENNESSEE.

Beans.—Black Wax—produced a remarkable crop; Dwarf or Bush, Early China Red Eye—fine variety for this country.

Beet.—Dewing's Improved Turnip—medium size and good quality; Edmand's Blood Turnip—excellent; Early Blood Turnip—large and of fine flavor; Egyptian Dark Red—fine.

Cabbage.—Early Etampes—early and made good, solid heads.

Corn.—Crosby's Sweet—two weeks earlier than any variety, excellent quality.

Lettuce.—Butter Cup—exceedingly well flavored; Early Simpson—beautiful and of fine flavor; White Cabbage—early and crisp; White Seeded Simpson—heads equal to cabbage, want none better.

Onion.—Large Red Wethersfield—very fine; Yellow Globe Danvers—very large and fine.

Peas.—Extra Early—two weeks earlier than any variety, long bearing; Rural New Yorker—very good; Telephone—prolific and excellent in quality

Spinach.—Perfection Curled—very fine.

Squash.—Mammoth Chili—large and delicious in flavor.

Tomato.—Acme—very fine.

Turnip.—White globe—excellent; Yellow Aberdeen—"finest I ever saw."

TEXAS.

Beans.—Dwarf or Bush, Flageolet Scarlet Wax—great success; Dwarf or Bush, Red Valentine—good, prolific; Early Rachel—early and good quality.

Beet.—Dewing's Early Red—fine; Eclipse—week earlier than any other variety and very tender; Early Blood Turnip—very large and sweet; Edmand's Blood Turnip—grew large, were good in flavor, and fine red in color; Long Smooth Blood Red—fine, large, and very sweet.

Cabbage.—All the Year Round—thrifty, and headed well; American Large Flat Dutch—early and excellent in flavor; Large Late Drumhead—fine, some heads weighing 6¾ pounds; Large York—did finely, stand drought well; Early Summer—large, compact heads, and keep well.

Carrot.—Danvers Half Long—can not be excelled; Improved Long Orange—stood drought exceedingly well and was of good quality.

Clover.—Alsike or Swedish—good stand.

Corn.—Black Mexican Sweet—highly recommend it; Evergreen Sweet—prolific, early, and delicious in flavor.

Cotton.—King's Improved—136 pounds of seed cotton made 54 pounds of lint; Peterkin—yields well, both in the field and at the gin; Southern Hope—fine, long staple, gathered 900 pounds seed cotton off an acre, and that with an unfavorable season.

Cucumber.—Boston Pickling—good for pickling, small and green.
Egg Plant.—Large Round Purple—did finely, bearing until fall.
Field Corn.—Pride of the North—great success, early, and made a fine yield.
Grass.—Orchard—stood a long drought and was very satisfactory.
Kale.—Dwarf Green Curled—finest ever grown, nothing like it for salad.
Lettuce—Black Seeded Simpson—of rapid growth, crisp, and tender; St. Louis Market—excellent, quick growth, and very tender; Salamander—"fine lettuce, best I ever raised;" White Seeded Simpson—excellent in all respects.
Muskmelon—Delmonico—yields well, is very early; Early Hackensack—very prolific, of excellent flavor; Montreal—prolific and delicious in flavor; Netted Gem—small, round, and very sweet.
Oats.—White Bonanza—produced a fine crop.
Onion.—Red Globe—exceedingly fine flavor; Large Red Wethersfield—very fine results; White Bermuda—well adapted to this soil and climate; Yellow Globe Danvers—mild in flavor and grew to a large size.
Peas.—Dexter's Early—prolific, quick in growth, and excellent in quality; Extra Early Morning Star—grew and yielded well, were delicious; McLean's Advancer—gave perfect satisfaction; Telephone—a great success.
Pumpkin.—Sweet or Sugar—very fine.
Radish.—Chartier—grows very quickly, of excellent flavor and large; Early French Breakfast—very early and fine in quality; Long Scarlet Short Top—of quick growth, smooth, and crisp; Scarlet Turnip—fine as ever grew; White Strasburg—can not be excelled.
Salsify.—Long White French—did very well.
Sweet Corn.—Evergreen—fine ears, some 10 inches long.
Tobacco.—White Burley and Gold Finder—both grew well, Burley preferred.
Tomato.—Livingston's Beauty—matures quickly and of good size; Livingston's Perfection—produced large, fine fruit; Paragon—fine in every way.
Turnip.—Red Top Strap Leaf—prolific and of fine flavor; Pomeranian White Globe—very sweet and nice; White Globe—did well both spring and fall; White Top Strap Leaf—a wonder to all who saw them.
Watermelon.—Rattlesnake—grew finely.

UTAH.

Beans.—Dwarf or Bush Scarlet—very prolific and a good variety.
Buckwheat.—Japanese—very successful.
Cabbage.—Early Summer—excellent, producing fine, solid heads; Jersey Wakefield—compact heads of good quality, fine early cabbage; Succession—first class.
Cucumber.—Boston Pickling—did finely.
Lettuce.—Salamander—fine, tender heads; White Seeded Simpson—very fine.
Oats.—White Wonder—distributed in four different localities, a great success, yielded heavily.
Onion.—Oval Yellow Danvers—fair; Red Wethersfield—did well; Silver Skin—large and mild.
Peas.—Early May—planted May 5, formed full pods July 2; Horsford's Market Garden—better than Telephone, Stratagem, Little Gem, Bliss' Everbearing, or Marrowfat, both in quality and quantity; Yorkshire Hero—yielded a fine crop.
Radish.—Rosy Gem—very productive and excellent in flavor.
Tomato.—Livingston's Perfection—about the only variety that ripened.
Watermelon.—Rattlesnake—produced large fruit of excellent flavor.

VERMONT.

Beans.—Dwarf German Wax—very early, large yield, were edible for seven weeks.
Beet.—Dewing's Blood—large, smooth, tender, and well flavored; Edmand's Blood Turnip—fine quality for table use.
Cabbage.—Fottler's Improved Brunswick—good heads, early, and solid.
Corn.—Portland Hybrid Sweet—one of the best, early, green a long time, excellent.
Cucumber.—Improved Long Green—very fine; White Spine—very prolific.
Parsnip.—Hollow Crown—all that could be desired.
Peas.—Premium Gem—very prolific.
Tomato.—Acme—very fine; General Grant—an excellent variety; Perfection—did very well.
Turnip.—Rutabaga, Laing's Improved—large crop of large, smooth, solid, fine-flavored turnips; Pomeranian White Globe—did very well.

VIRGINIA.

Beans.—Red Valentine—best ever raised, tender, very prolific.
Beet.—Early Blood Turnip—fine table beet, sweet and nice; Edmand's Turnip Blood—not to be excelled.
Cabbage—Fottler's Improved—one of the best winter cabbages; Jersey Wakefield—produced fine large heads; Late Improved Drumhead—produced large, solid heads, crisp, tender, and sweet; Winningstadt—fine heads, of excellent quality.
Cucumber.—Boston Market White Spine—very prolific.
Corn.—Chicago Market Sweet—satisfactory.
Lettuce.—Boston Curled—good; Early Curled Simpson—excellent; Salamander—none better.
Onion.—Large Red Wethersfield—good crop; Southport Large Red Globe—prolific, good.
Parsnip.—Hollow Crown—can not be excelled.
Peas.—Early American Wonder—very prolific, and fine in flavor; Forty Fold—fine flavor, very productive.
Radish.—Scarlet Turnip White Tipped—very crisp, sweet, and of fine flavor; St. Louis White Summer—one of the best, tender and sweet.
Tomato.—Livingston's Beauty—smooth, red, and delicious in flavor; Perfection—fine variety for this soil.
Turnip.—Pomeranian White Globe—very tender and sweet.
Watermelon.—Golden Honey—prolific, small, but fine flavor; Improved Kolb Gem—good flavor, early, and very prolific.

WASHINGTON.

Beans.—Kidney Wax—an excellent variety; Rust Proof Golden Wax—prolific, very fine.
Beets.—Bastian's Blood Turnip—very good; White Silesian—"better than any we have ever had."
Buckwheat.—Japanese—did well.
Cabbage.—Early Jersey Wakefield—solid, medium-sized heads; Early Summer—made a splendid crop; Large York—firm heads and good flavor; Reynolds—satisfactory.
Carrot.—Midsummer—"from one-half ounce seed sent raised 300 pounds finest vegetables I ever saw."
Corn.—Early Cory Sweet—slow to mature, but nice when matured, good for fodder; Hickox Improved—finest, sweetest corn ever raised here.
Cucumber.—Early Frame—extra in every way; Large Netted Russian—large, and an abundant bearer.
Grass.—Johnson—did well.
Lettuce.—Paris Green Co.'s Paris green—very good and of fine flavor; St. Louis Market—fine enough for any market.
Oats.—White Wonder—good variety to yield.
Onion.—Large Red Wethersfield—largest weighed half a pound—did not use fertilizer; Yellow Danvers—raised a fine crop.
Parsnip.—Hollow Crown—made an excellent growth; Long White Sugar—did very well, good size and length.
Peas.—Yorkshire Hero—very prolific, gave entire satisfaction; Climax, Telephone, and Stratagem—all bore profusely.
Radish.—French Breakfast—excellent; Ne Plus Ultra—very fine, success.
Salsify.—Long White French—very nice.
Squash.—Boston Marrow—good growth, ripened well, and of fine quality; Pike's Peak—very dry and sweet, size from 5 to 9 pounds.
Tobacco.—Oronoko—had large, healthy leaves.
Tomato.—Livingston's Beauty—fine; Perfection—smooth and firm, fine flavor and quality.
Turnip.—Red Top Strap Leaf—early, large, and fine flavor; White Globe—crisp, juicy, and tender, growing to a good size.
Watermelon.—Mountain Sweet—every seed germinated, had fine melons.

WEST VIRGINIA.

Beans.—Dwarf Black Wax—most satisfactory.
Beet.—Egyptian Dark Red—juicy and tender.
Cabbage.—Large Flat Dutch—heads weighed from 20 to 25 pounds.
Carrot.—Belgium—very satisfactory.
Corn.—Black Mexican Sweet—very early, gave good satisfaction; Crosby's Early Sweet—did well, made a fine crop of corn; Hickox Improved—extra good in size and quality.

Cucumber.—Boston Pickling—very prolific; Giant Pera—large, crisp, tender, and very prolific.
Field Corn.—Yellow Eclipse—averaged 170 bushels to the acre.
Lettuce.—California All Heart—very good; Prize Head—gave entire satisfaction.
Oats.—White Wonder—yielded 95 bushels to the acre under unfavorable circumstances.
Onion.—Large Red Wethersfield—great success.
Peas.—McLean's Little Gem—ten days earlier than any other variety, very prolific, pods filled with smooth, plump peas; Telephone—yielded abundantly.

WISCONSIN.

Beet.—Dewing's Improved Early—early, good size, and solid; Early Blood Turnip—produced a remarkable crop; Edmand's Turnip Blood—were large and sweet.
Cabbage.—Early Jersey Wakefield—a success; Early Summer—every seed produced a large, fine head; Reynolds—extra fine, a success.
Celery.—Giant White Solid—fine and tender; Golden Dwarf—very good.
Cucumber.—Perfection White Spine—excellent.
Grass.—Red Top—produced grass 3 feet high.
Lettuce.—California All Heart—crisp and lasting; Royal Cabbage—fine solid heads, crisp and tender; Salamander—fine flavor, very productive.
Onion.—Extra Early Red—early, of medium size, and pleasant flavor.
Parsley.—Emerald Gem—fine and tender.
Peas.—Extra Early American Wonder—two weeks earlier than any other variety; Yorkshire Hero—very sweet and productive.
Radish.—Early French Scarlet White Tipped—one of the best for early use, juicy and tender; Early White Turnip—splendid variety; Scarlet Turnip White Tipped—recommend them in preference to any other.
Spinach.—Longstanding—fine and firm.
Squash.—Improved Orange Marrow—grows large and is excellent; Pike's Peak or Sibley—very fine, productive to an unusual degree.
Tomato.—Acme—very satisfactory; Paragon—large, smooth fruit, finely flavored, ripen well.
Turnip.—Red Top Strap Leaf—very good; Rutabaga—very successful, smooth, fine-grained, and sweet.

WYOMING.

Cucumber.—Early Cluster—fine, stood the drought better than any other kind.
Lettuce.—Black Seeded Simpson—"best I ever saw."

RECORD OF SEED DISTRIBUTED.

The following tabular statement shows the kinds and quantities of seed issued from this division, but does not include the seeds which were distributed under the supervision of the Division of Chemistry and the Division of Forestry, although the work involved in such distribution was performed in this division. The seed sent out under direction of the Chemist consisted of improved varieties of beet seed (see p. 134), and those from the Division of Forestry chiefly of tree seeds of the cone-bearing species (see p. 298).

Statement showing the kinds and quantities of seed issued from the Seed Division of the Department of Agriculture, under the general appropriation act of Congress, from July 1, 1891, to June 30, 1892.

Description of seeds.	Varieties.	Senators, Representatives, and Delegates in Congress.	County statistical correspondents.	State statistical agents.	Agricultural associations, experiment stations, and miscellaneous applicants.	Total.
		Packages.	*Packages.*	*Packages.*	*Packages.*	*Packages.*
Vegetable	235	4,062,323	203,185	52,370	725,816	5,043,694
Flower	120	369,794	49,050	13,240	290,648	722,732
Honey plant	2				492	492
Herbs	5				548	548
Sunflower	1				236	236
Tobacco	12	69,682	837	362	5,354	76,235
Tree	2				427	427
FIELD.						
Wheat	2	30	219	43	980	1,272
Oats	1	320	419	31	2,445	3,215
Corn	4	7,260	448	163	3,753	11,624
Barley	1				32	32
Kaffir corn	1		72		219	291
Turnip	10	2,376	16,255	5,469	5,894	29,994
Mangel-wurzel	3	34	132	71	240	477
Grass	12	12,415	470	182	4,123	17,190
Clover	4	574	233	167	1,547	2,521
Millet	1				104	104
Forage plants	2		121	94	929	1,144
TEXTILE.						
Cotton	7	17,369	432	165	2,498	20,464
Ramie	1				297	297
Grand total		4,542,177	271,873	72,357	1,046,582	5,932,989

REPORT OF THE CHIEF OF THE DIVISION OF ILLUSTRATIONS.

SIR: I have the honor to submit my third annual report, which contains a brief statement of the work of the Division of Illustrations during the year 1892.

Very respectfully,

GEORGE MARX,
Chief.

Hon. J. M. RUSK,
Secretary.

During the past year the number of illustrations produced has been increased nearly one-half, the correspondence greatly augmented, and the work of extending the usefulness of the electrotype-room has been carried forward. With regard to the number of illustrations, I have to state that my small force of eight assistant draftsmen has made about 1,400 illustrations, a large part of which appear in the periodical publications of the several divisions, or in the present report.

The work of the division embraces nearly every variety of illustration, such as drawing on wood with pencil or ink-wash for the wood-engravers, pencil and crayon drawings for the lithographers, pen and ink drawings for reproduction by the process-engravers, and India ink-wash for the delicate photo-tone or half-tone engravings. A large number of water-color paintings which are almost unexcelled in fidelity and artistic effect have also been prepared.

The work done for the various divisions of the Department embraces the following:

For the Division of Botany, 17 full-page drawings for wood-engravings, 44 in pencil drawings, 13 in pen and ink, 44 in ink-wash, and 2 water-colors. These illustrations were chiefly for the grasses and plants of the Pacific slope, including Alaska.

For the Division of Vegetable Pathology, 115 figures in pen and ink work, representing about 15 plates, 1 ink-wash, and 25 water-color paintings.

For the Division of Forestry, drawings on wood of seven large illustrations of as many varieties of Pinus, and 62 pen and ink drawings, including maps and charts.

For the Division of Pomology, 83 paintings of fruits in water-colors, 13 large drawings (containing about 115 figures) of indigenous and foreign nuts, executed in the finest pen and ink work, and 6 large drawings in ink-wash to be reproduced in half-tone process.

For the Division of Fiber Investigations, 18 figures for illustrations.

For the Superintendent of Gardens and Grounds, 8 illustrations.

For the Bureau of Animal Industry, 66 drawings in pencil for lithographing, 61 in pen and ink, 41 in ink-wash, and 54 water-color paintings illustrating the various stages of diseases in animals as well as the experiments which are being prosecuted.

For the Division of Ornithology, 2 drawings.

For the Division of Entomology, illustrations for about 100 insects, 60 of which have appeared in print.

For the Division of Chemistry, 17 drawings in pen and ink work.

For the Division of Microscopy, 16 pen and ink drawings.

For the Division of Statistics, 5 maps and charts.

Besides considerable miscellaneous work for the Department outside of the divisions above named has been satisfactorily completed. All the work shows a marked improvement over that of the preceding year, both in regard to the minute representation of natural objects as well as a higher attainment in artistic beauty. This is due to the efficiency resulting from increased experience and to the constant personal supervision of every piece of work by the chief of the division.

With regard to the work performed by the wood-engraving branch of the division, I have to report that the force has proved entirely inadequate for the amount of work which could be more advantageously executed by this method; of the three wood-engravers employed in my division, the third (assistant wood-engraver) had to be detailed to perform clerical work, while the two others have been continuously engaged in engraving for only two divisions, namely, the Divisions of Botany and Forestry. They have engraved during the past year 36 full-page illustrations, and I have been compelled to have the work for the other divisions, especially for the Division of Entomology, reproduced by the more rapid and cheaper but inferior photo-process.

While in the nature of the case wood-engraving must always be more expensive than the process forms of illustrations, it is advisable and even essential that this method should be extended to the work of some of the other divisions of the Department; therefore I would respectfully suggest that the force of engravers may be increased by the addition of two competent artists, or that hereafter the chief of the Division of Illustrations may be empowered to give out part of the drawings on wood, by competition, to responsible engravers. In this way the Department would obtain a larger amount of engraved illustrations, without lowering the standard of execution or greatly increasing the expense.

At the date of my last report the division had just entered upon the work of classifying and arranging the collection of wood blocks and electrotypes constituting the illustrative matter pertaining to the publications of the Department since 1858. The collection numbers over 6,000 pieces, all of which have been made available for instant reference and use. Conformably to the policy of the Department, duplicates of these blocks or electro-plates are furnished to the agricultural colleges, experiment stations, and technical publications at small cost to those applying for them, upon the recommendation of the proper officers of the Department and with the approval of the Assistant Secretary. During the year 206 duplicates have been supplied under this system and the usefulness of the Department to that extent has been increased without sensible cost to the public treasury.

Gratifying results have followed the arrangement of enlarging the scope by which the chief of the Division of Illustrations has been invested with the supervision of all the work of the reproducers, as well as the printing work connected with the illustrations intended for the use of the Department. Not only have the prints been produced with greater promptness, but a much larger measure of correctness and finish has been secured, and it is highly desirable that all the chiefs of the divisions of the Department should habitually coöperate in carrying out the wishes of the Secretary in this particular, by consulting the chief of the Division of Illustrations in reference to all that pertains to their illustrative matter, as it has for its object the issuance of the publications of the Department in their best attainable, and therefore most serviceable form.

Though these new functions have increased the labor and responsibility of the division, I take pleasure in testifying to the skilled and faithful service rendered by the employees therein. I would also respectfully suggest that a way of promotion be opened by which efficiency and industry shall be recognized and rewarded.

REPORT OF THE CHIEF OF THE DIVISION OF RECORDS AND EDITING.

SIR: I have the honor to present herewith my third report, covering the work of this division for the year 1892.

Very respectfully,

GEO. WM. HILL,
Chief.

HON. J. M. RUSK,
Secretary.

With the close of the last fiscal year, this division had been practically in existence three years, the work assigned to me when appointed on the staff of the Statistician, July, 1889, not differing materially from that now carried on by the division, although necessarily the work was at that time very inadequately performed, owing to the fact that the division could not be properly organized, as regards expert and clerical assistance, until such time as it was regularly established by the action of Congress, thus postponing the full carrying out of the work of the division until July, 1890. It is, therefore, only two years since the regular work of the division as now carried on, and as originally designed by yourself in making my appointment, has been fairly undertaken under conditions which afford a fair test of its services on behalf of the general publication work of the Department. Although I was able in my first report in 1890 to point out some good results effected by the organization of the division, necessarily that report consisted principally of suggestion, the result of the experience obtained during my first year's service and through frequent conferences with those officers of the Department from whose divisions the larger portion of our publications emanate. In the present report I shall offer a few additional suggestions as to the work in the future, and shall also present for your consideration some facts which will testify strongly, I think, as to the good results obtained, on the lines of both economy and efficiency, through the work of the division, the establishment of which was one of the early acts of your administration. First, as to economy.

The printing fund of the Department has been greatly increased, it is true, but that expense must be measured, I submit, in the light of the results achieved. I have already in my last report claimed that, with reference to the work of this division upon the annual report alone, a sum considerably larger than the entire cost of maintaining the division has been annually saved, and this fact is even more conspicuously evident to-day than it was a year ago. As regards the printing accomplished under the regular printing fund of the Department, while the amount available for 1892 has been not far from twice as large as that for 1888, the year before the work of the division was undertaken, the amount of actual printing was very much greater proportionally to the expense. The total amount of printed matter issued from the Department in 1888, exclusive of the annual report, represented barely 20,000,000 printed pages, an aggregate which was doubled the following year, and has steadily increased, until for the year 1892 the total printing aggregates nearly 97,000,000 pages. It will thus be seen that the administration of the printing fund has been economical, and that the systematizing of the publication work of the Department and the careful preparatory work done in this division on every manuscript transmitted to the printer has actually resulted in a very great saving of money.

Another measure looking to economy has been the dissemination of a great deal of valuable information contributed by the several divisions, in the form of comparatively inexpensive tracts or pamphlets, so that the editions of the larger, more costly bulletins have been but little increased, nothwithstanding the greatly increased demand and the greatly increased number of persons served. This effort toward economy, by a modification in the form of the bulletins, has also been aided somewhat by improvement in the manner of distribution, although it must be admitted that in the important work of distribution there is room for still further improvement.

In connection with this subject, I can not too strongly emphasize the observation made in a previous report, that applicants requesting that they be placed on the Department lists to receive all of its publications should be entirely disregarded. The means now taken to give publicity to the character of every publication issued should be ample to keep all the constituents of the Department well informed as to its current publications, so that each one may apply for a publication as he wants it. If a publication of the Department is not worth a postal card and the trouble of writing it, it is not worth anything. In addition to the sending out of advance notices of the publications, a practice adopted from the very beginning, there is now prepared, on the first of each month, a careful list of the publications issued from the Department during the month previous. This notice is mailed to all the papers on our list, which includes all the agricultural papers throughout the country. Under those circumstances, if the agricultural press coöperates heartily with the Department in keeping their readers posted as to its work and the information it is prepared to give, every farmer who reads will have the information necessary to enable him to procure from the Department directly such publications as will be of service to him. On the other hand, it must be said that even with all these means for keeping the demands upon the Department for its reports and bulletins within reasonable bounds, there must necessarily be a constant increase as the country grows larger, the constituents of the Department more numerous, and its services and the information rendered by it more valuable. Another year's experience only confirms me in the conviction expressed in my last year's report, that the practice which obtains in regard to some of the Departments, and even to some of the publications of this Department, should be made general; namely, that a small charge, even if hardly more than a nominal price, be affixed to every publication, limiting the gratuitous distribution to free libraries, to agricultural associations, and to persons who by services rendered to the Department earn their right to its publications. The affixing of a price would shut off at once a large number of demands coming from persons actuated purely by curiosity or a desire to get something for nothing, and would, at the same time, satisfy book dealers, both in this country and abroad, many of whom are willing and anxious to keep the Department's publications upon their shelves, and to supply customers who could thus promptly and without soliciting favors from anyone obtain as many copies as they need.

The efforts made during the last Congress to effect some reform and retrenchment in the printing work of the Government emphasizes the importance of all suggestions looking to this end, and the discussions which attended the debate on the subject in question, in my opinion point very strongly to the fact that to continue a universal gratuitous distribution must inevitably lead to the wasteful expenditure of a large amount of money for printing. At one time sundry restrictions were proposed upon the publication work of this Department which would have seriously impaired his usefulness, but it is gratifying to be able to report that after a full hearing before the committee and due consideration of the facts so ably presented to them by the Assistant Secretary of this Department, all such restrictions were very greatly modified and ultimately entirely withdrawn; the principle being evidently recognized that the publication work of this Department is as essentially a part of its duty as the work of its various bureaus and divisions in the direction of inquiry and investigation, and that, whereas the publications of the other Departments of the Government are generally intended for the information of Congress or of its own employees, the publications of the Department of Agriculture are necessarily designed to reach a constituency numbering not thousands, but millions of people, all having an equal right to the information it is prepared to give.

In addition to the suggestions contained in my first and second reports, none of which do I desire to withdraw in the light of added experience, I desire now to add one which would not only, in my opinion, simplify the work of the chief of this division and his assistants, but would prove very useful to the head of this Department and the Assistant Secretary, besides furnishing a basis for a considerable extension of the series of departmental bulletins known as Farmers' Bulletins, a series which has proved sufficiently beneficial to justify its very great extension. I would suggest that every report presented for publication should be accompanied by a synopsis prepared in the bureau or division from which it emanates, setting forth clearly its character, the nature of the information it contains, and the conclusions, whether positive or negative, at which the author has arrived on the subject treated of, and which he ventures to present as having a practical value for the farmer. In many cases where the bulletin or report, however scientific it may be, presents results having a direct practical bearing upon agriculture, this synopsis could be enlarged if necessary and issued as a Farmers' Bulletin in advance of the publication of the full report. Such a synopsis would also facilitate prompt decision as to the urgency or otherwise of the information contained in the bulletin, and would expedite its assignment to its proper place in the current printing work of the Department.

Another suggestion which I beg leave to offer, or rather to reiterate, is that steps should be taken without delay to undertake and finish a complete and satisfactory index to the publications of the Department. No index of any kind exists covering the publications for several years past, though these recent years have been extremely prolific in the matter of publication, and the indexes to the publications of previous years are very incomplete and unsatisfactory.

In making this suggestion I find it necessary to emphasize the fact that the small force allotted to this division remains the same as that asked for in the first appropriation bill in which its existence was recognized. What I have said above in reference to the great increase of the work, during the past two years especially, affords ample evidence that the small force of the division is greatly overtaxed by the demands made upon it. It is only by a disregard on the part of the employees of this division of the regular office hours, and of the privileges in the way of leave of absence usually accorded to employees in the Government service, that it has been possible to meet the demands entailed by the current work of the office, and I owe it to all members of the division force to recognize here the unvarying cheerfulness with which they have met the frequent demands upon them for extra work. It is, therefore, with great hesitation that I present the necessity for additional labor, which will, without doubt, devolve upon this division for accomplishment. For this reason I suggest nothing which I do not deem of the utmost importance, and I must accompany the demand with an earnest appeal that provision be made for an enlargement of my present force. The fact that the work of this division effects annually a saving in the expenditures of the Department, exceeding several times over the entire cost of its maintenance, is an ample justification for its more liberal equipment.

PUBLICATIONS OF THE YEAR.

I append the usual list of the publications of the Department for the calendar year, from which it will be seen that, exclusive of maps, charts, circulars of inquiry, and work which may be classed as reprints, the publications of the Department handled by this division, and nearly all of which were prepared for the printer in this office, amounted to 122, representing 10,707 printed pages. Included in this list are certain reports which emanated from this Department but were printed and for the most part distributed by Congress. These comprise the report of the Secretary of Agriculture for 1891 and the reports of the Bureau of Animal Industry for 1889 and 1890, the cost of which is provided for by special appropriation acts, and also Senate Executive Documents Nos. 11, 41 and 45, the usual number of which, 1,734, was printed upon the order of the Senate. The size of each publication is octavo unless otherwise specified.

OFFICE OF THE SECRETARY.

	Copies.
Report of the Secretary of Agriculture for 1891. Pp. 653, illustrated. May, 1892	400,000
Report of the Secretary of Agriculture for 1892. (Preliminary report to the President.) Pp. 64. November, 1892	30,000
Report on the Use of Indian Corn in Europe:	
German edition, pp. 23. May, 1892	2,500
French edition, pp. 22. June, 1892	2,500
Spanish edition, pp. 24. October, 1892	2,500
Scandinavian edition, pp. 22. December, 1892	2,500
Farmers' Bulletin No. 6. Tobacco: Instructions for its Cultivation and Curing. Pp. 8. February, 1892	15,000
Special Report of the Assistant Secretary—Coöperation of the Department of Agriculture with the Educational Forces in the United States relating to Agriculture. (From the Report of the Secretary of Agriculture for 1891.) Pp. 65-81. June, 1892	500
Letter from the Secretary of Agriculture transmitting the Report of the Bureau of Animal Industry for the year 1891. (Senate Executive Document No. 11, Fifty-second Congress, first session.) Pp. 129. January, 1892	1,734

BUREAU OF ANIMAL INDUSTRY.

	Copies.
Sixth and Seventh Annual Reports of the Bureau of Animal Industry, for the Years 1889 and 1890. Pp. 503. February, 1892	50,000
Special Report on Diseases of Cattle and on Cattle Feeding. Pp. 496, pls. 44. December, 1892	10,000
Special Report on the History and Present Condition of the Sheep Industry of the United States. Pp. 1000, pl. 96. December, 1892	10,000
Farmers' Bulletin No. 8. Results of Experiments with Inoculation for the Prevention of Hog Cholera. Pp. 40. May, 1892	75,000
Report of the Chief of the Bureau of Animal Industry for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 83–142. June, 1892	500

DIVISION OF BOTANY.

Botanical Bulletin No. 13, Part I. Grasses of the Pacific Slope, including Alaska and the Adjacent Islands. Plates and Descriptions (50) of the Grasses of California, Oregon, Washington, and the Northwestern Coast, including Alaska. Size, $7\frac{1}{2}$ by $11\frac{1}{2}$ inches. October, 1892	5,000
Contributions from the U. S. National Herbarium, Vol. 1, No. 5. List of Plants collected by Dr. Edward Palmer in 1890 on Carmen Island; List of Plants Collected by the U. S. S. *Albatross* in 1887–'91 along the Western Coast of America; Revision of the North American Species of Hoffmanseggia; Systematic and Alphabetic Index of New Species of North American Phanerogams and Pteridophytes published in 1891. Pp. 129–188, pls. 12–16. September, 1892	2,500
Contributions from the U. S. National Herbarium, Vol. 1, No. 6. List of Plants collected by C. S. Sheldon and M. A. Carleton in the Indian Territory in 1891; Observations on the Native Plants of Oklahoma Territory and Adjacent Districts. Pp. 189–232, pls. 17 and 18. December, 1892	2,500
Contributions from the U. S. National Herbarium, Vol. 2, No. 2. Manual of the Phanerogams and Pteridophytes of Western Texas. Pp. 153–345. June, 1892	2,500
Contributions from the U. S. National Herbarium, Vol. 3, No. 1. Monograph of the Grasses of the United States and British America. Pp. 89. February, 1892	2,500
Report of Grass and Forage Experiment Stations in the South and West—Grass and Forage Experiment Station at Garden City, Kans., and Coöperative Branch Stations in the South. (Reprinted from the Report of the Botanist in the Report of the Secretary of Agriculture for 1891.) Pp. 12. May, 1892	10,000
Report of the Botanist for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 341–358, pls. 8. June, 1892	500

DIVISION OF CHEMISTRY.

Chemical Bulletin No. 13, Part 6. Foods and Food Adulterants—Sugar, Molasses and Sirup, Confections, Honey and Beeswax. Pp. 633–874. April, 1892	10,000
Chemical Bulletin No. 13, Part 7. Foods and Food Adulterants—Tea, Coffee, and Cocoa Preparations. Pp. 875–1014, pl. 39–47	10,000
Chemical Bulletin No. 27. The Sugar-Beet Industry—Culture of the Sugar Beet and Manufacture of Beet Sugar. Pp. 262, pl. 11. (Reprint)	2,500
Chemical Bulletin No. 28. Proceedings of the Seventh Annual Convention of the Association of Official Agricultural Chemists, held at the U. S. National Museum, August 28, 29, and 30, 1890—Methods of Analysis of Commercial Fertilizers, Foods and Feeding Stuffs, Dairy Products, Fermented Liquors, and Sugars. Pp. 238, figs. 21. (Reprint)	500
Chemical Bulletin No. 30. Experiments with Sugar Beets in 1890. Pp. 93. (Reprint)	1,500
Chemical Bulletin No. 31. Proceedings of the Eighth Annual Convention of the Association of Official Agricultural Chemists, held at the Columbian University, Washington, D. C., August 13, 14, and 15, 1891—Methods of Analysis of Commercial Fertilizers, Foods and Feeding Stuffs, Dairy Products, Fermented Liquors, and Sugars. Pp. 253, February, 1892	2,500
Chemical Bulletin No. 32. Special Report on the Extent and Character of Food Adulterations, including State and other Laws relating to Foods and Beverages. Pp. 174. April, 1892	6,000

	Copies.
Chemical Bulletin No. 33. Experiments with Sugar Beets in 1891. Pp. 158. June, 1892	10,000
Chemical Bulletin No. 34. Record of Experiments with Sorghum in 1891. Pp. 132. June, 1892	10,000
Chemical Bulletin No. 35. Proceedings of the Ninth Annual Convention of the Association of Official Agricultural Chemists, held at the National Museum, Washington, D. C., August 25, 26, and 27, 1892. Pp. 243. December, 1892	2,500
Report of the Chief of the Division of Chemistry for 1891. Pp. 143–190. (From the Report of the Secretary of Agriculture for 1891)	500

DIVISION OF ENTOMOLOGY.

Entomological Bulletin No. 26. Reports of Observations and Experiments in the Practical Work of the Division, made under the Direction of the Entomologist. Pp. 95. June, 1892	3,000
Entomological Bulletin No. 27. Reports on the Damage by Destructive Locusts during the Season of 1891. Pp. 64. May, 1892	5,000
Insect Life. (Devoted to the economy and life habits of insects, especially in their relations to agriculture, and edited by the Entomologist and his assistants.)	
Vol. 4, Nos. 5 and 6. Pp. 163–230. January, 1892	5,000
Vol. 4, Nos. 7 and 8. Pp. 231–292. April, 1892	5,000
Vol. 4, Nos. 9 and 10. Pp. 293–352. June, 1892	5,000
Vol. 4, Nos. 11 and 12. Pp. 353–441. August, 1892	5,000
Vol. 5, No. 1. Pp. 62. September, 1892	5,500
Vol. 5, No. 2. Pp. 63–146. November, 1892	5,500
Habits and Natural History of the Ox Bot in the United States. (Reprinted from Insect Life, Vol. 4, Nos. 9 and 10.) Pp. 16. July, 1892	1,000
Report of the Entomologist for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 231–266	500

OFFICE OF EXPERIMENT STATIONS.

Experiment Station Bulletin No. 2. Digest of the Annual Reports of the Agricultural Experiment Stations in the United States for 1888:	
Part 1. Pp. 258. (Reprint)	1,000
Part 2. Pp. 173. (Reprint)	1,000
Experiment Station Bulletin No. 3. Report of a Meeting of Horticulturists of the Agricultural Experiment Stations, at Columbus, Ohio, June 13, 14, 1889. Pp. 12. (Reprint)	500
Experiment Station Bulletin No. 7. Proceedings of the Fifth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations held at Washington, D. C., August 12–18, 1891. Pp. 113. April, 1892	4,000
Experiment Station Bulletin No. 8. Six Lectures on the Investigations at Rothamsted Experimental Station, delivered under the Provisions of the Lawes Agricultural Trust by Robert Warington, F. R. S., before the Association of American Agricultural Colleges and Experiment Stations, at Washington, D. C., August 12–18, 1891. Pp. 113, pls. 11. June, 1892	5,000
Experiment Station Bulletin No. 9. The Fermentations of Milk. Pp. 75. June, 1892	5,000
Experiment Station Bulletin No 10. Meteorological Work for Agricultural Institutions. Pp. 23. March, 1892	7,500
Experiment Station Bulletin No. 11. A Compilation of Analyses of American Feeding Stuffs. Pp. 155. December, 1892	5,000
Experiment Station Bulletin No. 12. Organization Lists of the Agricultural Experiment Stations and Agricultural Schools and Colleges in the United States. Pp. 78. June, 1892	2,500
Experiment Station Record. (A condensed record of the contents of the bulletins and reports issued by the Agricultural Experiment Stations in the United States.)	
Vol. 2, No. 1. Pp. 40. (Reprint)	1,000
Vol. 2, No. 3. Pp. 89–138. (Reprint)	1,000
Vol. 2, No. 7. Pp. 309–384. (Reprint)	1,000
Vol. 2, No. 10. Pp. 541–624. (Reprint)	1,000
Vol. 2, No. 11. Pp. 625–698. (Reprint)	1,000
Vol. 2, No. 12. Pp. 699–853. (Reprint)	1,000
Vol. 3, No. 1. Pp. 72. (Reprint)	1,000

				Copies.
Experiment Station Record—Continued.				
Vol. 3, No. 2.	Pp.	73–138.	(Reprint)	1,000
Vol. 3, No. 3.	Pp.	139–206.	(Reprint)	1,000
Vol. 3, No. 4.	Pp.	207–274.	(Reprint)	1,000
Vol. 3, No. 5.	Pp.	275–364.	(Reprint)	1,000
Vol. 3, No. 6.	Pp.	365–438.	January, 1892	6,200
Vol. 3, No. 7.	Pp.	439–506.	February, 1892	6,500
Vol. 3, No. 8.	Pp.	507–584.	March, 1892	6,000
Vol. 3, No. 9.	Pp.	585–664.	April, 1892	6,000
Vol. 3, No. 10.	Pp.	665–758.	May, 1892	6,000
Vol. 3, No. 11.	Pp.	759–840.	June, 1892	6,000
Vol. 3, No. 12.	Pp.	841–970.	July, 1892	6,000
Vol. 3, Index.	Pp.	971–1059.	December, 1892	5,600
Vol. 4, No. 1.	Pp.	110.	August, 1892	6,000
Vol. 4, No. 2.	Pp.	111–230.	September, 1892	6,000
Vol. 4, No. 3.	Pp.	231–322.	October, 1892	6,000
Vol. 4, No. 4.	Pp.	323–394.	November, 1892	6,000
Vol. 4, No. 5.	Pp.	395–454.	December, 1892	6,000

Farmers' Bulletin No. 1. The What and Why of Agricultural Experiment Stations. Pp. 16. (Reprint) 5,000

Farmers' Bulletin No. 2. The Work of the Agricultural Experiment Stations—Better Cows; Fibrin in Milk; Bacteria in Milk; Silos and Silage; Alfalfa; Field Experiments with Fertilizers. Pp. 16. (Reprint) 5,000

Farmers' Bulletin No. 9. Milk Fermentations and their Relations to Dairying. Pp. 24. July, 1892 25,000

Report of the Director of the Office of Experiment Stations for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 503–531, pl. 1. June, 1892 1,000

OFFICE OF FIBER INVESTIGATIONS.

Fiber Report No. 1. A Report on Flax, Hemp, Ramie, and Jute, with Considerations upon Flax and Hemp Culture in Europe, a Report on the Ramie Machine Trials of 1889 in Paris, and Present Status of Fiber Industries in the United States. Pp. 104, figs. 7. (Reprint of Report No. 1, Miscellaneous Series, of the Division of Statistics) 3,000

Fiber Report No. 4. A Report on Flax Culture for Fiber in the United States, including Special Reports on Flax Culture in Ireland, in Belgium, and in Austria, with Statements relative to the Industry in Russia. Pp. 93, pls. 2, figs. 12. July, 1892 10,000

Annual Report upon Fiber Investigations for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 417–438, figs. 11. June, 1892 500

DIVISION OF FORESTRY.

Forestry Bulletin No. 5. What is Forestry? Pp. 52. (Reprint) 15,000

Forestry Bulletin No. 6, Part 1. Timber Physics—Preliminary Report: Need of the Investigation; Scope and Historical Development of the Science of Timber Physics; Organization and Methods of the Timber Examinations in the Division of Forestry. Quarto, pp. 57, pls. 6. May, 1892 10,000

Timber Physics—Preliminary Report: Need of the Investigation. Pp. 16. March, 1892. (Advance sheets of Forestry Bulletin No. 6, Part 1) 500

Circular No. 8 of the Division of Forestry. Strength of "Boxed" or Turpentine Timber. Pp. 3. March, 1892 5,000

Report of the Chief of the Division of Forestry for 1890. (From the Report of the Secretary of Agriculture for 1890.) Pp. 193–236. (Reprint) 3,000

Report of the Chief of the Division of Forestry for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 191–229, pls. 8. June, 1892 15,000

DIVISION OF GARDENS AND GROUNDS.

Report of the Superintendent of Gardens and Grounds for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 463–484, pls. 7. June, 1892 1,000

OFFICE OF IRRIGATION INQUIRY.

Senate Executive Document 41, Fifty-second Congress, first session:

Part 1. A Report on Irrigation and the Cultivation of the Soil thereby, with Physical Data, Conditions, and Progress within the United States for 1891. Pp. 459, with maps, charts, and other illustrations. June, 1892 1,734

Senate Executive Document 41, Fifty-second Congress, first session—Cont'd.	Copies.
Part 2. Artesian and Underflow Investigation: Final Report of the Chief Engineer, Edwin S. Nettleton, C. E., to the Secretary of Agriculture. Pp. 116, with maps, profiles, and tabulated data. June, 1892	1,734
Part 3. Final Geological Reports of the Artesian and Underflow Investigation between the Ninety-seventh Meridian of Longitude and the Foothills of the Rocky Mountains, to the Secretary of Agriculture. Pp. 209, with maps, profiles, and illustrations. June, 1892	1,734
Part 4. Final Report on the Mid-plains Division of the Artesian and Underflow Investigation between the Ninety-seventh Meridian of Longitude West of Greenwich and the Foothills of the Rocky Mountains, and a Special Report on Certain Artesian Conditions in the State of South Dakota. Pp. 61, figs. 20, and profiles. June, 1892	1,734
Report of the Special Agent in Charge of the Artesian and Underflow Investigations and of the Irrigation Inquiry for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 450, with map. June, 1892	2,000

DIVISION OF MICROSCOPY.

Food Products, No. 1. Twelve Edible Mushrooms of the United States, with Directions for their Identification and their Preparation as Food. (Reprinted from the Report of the Commissioner of Agriculture for 1885, with an Appendix on the Preparation of Mushroom Beds.) Pp. 20, pl. 1. December, 1892	3,000
Report of the Microscopist for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 405-416, pls. 9. June, 1892	2,000

DIVISION OF ORNITHOLOGY AND MAMMALOGY.

Report of the Ornithologist and Mammalogist for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 267-271. June, 1891	3,500

DIVISION OF POMOLOGY.

Pomological Bulletin No. 1. Report on the Condition of Tropical and Semi-tropical Fruits in the United States in 1887. Pp. 149. (Reprint, without plates, of first edition)	1,000
Pomological Bulletin No. 4. Report on the Relative Merit of Various Stocks for the Orange, with Notes on Mal di Goma and the Mutual Influence of Stock and Scion. Pp. 21. (Reprint)	2,000
Pomological Circular No. 8. (Circular of Inquiry relative to Grape Culture.) Pp. 4; size, 8 by 13 inches. March, 1892	5,000
Report of the Pomologist for 1891. (From the Report of the Secretary of Agriculture for 1891). Pp. 379-404. June, 1892	10,000

DIVISION OF RECORDS AND EDITING.

Report of the Chief of the Division of Records and Editing for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 489-498. June, 1892	500

RAINFALL INVESTIGATION.

Report of the Special Agent of the Department of Agriculture for Making Experiments in the Production of Rainfall. (Senate Executive Document No. 45, Fifty-second Congress, first session.) Pp. 59, pls. 9. May, 1892	2,234

DIVISION OF STATISTICS.

Report No. 2, Miscellaneous Series. Report on the Agriculture of South America, with Maps and Latest Statistics of Trade. Pp. 189, pls. 3. May, 1892	10,000
Report No. 3, Miscellaneous Series. Coöperative Credit Associations in Certain European Countries, and their Relation to Agricultural Interests. Pp. 117. May, 1892	6,000

	Copies.
Report No. 4, Miscellaneous Series. Wages of Farm Labor in the United States. Results of Nine Statistical Investigations, from 1866 to 1892, with Extensive Inquiries concerning Wages from 1840 to 1865. Pp. 69. May, 1892	20,000
Statistical Report No. 92. Report upon the Number and Values of Farm Animals, and on Freight Rates of Transportation Companies. (With Cotton Report and European Crop Prospects for February, Notes on Foreign Agriculture, and article on New Railway Construction, 1891.) Pp. 44. February, 1892	20,000
Statistical Report No. 93. Report on Distribution and Consumption of Corn and Wheat, and on Freight Rates of Transportation Companies. (With articles on Indications *vs.* Estimates, More Overproduction, Wheat Crop of the World, and Official Statistics of Foreign Countries, and Notes on European Crop Prospects for March.) Pp. 45-92. March, 1892	20,000
Statistical Report No. 94. Report of the Condition of Winter Grain, the Condition of Farm Animals, and on Freight Rates of Transportation Companies. (With articles,—Speculation *vs.* Industry, and the Cotton Acreage; and European Crop Report for April.) Pp. 93-148. April, 1892	20,000
Statistical Report No. 95. Report of the Condition of Winter Grain and the Progress of Cotton Planting; also on the Freight Rates of Transportation Companies. (With articles,—A Wool Retrospect, and French Tariff and Reciprocity Treaties; also Notes on European Crop Prospects for May and on Foreign Agriculture.) Pp. 149-196. May, 1892	20,000
Statistical Report No. 96. Report on the Acreage of Wheat and Cotton and Condition of Cereal Crops, and on Freight Rates of Transportation Companies. (With European Crop Report for June and Notes on Foreign Agriculture.) Pp. 197-244. June, 1892	20,000
Statistical Report No. 97. Report on the Area of Corn, Potatoes, and Tobacco, and Condition of Growing Crops. Pp. 245-272. July, 1892	20,000
Special Report of the Statistician, July, 1892. Contents: European Crop Prospects for July, Notes on Foreign Agriculture, Indian Cotton Crop of 1892, Suspension of Duties on Corn Imported into Mexico, Removal of Restrictions upon Russian Grain Exports, Exports of Corn, and Transportation Rates. Pp. 273-296	20,000
Statistical Report No. 98. Report of the Statistician, August, 1892. Contents: Primary Prices of Farm Products, Foreign Trade in Agricultural Products, European Crop Prospects for August, Consular Notes on Foreign Agriculture, and Freight Rates of Transportation Companies. Pp. 297-328.	20,000
Statistical Report No. 99. Report of the Statistician, September and October, 1892. Contents: Farm Prices in Two Centuries, the Ramie Machine Trials at New Orleans, Indian Wheat Crop of 1892, Notes of Domestic and Foreign Trade and Industry, European Crop Report for September, and Transportation Rates. Pp. 329-376	20,000
Statistical Report No. 100. Report of the Statistician, November and December, 1892. Contents: Agricultural Production and Distribution of the World, Tests of Averages of Condition, Annual Meeting of Patrons of Husbandry, Reciprocity and Agricultural Exports, European Crop Report for December, and Transportation Rates. Pp. 377-416	20,000
Report on Condition of Growing Crops. August, 1892. Pp. 16	20,000
Report on the Condition of Crops. September, 1892. Pp. 20	20,000
Report on the Condition of Crops and Yield of Grain per Acre. October, 1892. Pp. 23	20,000
Report on Yield of Crops per Acre and on Product Compared with Last Year. November, 1892. Pp. 16	20,000
Report on the Crops of the Year. December, 1892. (With article on Farm Prices.) Pp. 28	20,000
Monthly Crop Synopsis. (A four-page summary of the condition, prospects, yield, price, distribution, and consumption of crops and the number and value of farm animals. Issued soon after the 10th of each month for prompt and wide circulation in advance of the more extended monthly crop report from which it is condensed.)	
February Synopsis. (From Statistical Report No. 92)	122,000
March Synopsis. (From Statistical Report No. 93)	122,000
April Synopsis. (From Statistical Report No. 94)	122,500
May Synopsis. (From Statistical Report No. 95)	122,500
June Synopsis. (From Statistical Report No. 96)	122,500
July Synopsis. (From Statistical Report No. 97)	122,500
August Synopsis. (From August Crop Report)	122,500
September Synopsis. (From September Crop Report)	122,500

	Copies.
Monthly Crop Synopsis—Continued.	
October Synopsis. (From October Crop Report)	122, 500
November Synopsis. (From November Crop Report)	122, 500
December Synopsis. (From December Crop Report)	122, 500
Report of the Statistician for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 273-340. June, 1892	1, 000

DIVISION OF VEGETABLE PATHOLOGY.

Bulletin No. 1 of Division of Vegetable Pathology. Additional Evidence on the Communicability of Peach Yellows and Peach Rosette. Pp. 65, pls. 38. (Reprint)	5, 000
Bulletin No. 2 of Division of Vegetable Pathology. The California Vine Disease. A Preliminary Report of Investigations by Newton B. Pierce, Special Agent. Pp. 222, pls. 25, charts 2. November, 1892	5, 000
Bulletin No. 3 of Division of Vegetable Pathology. Report on the Experiments made in 1891 in the Treatment of Plant Diseases. Pp. 76, pls. 8. November, 1892	11, 000
Journal of Mycology. (Devoted to the study of fungi, especially in their relation to plant diseases. With illustrations.)	
Vol. VII, No. 2. Pp. 65-194, pls. 11-17. April, 1892	2, 500
Farmers' Bulletin No. 4. Fungous Diseases of the Grape and their Treatment. Pp. 12. (Reprint)	1, 000
Farmers' Bulletin No. 5. Treatment of Smuts of Oats and Wheat. Pp. 8, pl. 1. February, 1892	15, 000
Farmers' Bulletin No. 7. Spraying Fruits for Insect Pests and Fungous Diseases, with a Special Consideration of the Subject in its Relation to the Public Health. Pp. 20. April, 1892	20, 000
A Disease of Almond Trees, and Suggestions in Regard to the Treatment of Cercospora Circumscissa. (Reprinted from the Journal of Mycology, Vol. VII, No. 2.) Pp. 66-78, pls. 11-14. April, 1892	2, 000
Report of the Chief of the Division of Vegetable Pathology for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 359-378, pls. 3. June, 1892	500

WEATHER BUREAU.

Weather Bureau Bulletin No. 1. Notes on the Climate and Meteorology of Death Valley, California. Pp. 50, figs. 10. June, 1892	5, 000
Weather Bureau Bulletin No. 2. Notes on a New Method for the Discussion of Magnetic Observations. Pp. 40, pl. 1. July, 1892	5, 000
Weather Bureau Bulletin No. 3. A Report on the Relations of Soil to Climate. Pp. 59. August, 1892	5, 000
Weather Bureau Bulletin No. 4. Some Physical Properties of Soils in their Relation to Moisture and Crop Distribution. Pp. 90. August, 1892	5, 000
Weather Bureau Bulletin No. 5. Observations and Experiments on the Fluctuations in the Level and Rate of Movement of Ground-water on the Wisconsin Agricultural Experiment Station Farm and at Whitewater, Wisconsin. Pp. 75, pls. 6, figs. 37. December, 1892	5, 000
Weather Bureau Bulletin No. 6. The Diurnal Variation of Barometric Pressure. Pp. 32. December, 1892	5, 000
Monthly Weather Review. (A summary by months of weather conditions throughout the United States, based upon reports of nearly three thousand regular and voluntary observers. Size, quarto.)	
Vol. XIX, No. 11, November, 1891. Pp. 259-288, charts 8	3, 000
Vol. XIX, No. 12, December, 1891. Pp. 289-318, charts 6	3, 000
Vol. XIX, Supplement to No. 12. Pp. 319-330, charts 7	4, 400
Vol. XX, No. 1, January, 1892. Pp. 32, charts 7	3, 300
Vol. XX, No. 2, February, 1892. Pp. 33-60, charts 7	3, 300
Vol. XX, No. 3, March, 1892. Pp. 61-88, charts 7	3, 300
Vol. XX, No. 4, April, 1892. Pp. 89-116, charts 5	3, 300
Vol. XX, No. 5, May, 1892. Pp. 117-148, charts 5	3, 300
Vol. XX, No. 6, June, 1892. Pp. 149-178, charts 4	3, 300
Vol. XX, No. 7, July, 1892. Pp. 179-206, charts 4	3, 400
Vol. XX, No. 8, August, 1892. Pp. 207-234, charts 4	3, 400
Vol. XX, No. 9, September, 1892. Pp. 235-260, charts 4	3, 400
Vol. XX, No. 10, October, 1892. Pp. 261-288, charts 5	3, 400
Report of the Chief of the Weather Bureau for 1891. (From the Report of the Secretary of Agriculture for 1891.) Pp. 539-631, pls. 4. June, 1892	3, 000
Instructions for Voluntary Observers. Pp. 100, figs. 21. March, 1892	5, 000

	Copies.
Instructions for Obtaining and Transcribing Records from Recording Instruments. Circular A, Instrument Room. Pp. 12	500
Directions for Use of Maximum and Minimum Thermometers. Circular B, Instrument Room. Pp. 10. May, 1892	500
Instructions for Use of the Rain Gauge. Circular C, Instrument Room. Pp. 8, figs. 3	500
Instructions to Operators on the U. S. Seacoast Telegraph Lines. Pp. 24	300
Instructions for Special River Observers. Pp. 50, figs. 8. August, 1892	500
Instructions to Observers and Code for Enciphering Reports at Cotton Region and Sugar and Rice Stations of the Weather Bureau. Pp. 1–27 and 3–16, figs. 10	500
Tables for Obtaining the Temperature of the Dew-point, Relative Humidity, and Vapor Pressure. Prepared for use in the Weather Bureau. Pp. 69–92	250
Cipher Code for Wind Signal Orders, Amending the Instructions to Special Displaymen. Pp. 10. November, 1892	500
Instructions to Special Displaymen of the Weather Bureau. Size 5 by 7½ inches; pp. 13. February, 1882	400
Appendices reprinted from the Annual Report of the Chief Signal Officer for 1891:	
No. 3. Part 1, Report of the Officer in Charge of the Verification of Official Forecasts; Part 2, Weather Forecasting at the Signal Office June 30, 1891. Pp. 51–60	300
No. 4. Report of Forecasts of Cold Waves. Pp. 61–65	50
No. 5. Report of Professor in Charge of the River and Flood Division. Pp. 67–260, map 1	300
No. 6. Report of the Officer in Charge of the State Weather Services. Pp. 261–292	2,000
No. 8. Annual Report of Data Division. Pp. 317–340	100
No. 10. Report of Assistant Professor in Charge of the Instrument Division. Pp. 343–386, figs. 11	200
No. 11. Report of Bibliographer and Librarian. Pp. 387–409	100
No. 13. Annual Meteorological Summary for the Year ending December 31, 1990. Pp. 433–533	200
No. 14. Temperature Data, 1890, from Signal Service and Voluntary Observers. Pp. 535–667	500
No. 15. Precipitation Data, 1890, from Signal Service and Voluntary Observers. Pp. 669–735	500
No. 16. Dates of the First and Last Killing Frosts for the Season 1890–'91. Pp. 737–745	100
No. 17. International Pressure and Storm Charts. Pp. 747–777, charts 26	25
Weather Map. (Issued twice daily, showing weather conditions throughout the United States, and furnishing forecasts of probable changes.)	
Edition published at Washington, D. C. Size, 19 by 24 inches. Average daily issue	615
Editions published at various stations of the Weather Bureau outside of Washington, D. C. Size, 13½ by 22½ inches. Average daily issue	6,792
Weather Crop Bulletin. (A brief summary of the condition of weather and crops of the United States, showing by maps and tables the departures from normal temperature and rainfall for the period covered by the bulletin. Issued weekly from April to October, inclusive, a separate monthly edition being continued throughout the year, and all issues being numbered consecutively in the order of their appearance. Uniform with Weather Map in size and form.) Nos. 1 to 33. Average number of each issue	3,260
Wreck Chart of the Great Lakes, showing the location of wrecks occasioned through founderings, gales of wind, fogs, and general stormy weather conditions from 1886 to 1891. Size, 24 by 33 inches	2,500
Daily Bulletin. (Issued at Weather Bureau stations outside of Washington, D. C., showing the weather conditions at selected stations of the Bureau, the data being telegraphed to the various observers, who enter the same and cause the bulletins to be displayed, as in the case of the weather maps.) Size, 6 by 14 inches. Average daily issue	2,437

EXPENDITURES FOR PRINTING AND BINDING.

The following statement presents the cost of the printing and binding done for the various divisions of the Department during the fiscal year ending June 30, 1892. The expenditures for printing can not be shown for the calendar year, as nearly all appropriations apply to the fiscal year, and the accounts of the Public Printer are not closed except at the end of this period:

From the fund appropriated for the public printing and binding:	
Bureau of Animal Industry	$9,050.64
Weather Bureau	10,969.29
Division of Accounts	650.66
Division of Botany	3,085.01
Division of Chemistry	4,853.16
Division of Entomology	3,511.96
Office of Experiment Stations	11,031.98
Office of Fiber Investigations	390.87
Division of Forestry	3,470.76
Division of Gardens and Grounds	377.50
Office of Irrigation Inquiry	40.92
Library	370.72
Division of Microscopy	239.45
Division of Ornithology and Mammalogy	467.31
Division of Pomology	1,393.05
Division of Records and Editing	86.45
Division of Statistics	13,732.19
Seed Division	693.24
Division of Vegetable Pathology	4,195.32
File Room	35.40
Document and Folding Room	191.07
Miscellaneous	3,604.51
From funds appropriated for the Department:	
Division of Botany	606.36
Division of Chemistry	4,967.08
Division of Statistics	324.45
Total	78,339.35

The cost of the blanks and blank books required during the year was $12,001.88, and of binding $4,170.12—somewhat more than 20 per cent of the total amount expended. Of the amount charged against the Weather Bureau, nearly all was expended for the blank forms found necessary in its work, the Bureau having been able, by utilizing its own printing equipment, to print nearly all of its publications.

REPORT OF THE SUPERINTENDENT OF THE DOCUMENT AND FOLDING ROOM.

SIR: I have the honor to submit herewith my report on the work of the Document and Folding Room for the year 1892.

Very respectfully,

A. T. LONGLEY,
Superintendent.

Hon. J. M. RUSK,
Secretary.

The name of this division sufficiently indicates the character of its work, but nevertheless it is unquestionably the fact that as that work increases from year to year, it becomes absolutely necessary to seek some methods looking toward greater efficiency and at the same time greater economy of labor. From year to year I have found it desirable to make some suggestion in this line, but I incline to the opinion that the time has now arrived which calls for a very thorough reorganization of the work.

The importance of our work being well and promptly done can only be appreciated by realizing the fact that all the publications of this Department reach the public only through this division. The policy of the Department under your administration has resulted in immeasurably increasing the calls on the part of the public for our publications, while at the same time a very great increase has taken place in the number of publications themselves. It is no exaggeration to state that the number of publications and documents of various kinds handled in this division, and for the prompt and correct transmission of which the chief of division is responsible, has been ten times greater than the number handled five years ago. It must be borne in mind that it is very nearly, if not quite, as much trouble to handle a small as a large publication. In each case a frank has to be directed and attached, and some sort of covering provided, whether envelope or wrapper, and the policy of the Department has inclined so markedly in the direction of larger numbers of small publications, and smaller numbers of the larger books, with one or two marked exceptions, as to account very largely for this extraordinary increase in the number of documents handled.

Considerable effort has been directed during the past two years toward preventing the duplication of names, but I am satisfied that this will never be entirely avoided until a thoroughly systematic plan of card lists has been perfected and adopted for the use of the Department. The permanent lists should be comparatively small. It seems evident that there can not be a very large number of persons throughout the country entitled to receive all the publications of any one division. Such persons, however, to whom it seems desirable to send all the publications of any one division should be so listed as to facilitate the immediate dispatch of every such publication as it is issued, and the force at the disposal of this division should be sufficient to permit the checking of every request for a publication with the permanent lists, and with a record of the publications already sent. I am of the opinion that every request for any publication of any division should pass through the hands of the chief of that division before being received by me, and that, when so received, such request should indidicate whether or not the party was to receive only the work asked for, or to be placed upon the permanent list of the division.

The enormous increase in the publications to be handled, and the very great aggregate value of these publications, of which many thousands are constantly under my charge, in my opinion, make it extremely desirable that some better method be adopted for their preservation. This can only be done, in my opinion, by providing proper storage facilities under lock and key, and appointing some responsible employee as the custodian or storekeeper, requiring him to sign the receipts for all publications turned over to the division, properly crediting them in a book for the purpose, and surrendering publications only upon the receipt of properly signed vouchers indicating their destination. A suitable person detailed for this work could practically keep a ledger account of every publication issued, which would show the number of publications on hand at any given date, while a reference to the vouchers from which the same was posted would indicate the character of the distribution given to each one. In addition to such an employee as I have indicated to be responsible for the safe custody of all the publications of the Department, I would strongly recommend the employment of an additional clerk at the rate of $1,000. In making this recommendation I may be permitted to call attention to the fact that the number of persons provided for by the appropriation for the fiscal year ending June 30, 1893, for the work of this division is the same as for the past three years, nor has there been any change in the remuneration provided for them. I think that for certain work devolving upon this division, efficient performance and economy will be alike subserved by the use of a mailer, such as is common in the case of newspapers and other periodical publications. Some of the lists, in spite of all efforts to the contrary, must necessarily be very large; such, for instance, as the list serving for the distribution of the monthly crop reports. It is apparent, upon very casual consideration, that the utmost correctness obtainable in the writing of thousands of franks can not compare with the correctness attained by the use of a mailing machine and a printed list.

When we consider that to the general public at least the total value of the Department's work is only appreciable by the publications which reach them, and when we appreciate, moreover, that the differentiation into scientific and popular publications is becoming more and more marked, and hence that a careful classification is necessitated of the people to whom these publications are distributed, I think a realizing sense may be had of the necessity for a thorough reorganization of the work of the division upon the lines which I have indicated, and for the adoption of all those methods which can insure promptness and correctness in the distribution of publications.

As it seems quite impossible to secure for the use of this Department such a number of its annual reports as would be adequate to supply the demands made upon it for this publication, I can only suggest and urge that on every possible occasion it should be made clear to the people of the United States that applications for the annual reports of this Department should not be addressed to it. The number placed at the disposal of the Department is practically only sufficient to supply those persons who have made themselves, in a certain sense, its creditors through services rendered, and to whom, consequently, an annual report should be sent direct, without waiting to receive an application.

After this Department shall have been supplied with its quota, 470,000 copies will remain for distribution by Senators and Members of Congress, and it is to these gentlemen that application should be made for a copy of the report. It is worthy of note that while this Department has no copies of the annual report for any year to spare, and is, in the case of some years, reduced to a single copy, thousands and thousands of the annual reports for very many years remain undistributed in the vaults of the Capitol. As every appeal for a copy of the annual report received at this Department entails the writing of a letter to the applicant, it seems desirable that our position in the matter should be widely understood.

A reference to the report of the chief of the Division of Records and Editing, which includes a detailed list of all the publications issued during the calendar year 1892, will satisfy even the casual observer as to the necessity of adopting the most improved methods available to save labor in handling and to secure promptness in the distribution of the documents of this Department. At the same time reference to the varied character of these publications will indicate the necessity for a complete revision of the mailing lists, and, indeed, for their continual revision. In this connection I would suggest, notwithstanding the increased labor which would be thus involved, that with every publication there should be furnished a receipt form on a postal card to be returned to this Department from the recipient. With the exception of 375,000 copies of the Annual Report, 40,000 copies of the Report of the Bureau of Animal Industry, and a comparatively insignificant number of the reports printed by order of the Senate on the subject of irrigation, all the publications mentioned in the list to which I have referred are handled in this Department. The number of publications issued in 1892 was 122, representing the enormous total of 2,409,029 copies.

I am well aware that the suggestions which I have thought it proper to offer in making my report for the past year involve increased labor, care, and responsibility upon the person in charge of this division, but I am of the opinion that in this respect the first consideration must be efficiency, and I therefore make such recommendations as would in my opinion secure the most efficient handling and distribution of the publications, assuming that the chief of this division will not be held accountable for carrying them out in their entirety without an adequate force being placed at his disposal to enable him to do so. I will add, further, that I am of the firm opinion, as the result of frequent conference with, and not infrequent complaint from, the chiefs of the various divisions, that the recommendations which I have the honor to submit herewith would meet with the general approval of the responsible officers of the Department, and would enable this division to relieve them in many cases from a great deal of annoyance and considerable clerical labor, which this division ought to be equipped to supply.

I subjoin a statement showing the number of franks written in the Folding Room, and the supplies, etc., mailed to correspondents; also the number of advance notices, prepared for the press in the Division of

Records and Editing, all of which are distributed through this division. The number of letters and postals written in this division under my direction will indicate very conclusively the urgency of my request for additional clerical help.

The supplies mailed to correspondents consisted of 196,300 sheets, 392,600 envelopes, besides 325,000 circulars folded and mailed, and 130,000 advance sheets mailed to newspapers, involving the writing in this division of 400,000 franks in addition to the franks written for our publications. Of these a full list is given in another report, and it is therefore unnecessary for me to mention them in detail. I would suggest, however, that a comparison of the list for the past year with that for 1888 will furnish ample evidence of the enormous growth of the work in this division. The total number of letters and postals written during the year was nearly 13,000.

REPORT OF THE CHIEF OF THE DIVISION OF ACCOUNTS AND DISBURSEMENTS.

SIR: I have the honor to submit herewith a summary of the business transacted in this division during the fiscal year 1892.

B. F. FULLER,
Chief.

Hon. J. M. RUSK,
Secretary.

The large apparent increase in the appropriations for this Department over preceding years was owing mainly to the addition of the Weather Bureau, which was transferred by act of Congress to the U. S. Department of Agriculture July 1, 1891, with an appropriation of $879,753.50. The appropriation for Agricultural Experiment Stations, $728,000, also goes to swell the total amount carried on the appropriation bill for this Department. Only $20,000 of the latter sum, however, can be expended by the Secretary of Agriculture; the remainder, $708,000, is drawn directly from the Treasury by the several States entitled to the same, and consequently does not enter into the accounts of the Department.

The following statement covers all appropriations under the control of the Department for the fiscal year ending June 30, 1892:

Appropriations and disbursements.

Object of appropriation.	Appropriated.	Disbursed.	Unexpended.*
Salaries	$256,800.00	$252,766.17	$4,033.83
Collecting agricultural statistics	100,000.00	86,401.16	13,598.84
Investigating foreign demands for United States agricultural products	2,500.00	2,223.38	276.62
Botanical investigations and experiments	40,000.00	40,000.00	....
Investigating the history and habits of insects	27,800.00	27,782.43	17.57
Investigations in ornithology and mammalogy	15,000.00	13,928.00	1,072.00
Pomological information	5,000.00	4,985.27	14.73
Microscopical investigations	2,000.00	1,246.46	753.54
Vegetable pathological investigations and experiments	15,000.00	15,000.00	....
Laboratory	19,400.00	19,272.59	127.41
Fiber investigations	10,000.00	7,760.68	2,239.32
Report on forestry	15,000.00	15,000.00	....
Illustrations and engravings	2,000.00	1,999.85	.15
Purchase and distribution of valuable seeds	105,400.00	104,920.35	479.65
Purchase and distribution of seeds to drought sufferers	150,000.00	....	†150,000.00
Document and Folding Room	2,000.00	1,996.82	3.18
Experimental Gardens and Grounds	28,500.00	28,414.14	85.86
Museum	4,000.00	3,909.17	90.83
Furniture, cases, and repairs, 1892	10,000.00	9,991.56	8.44
Furniture, cases, and repairs, 1891-'92	2,000.00	1,992.70	7.30
Library	3,000.00	2,578.92	421.08

*There are a number of unsettled bills standing against the Department that will be paid from the unexpended balances when presented and properly adjusted.

† Not available.

Appropriations and disbursements—Continued.

Object of appropriation.	Appropriated.	Disbursed.	Unexpended.
Postage	$5,000.00	$4,900.00	$100.00
Contingent expenses	25,000.00	24,584.54	415.46
Bureau of Animal Industry	500,000.00	....	....
Bureau of Animal Industry, deficiency appropriation	150,000.00	645,651.87	4,348.13
Quarantine stations for neat cattle	15,000.00	14,921.13	78.87
Agricultural experiment stations	20,000.00	19,961.25	38.75
Experiments in the manufacture of sugar, 1892	25,000.00	....	....
Experiments in the manufacture of sugar, deficiency appropriation	10,000.00	34,692.13	307.87
Experiments in the manufacture of sugar, 1891-'92	25,000.00	25,000.00	....
Irrigation investigations	10,000.00	8,431.59	1,568.41
Weather Bureau	879,753.50	824,770.20	54,983.30

Amount of cash paid out at Disbursing Office	$674,781.61
Number of checks drawn and transmitted	19,754
Number of accounts audited, adjusted, paid, entered, posted, and transmitted to the accounting officers of the Treasury for final adjustment	14,400
Number of letters written, copied, and transmitted	17,815
Number of letters received	23,712
Number of requisitions examined, and orders signed and transmitted	5,297
Number of transportation requests for passenger transportation	1,223
Number of transportation requests for freight transportation	541

In addition to the foregoing exhibit there is a considerable volume of miscellaneous work performed in this division, such as examining and filing leases, contracts, and proposals, supervising and copying authorizations, verifying monthly Treasury check statements, annual itemized report to Congress of the total expenditure of the Department, monthly financial statements, and many minor items requiring the time and labor of the clerks of this division.

The foregoing summary shows the very large volume of business transacted in this division during the fiscal year 1892, all of it of a nature requiring great care and much of it absolute accuracy, and I take great pleasure in commending to your favorable consideration the personnel of this office for faithful, efficient, and exceedingly exacting service.

REPORT OF THE DIRECTOR OF THE OFFICE OF EXPERIMENT STATIONS.

SIR: I have the honor to present herewith the report of the Office of Experiment Stations for the year 1892. I have not attempted more than a brief statement of the work of the office. The amount of space which could be devoted to the report of this office would be insufficient for a proper statement of the work of the experiment stations, and I have thought it best therefore to omit the illustrations of their work which have been included in other years, and to refer those interested in such work to the various publications of the Office of Experiment Stations which are described in my report.

During the year the editorial force of the office has been somewhat increased, and I take this opportunity to express again my appreciation of the faithful and efficient service of the entire force of the office, to which is largely due whatever success has attended the labors of the year. How well this commendation is deserved will be made clear in the report, in which it is shown that with a technical force consisting of six persons and a clerical force consisting of five persons the office has issued during the year over 2,000 printed pages, equivalent to one eight-page document for each working day of the year, and to do this has read and abstracted over 20,000 pages of printed matter, containing reports of American work in agricultural science, besides preparing abstracts of foreign publications, attending to correspondence, filing of documents, translations, visiting of stations, etc. I take great satisfaction, not only in the amount of work accomplished, but in the commendations which have been received for the accuracy and carefulness with which it has been done.

Respectfully,

A. W. HARRIS,
Director.

HON. J. M. RUSK,
Secretary.

OPERATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

WORK OF THE YEAR.

The principal business of the Office of Experiment Stations during the past year has been the preparation of publications relating to the work of the agricultural experiment stations. Twenty-six documents, aggregating 1,781 pages, have been issued, chief among which is the third volume of the Experiment Station Record, consisting of twelve numbers, with a classified table of contents and a detailed index. The office has, however, given much attention to other matters, some of which will be briefly mentioned in this report.

Correspondence.—The correspondence of the office is steadily increasing. The number of letters received during the year was 8,245, an increase of 16 per cent over last year. The number of packages and pamphlets received was 9,626. This correspondence is of a varied character and includes many letters from foreign countries, but seems to call for no special comment. It demands for its attention the equivalent of the whole time of two persons.

Visiting stations and conventions.—It has always been regarded by the office as an important part of its duty to keep itself well informed in regard to the conditions which surround the various experiment stations, and to cultivate, as far as practicable, an acquaintance with their officers. This knowledge of the stations is intended not only to enable the office to furnish the stations with the advice which the law requires, but also to enable it to perform its own work in the abstracting of American publications and selection of matter from foreign reports in such manner as to be of the greatest service. During the year officers of the force have visited fifteen of the stations. It has been our intention to visit each station at least once in two years, but unfortunately this has not been possible so far. This is all the more to be regretted, since some of the stations which it is most desirable to visit have by reason of their distance from Washington been visited least.

Since the last annual report representatives of the office have attended the meetings of the American Association for the Advancement of Science, at Rochester, N. Y.; the meeting of the Association of Official Agricultural Chemists at Washington, D. C.; the annual convention of the Association of American Agricultural Colleges and Experiment Stations at New Orleans, La., and the meetings of the National League for Good Roads at Chicago, Ill., and Washington, D. C. Prof. W. O. Atwater has attended the meetings of and visited experiment stations in Germany, Switzerland, Holland, Belgium, France, and England.

Collection of publications.—The current publications of the stations have been carefully collected and catalogued, and successful efforts have been made to render the office list of the earlier publications more complete. Since the undertaking of the abstracting and indexing of reports of investigations in foreign countries, it has become necessary to begin the collection of foreign publications. Lack of funds has so far made it impossible to do more than obtain the most important publications in English, German, and French. For the proper prosecution of work in this line not only should the list of current periodical publications be enlarged to include those from all the countries in which investigations in agricultural science are in progress, but the office should also obtain such original accounts of inquiries as are not published in journals. The office is at present devoting itself, at considerable cost, to the reviewing of foreign work without the possession of any considerable number of foreign publications. To obtain such a working library as the proper performance of this work demands will involve the annual expenditure of a considerable sum beyond the present resources of the office.

It should be understood that such a library of foreign publications as is here contemplated would be for the use not only of this office, but of the stations also. It is evident that it is now, and must be in the future, increasingly difficult for the stations to accumulate libraries which shall include, in addition to the standard publications, those which, while necessary at times, will as a rule be used infrequently. It is hoped that it may be possible to build up in the Department a reference library which shall contain not only those documents which are necessary for the regular work of the office, but those which by their cost or rarity will not be found in the libraries of the stations, or which by reason of the infrequency of their use it would be inexpedient for the stations to purchase. Certainly the Department should possess all the documents on which the indexes and abstracts prepared by this office are based.

As soon as opportunity shall offer, it is proposed to prepare a collective catalogue of the libraries of the various experiment stations, and, if possible, to perfect some arrangement by which books can be loaned from one to another. It is also the purpose to collect from the various stations duplicates of the rarer station publications and to distribute them so as to complete as far as possible the files of the various stations. The total number of volumes now in the office collection is nearly 4,000. The number added during the year 1892 is nearly 1,000.

Mailing list of the office.—The office has used the greatest care in the formation of its mailing list. As the Experiment Station Record and many other of its publications are works of reference intended for workers in agricultural science rather than for farmers, it has not been the object to distribute them widely. The list is, however, growing, and contains a larger number of names of persons who are not connected either with institutions for agricultural research and education, or with agricultural publications, and an increasing number of persons not residents of this country. This fact has led me to make a recommendation in regard to the sale of documents of which I speak at the end of my report.

World's Fair handbook.—The office has been engaged for some time in preparing for distribution at the World's Fair a pamphlet containing a résumé of experiment station results. This is intended for farmers especially, and is arranged upon the dictionary plan. The experiment station publications have been carefully reviewed to gather together the valuable information which they contain on a great number of topics. This information is stated briefly and is accompanied with references to the publications from which the facts are derived. The work is one of considerable magnitude and only rendered possible by the careful indexes which the office has been engaged in making for several years past. It is hoped that a publication containing so much information of a practical character will justify the labor which has been spent upon it.

The card index of experiment station work.—The office has nearly completed a manuscript card index of the station publications. It is very much to be regretted that it is not supplemented by a corresponding index of the publications of the U. S. Department of Agriculture. It was the intention to print this index on cards as rapidly as prepared, and distribute it to the experiment stations. Its usefulness in the work of this office fully demonstrates the wisdom of placing such an index in every experiment station. But, in carrying out this plan, the office has met with serious difficulties in the part of the work in which the least trouble was anticipated. It was known that the making of a classification of the subjects covered by agricultural science would be a matter of great difficulty, and it was expected that experience in the use of any classification when made would inevitably develop many weak points and call for many additions and changes. The greatest care was therefore taken in the preparation of the classification, and I am very much gratified to be able to say that it has proved to be unexpectedly satisfactory. So far no serious faults have been developed. It was also feared that it would be very difficult for the office force to accomplish the extra work of indexing the station publications which were published before the office began its work, or had been abstracted before the index was begun. This work has been accomplished.

Our great difficulty has been experienced in the printing of cards, which has caused serious delay. In order to make the index useful, the cards must turn easily under the fingers when laid together, and it is therefore necessary that they should be of the same size with only the most minute variation. To obtain this accuracy, the cards were purchased from the Library Bureau of Boston and printed separately. This work was done in the printing office of the Department under my immediate supervision. The work went very slowly and it soon became evident that sufficient rapidity in the printing could not be attained without imposing upon the printing office of the Department more work than its small force could accomplish. It was therefore decided in the summer of the year that the work must be taken to the Public Printer. In September the attempt to print in the Department was given up, and the matter was referred to the Public Printer through the Division of Records and Editing of the Department. The first installment of printed cards was received by this office January 19, 1893. In the meantime the office has accumulated a large number of cards not printed. It is hoped, however, that it will be possible to push the printing so that these arrears may be cleared away in six months. If so, it will not be difficult to keep the index up to date.

The index has been issued during the year as rapidly as the arrangements for printing permitted. The installments thus far sent out include 1,500 cards and cover most of the literature for the year 1890. In response to numerous requests, Congress has granted permission to sell sets of the card index at a price covering the expense of printing them. This will make it possible for private individuals, libraries, and other institutions to secure them on very reasonable terms.

EXHIBITS AT THE WORLD'S COLUMBIAN EXPOSITION.

As detailed in previous reports, this office submitted to the representatives of the agricultural experiment stations at the convention of the Association of American Agricultural Colleges and Experiment Stations held at Champaign, Ill., November, 1891, a plan for an exhibit to be made by the office in the Government Building, illustrating the work, methods, and results of the experiment station enterprise in the United States. It was proposed that this exhibit should be prepared and cared for by the office in coöperation with a committee of station directors selected by the association. It was felt that this was a proper and appropriate part of the exhibit of the U. S. Department of Agriculture, since the stations are in intimate relations with the Department, and the Office of Experiment Stations was created especially to unite the stations to each other and to the Department. The plan proposed was approved by the Assistant Secretary of Agriculture, the Department representative of the Government board, and was cordially adopted by the association. The committee called for was appointed, with Director H. P. Armsby, of Pennsylvania, at its head, and work was begun at once. It soon became evident that the space needed for such an exhibit could not be obtained in the Government Building, and the representative of the Department therefore entered into negotiations with Mr. W. I. Buchanan, Chief of the Department of Agriculture of the World's Columbian Exposition, for the assignment of space in the Agricultural Building sufficient for this exhibit. As a result, Mr. Buchanan assigned to this Department a large space, very advantageously located.

The office will not, however, confine its exhibit to the Agricultural Building, but will also make a small exhibit in the Government Building to illustrate its own work and operations. It has, then, two exhibits, one illustrating its own work, to be shown in the Government Building, the other illustrating the whole experiment station enterprise, including both the office and the stations, to be shown in the Agricultural Building. Immediately adjoining the latter exhibit, and making a part of it, will be an exhibit intended to show the methods pursued in the agricultural colleges in this country.

The exhibit of the Office of Experiment Stations in the Government Building.—In view of the nature of the work done by the office and the relation which it bears to the experiment stations, it is proposed that its exhibit shall take the form of a bureau of information regarding the experiment station enterprise in the United States, which shall be at the same time a model office where the necessary executive business connected with associated exhibits may be conveniently transacted. In addition to this, it is proposed to illustrate by means of still exhibits the processes of preparing the more important office publications, the Record with its index, and the card index of experiment station literature.

The space allotted is to be supplied with the usual office furnishings, desks, file cases, catalogue case, letter press, etc., for illustrating the routine executive work of the office; a bookcase containing a bound volume of one year's publications of each station, together with the unbound copies for the current year; a similar set of the publications of the U. S. Department of Agriculture, and a complete set of the publications of this office. It is intended that this collection shall not only indicate the mass and quality of the experiment station literature at present being published, but shall also show the office methods of cataloguing and arranging it for ready reference. A card catalogue of the collection of station and office publications will be on exhibition, and an index or résumé of station work printed in pamphlet form will be distributed.

In cases will be shown the Record and the indexes in successive stages from the publications which are the raw material to the finished product ready for mailing.

Wall space will be devoted to maps or charts giving statistical data relating to the organization, equipment, and work of the stations, to pictures illustrating model stations in America and Europe, and to photographs of prominent agricultural scientists. In albums or in wing frames will be displayed such views of station buildings and grounds and pictures of distinguished agricultural scientists as can not be disposed of on the wall space available.

The collective station exhibit in the Agricultural Building.—The collective experiment station exhibit which is to be shown in the Agricultural Building has been in charge of this office and a committee of station directors appointed by the Association of American Agricultural Colleges and Experiment Stations. By the division of labor agreed upon, the collection of material for the exhibit and its arrangement have devolved chiefly upon this committee. The installation and care of the exhibit will be the duty of the Office of Experiment Stations. The collection of material for the four working laboratories has, however, been left entirely to this office.

The exhibit is divided into sections, each one of which is planned to illustrate the methods and results of station work in some important line. These sections and the names of the persons in special charge of their preparation are as follows: (1) Animal nutrition, W. H. Jordan; (2) Botany, S. M. Tracy; (3) Crops, C. S. Plumb; (4) Dairying, H. H. Wing; (5) Entomology, S. A. Forbes; (6) Feeding Stuffs, W. A. Henry; (7) Fertilizers, M. A. Scovell; (8) Horticulture, A. E. Popenoe; (9) Soils, E. W. Hilgard.

The laboratories are (1) Botanical; (2) Biological; (3) Chemical, showing methods of investigation; (4) Chemical, showing methods of instruction.

Each laboratory will contain (*a*) a collection of new, original, or peculiar apparatus, with which it is expected that experts will from time to time give demonstrations intended for specialists; (*b*) ordinary apparatus, with which daily experiments will be made to illustrate in a simple manner methods of investigation employed in such laboratories.

The collective college exhibit in the Agricultural Building.—The collective college exhibit is being prepared by a committee appointed by the Association of American Agricultural Colleges and Experiment Stations. The chairman of this committee is Maj. H. E. Alvord, of Virginia. This exhibit is not formally connected with this office, but will join the collective station exhibit, and with it form an integral whole. The office has gladly rendered such assistance as it could. The exhibit is intended not to show what any one of the agricultural colleges is, but to illustrate, in a simple manner, the methods of instruction now in use at these colleges. This exhibit is expected to cover engineering in its various branches and to give especial attention to agriculture.

PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

The publications of the office may be classified as follows:

(1) Experiment Station Record, issued in parts and containing brief abstracts of the current publications of the American stations, and of institutions doing similar work in other countries, together with matters of kindred interest.

(2) Bulletins intended for station workers and others specially interested in agricultural science. As thus far issued these have been arranged in two series as Experiment Station Bulletins and Miscellaneous Bulletins. Hereafter they will be issued in one series as bulletins of the office.

(3) Farmers' Bulletins, containing accounts of experiment station work and cognate information in brief popular form. These bulletins are issued as part of the general series of Farmers' Bulletins of the Department of Agriculture, and are intended for wide popular distribution.

(4) Circulars containing matters of transient or restricted importance and usually intended for limited circulation.

During the calendar year 1892 the office published 1,781 pages, to which should be added 1,500 printed index cards, equivalent to 250 pages. The number of documents issued is 26. The following publications seem to call for special mention:

Experiment Station Record.—The third volume of the Experiment Station Record was completed with the number for July, 1892. This volume of 970 pages contains abstracts of 304 bulletins and 45 annual reports from 53 experiment stations in the United States and 65 bulletins from the Department of Agriculture. The total number of pages in these publications is 17,514. There are also abstracts of 134 reports of foreign investigations. The total number of titles abstracted is 1,120, classified as follows: Chemistry—analyses, methods, 30; botany—mycology, 113; zoölogy, 6; entomology—apiculture, 89; meteorology and water, 57; soils, 41; fertilizers, 69; crops—varieties, composition, field experiments, 192; crops—curing and storage, 17; horticulture, 116; forestry, 8; seeds, 14; weeds, 12; foods, feeding stuffs, and feeding of animals, 122; veterinary science and practice, 24; dairying, 72; technology, 8; agricultural engineering, 15; station statistics, 94; agricultural statistics, 21.

Facts regarding the stations, the changes in their working corps, additions to their equipment, and new legislation affecting their work are concisely stated in experiment station notes. There are also brief editorial articles giving accounts of the agricultural experiment station at Göttingen, Germany, under the directorship of Prof. Henneberg; investigations at Rothamsted, England; the fifth annual convention of the Association of American Agricultural Colleges and Experiment Stations; the meeting of representatives of the German experiment stations at Halle in September, 1891; recent German methods for pot, box, and plat experiments; agricultural experiment stations in Java; notes on progress in agricultural research in 1891; general index of station literature; statistics of the agricultural experiment stations in the United States for 1891; institutions for agricultural education and research in France; some lessons from recent feeding experiments in Prussia; meteorological work for agricultural colleges and experiment stations; need of investigation of the fermentations of silage; problems in soil investigations; improvement of American grasses and cereals by increasing the nitrogen content; an error in our agricultural production and the remedy; index to mycological literature; suggestions regarding station publications; requirements of experiment station work in the South.

Other features of this volume are numerous titles of articles in recent foreign publications on subjects related to the work of the stations and a subject list of the publications of the stations in the United States issued prior to January 1, 1892.

The publication of a detailed subject and author index, as well as a classified table of contents, has been continued. The usefulness of the index to the Record in enabling the student to discover in detail what has been published not only by the stations and this Department, but also in numerous foreign journals, more than justifies the large expenditure of labor involved in its preparation.

While the abstracts of the current publications of the American stations were confined within the limits originally set for this publication, much more space than heretofore was devoted to the reports of European investigations. The attempt was made to select such material as would be most interesting and useful to our station workers. There is every reason to believe that the efforts of the Department to collate in a readily available form the accounts of work published in other countries is much appreciated, not only by our station workers, but by a large number of intelligent students and practitioners of advanced methods in agriculture. In spite of systematic efforts to confine the distribution of the Record to those who are especially interested in its contents, the mailing list for this publication has steadily increased. It is also worthy of note that it is called for by an increasing number of libraries and scientific institutions in this and other countries.

In the fourth volume of the Record, which began with the number for August, 1892, a change in the arrangement of the material was inaugurated, by which the abstracts of the publications of the American stations are grouped by topics, instead of by stations, as formerly. This brings together accounts of investigations on allied subjects, so that they may be more conveniently consulted and compared, and makes it possible to give prominence to the more important matters. To make the contents of the Record more readily available to those who lack the time for reading detailed abstracts, brief synopses are prefixed to the longer abstracts wherever the subject-matter makes this feasible. The synopsis gives the nature and extent of the experiment and the results obtained, leaving all details to the full abstract. As the work of the office has developed and the editorial staff has been increased, a division of duty has been made in accordance with the taste and acquirements of the several members of the force. As far as possible opportunities have been given for work in special lines. The new arrangement of the Record makes it practicable to assign to individuals departments of work for which they are responsible. No attempt has been made to show exactly the share of each worker in the preparation of the Record, but rather to point out the subjects to which individuals are giving their most careful attention. The office force is at present constituted as follows: A. W. Harris, director; A. C. True, assistant director and editor of departments of botany, field crops, and horticulture; W. O. Atwater, special editor for foreign work; E. W. Allen, editor of departments of chemistry, foods and animal production, and dairying; W. H. Beal, editor of departments of fertilizers, soils, and indexes; Walter H. Evans, editor of departments of seeds, weeds, and diseases of plants; S. L. Sommers, librarian and record clerk.

It is, of course, impracticable to give special credit for the large amount of labor expended in editorial oversight and painstaking elaboration of details. It is hoped that it will be possible in the future to make a still further division of our work, according to special subjects, and that each worker will have opportunity to traverse the literature of his chosen field.

Lectures on investigations at Rothamsted Experimental Station.—A course of six lectures, by Mr. R. Warington, F. R. S., chemist of the experiment station at Rothamsted, England. These lectures were delivered before the Association of American Agricultural Colleges and Experiment Stations, at Washington, D. C., in August, 1891, under the provisions of the Rothamsted trust instituted by Sir John Bennet Lawes. The subjects treated were: The Rothamsted Experimental Station; the circumstances which determine the rise and fall of nitrogenous matter in the soil; nitrification; nitrification and denitrification; nitrification of soils and manures; drainage and well waters. Mr. Warington's description of the work of the Rothamsted Station and his more detailed accounts of the processes and results of the investigations of problems of nitrification were followed with much interest by the scientists present, and in their published form constitute a valuable contribution to the literature of scientific investigations in agriculture.

Among the illustrations accompanying the lectures are a portrait of Sir J. B. Lawes, views of the Rothamsted manor house and laboratory, and representations of nitrous, nitric, and denitrifying organisms.

The Fermentations of Milk.—This bulletin was prepared by H. W. Conn., PH. D., professor of biology at Wesleyan University, who has devoted much time and energy to the collection of literature on this subject, as well as to original researches which have given interesting and valuable results. The bulletin contains a résumé of our present knowledge regarding the decomposition changes of milk under the influence of ferments and bacteria with special reference to the practical application of this information to the needs of the dairy industry. The subject is treated under the following heads: Composition of milk; fermentation of milk by rennet; souring of milk; number of bacteria in milk; relation of electricity to the souring of milk; alkaline fermentations; butyric acid; bitter milk; alkaline curdling of milk, and the peptonizing power; blue milk; alcoholic fermentation; slimy fermentation; miscellaneous fermentations; practical bearings of the subject upon dairying; list of references to the literature.

In view of the practical importance of the results of recent bacteriological investigations of milk and its products to an intelligent practice of improved methods in dairying, a popular summary of Prof. Conn's review of the investigations on the fermentations of milk was issued as Farmers' Bulletin No. 9.

Meteorological Work for Agricultural Institutions.—This bulletin was prepared by Mark W. Harrington, chief of the Weather Bureau, at the request of numerous officers of the experiment stations, and contains suggestions of meteorological work for agricultural colleges and experiment stations. The kind of service which the colleges and stations can best render in meteorological lines is pointed out and suggestions are made which will be of great service in the planning and executing of much-needed investigations regarding the relations of our climate to agriculture.

Compilation of Analyses of American Feeding Stuffs.—This compilation was prepared by E. H. Jenkins and A. L. Winton, of the Connecticut State Station, and includes all analyses of American feeding stuffs which were published before September, 1890, and were accessible to the compilers. The analyses are collated from the publications of this Department, of forty-nine experiment stations, and of schools, colleges, and agricultural societies in the United States and Canada. The earliest were analyses of corn made in 1869 in the chemical laboratory of the Sheffield Scientific School under the direction of Prof. S. W. Johnson. The total number of specimens of which analyses are given is 3,273. The analyses are classified as follows: Green fodder—cereal grasses, other grasses and legumes; silage; hay and dry coarse fodder; roots, bulbs, tubers, and other vegetables; grains and other seeds; mill products, and waste products. The usefulness of such a compilation is obvious.

RECOMMENDATIONS, NEW WORK, ETC.

Newspaper bulletins.—The law establishing experiment stations requires them to send a copy of each bulletin to the newspapers of the State. As a result much of the station work has been carefully reported in a large number of papers. The agricultural papers give especial attention to the bulletins and reports of the experiment stations. Some of the stations have made still further attempts to utilize the newspapers by means of carefully prepared newspaper bulletins, short popular statements of station results, which are printed on slips and sent to papers for publication. At least one station has an agreement with a large number of papers to print one column of matter per week furnished by the station. The labor of preparing these bulletins is, however, too great for many of the stations to perform in addition to the other work in which they are already engaged. It has, therefore, been suggested that there should be organized in this office a division or section whose duty would be to furnish to papers each week popular statements of experiment station results.

I have given this suggestion careful investigation, and although I realize that its success is by no means certain, I think it desirable that some such plan should be tried. The General Government is now expending about $700,000 for the support of agricultural investigations at the experiment stations. Each station distributes its bulletins within the boundaries of its own State, but financial limitations prevent distribution in any considerable numbers outside, and even the most liberal editions of bulletins can reach in any one State but a very small proportion of the persons who are reached by the newspapers. The ultimate value of station investigations can not be attained until results of these investigations are applied in practice by the farmers. It seems to me therefore proper and desirable to give a fair test to any system or plan which shows fair promise of giving to the whole country the benefit of the whole amount spent for station support.

Road-making.—The need of good roads in the United States is attracting more and more attention. The experiment stations and the agricultural colleges are admirably fitted to lead in the agitation for better methods of road-making and road care. The stations should make studies of the methods of road-making, make trials of road machinery, determine the fitness of different forms of vehicles for different roads, etc. The colleges should teach the best methods of road-making, should offer courses in road engineering, etc., and both should assist in educating the general public in the art of good road building. To accomplish these ends, assistance is needed from the Department and should be given.

Alaska.—The Government has now provided for the maintenance of experiment stations in all the States of the Union and in all the Territories, except Alaska. This omission is certainly not due to any lack of need for such an institution on the part of the omitted Territory. A superficial study of the conditions and possibilities of Alaska leads me to believe it desirable to continue and extend the study in order to determine whether the Department should not in the near future recommend the appropriation of $15,000 for the maintenance of an agricultural experiment station in Alaska, perhaps under the direct supervision of this office.

Reports of European experiment stations.—Prof. W. O. Atwater, special agent of this Department, has now spent the winters of two years in Europe, visiting experiment stations at his own expense. He has arranged for a series of monographs by the most distinguished investigators, giving accounts of experiment station methods, work, and results in Germany, France, Belgium, Holland, Denmark, Switzerland, and Italy, and has inaugurated a system of exchange by which it is hoped that the office may obtain for the Record abstracts of foreign reports made by the editors of similar journals, in exchange for advance sheets of the Record.

Digests.—In the preparation of the Record and other publications of the office, much material is found which could be digested and put into separate publications. Examples of such work is to be found in the bulletin on Bacteria in Milk, and the Compilation of Analyses of Feeding Stuffs, spoken of elsewhere. In a great number of subjects many stations have been working toward the solution of the same problems, sometimes by the same routes and sometimes by different routes. The value of their work would be very much increased if it could be carefully studied, compared, and reported in one document. These digests would sometimes be of a technical character especially suited to the use of investigators, sometimes of a popular character suited for publication in the series of farmers' bulletins. Now that it has been possible to make a topical division of the work of the office, the members of its force will be able, when the pressure of the World's Fair work is past, to make careful studies of the subjects in which their work lies, and to prepare such digests at somewhat regular intervals. In order to print these digests, the amount of money to be devoted to this office from the printing fund of this Department must be largely increased.

Danger from fire.—In view of the increase of the library of the office, the accumulation of its indexes and valuable manuscripts, I feel it my duty to call attention to the great danger from fire to which they are exposed in the temporary wooden building in which they are stored. These collections and documents have cost the Department a large sum of money and a great amount of labor, and have just been brought to the condition which enables the office to look forward to its best work in the near future. If they were destroyed, it would be necessary to go back and replace them—a task which would probably involve at least as great expenditure of time, labor, and money as the original collection, owing to the increased difficulty of gathering together the data on which they are based.

Educational work.—The stations have two duties: to gain information or to investigate, to disseminate information or to teach. President J. H. Smart, of Purdue University, said at the last convention of the Association of American Agricultural Colleges and Experiment Stations that the experiment stations constituted the greatest system of university extension which this country has known. It is a large part of the duty of this Department to do similar work.

In my opinion the agricultural colleges should not confine their work to the instruction of those young men and women who seek their class rooms, but should endeavor by all proper methods to become the sources of knowledge for the whole agricultural communities which they serve. They should strive to be leaders in all reforms of agricultural practice and to be a source of inspiration to all those who would devote to agriculture the careful study which it needs for its best development. In these endeavors the Department should work with them hand in hand.

I hope, then, that it may be possible in the near future for this office to join with the agricultural colleges and experiment stations in a systematic attempt to unite the agricultural public in the study of better methods by means of courses of home readings, popular lectures, and correspondence with experts in agricultural science and practice. The State College of Pennsylvania has undertaken such a work in its State, and I believe that its success is of vital interest to the agriculture of this country. Many of the States have established systems of farmers' institutes which also furnish valuable suggestions for the plan for such a movement, and might easily be made a part of it.

Selling of publications.—Congress has given the Department authority to sell the card index of agricultural literature prepared by this office at a price covering the cost of presswork and paper, but no provision has been made by which other publications may be sold by the Department. It is true that our publications may be purchased from the Public Printer by making application in due time, but this privilege is of no advantage to individuals who desire to buy single sets of the Experiment Station Record or single documents.

As detailed in another part of this report, I have taken all proper means to insure a wise and economical distribution of the Experiment Station Record, and I am of the opinion that a comparatively small proportion of the copies sent out fail to fall into the hands of persons who will make good use of them. We are, nevertheless, often embarrassed by requests of two kinds. The first come from persons who ask to be furnished with the back numbers of the Record. As this publication is a work of reference containing abstracts of all the publications of the stations, carefully arranged and indexed, its value increases as the number of issues increases. The mass of material sent out from the stations is so great that each year it becomes more and more difficult for anyone to obtain a full and clear idea of what has been done in any particular line unless he has the assistance of some such publication as the Record. At the same time it is important that the station workers and others engaged in similar lines of investigation should have the means of informing themselves easily upon what has been done in their own lines in the remote as well as the immediate past. It is important, therefore, that a considerable supply of the Record should be kept on hand. It is also important, however, that the requests of persons who really need the Record at the present time should not be denied in the interest of similar requests which we expect in the future. It has seemed to me that a solution of this trouble, as far as the United States is concerned, might be found by adopting the rule that: (1) All persons applying for the Record, who are willing to certify after examining one number that they believe it to be of value to them, shall be placed on a mailing list which shall be revised at frequent intervals; (2) back numbers shall be furnished experiment station and college workers and others occupying official or public positions; (3) back numbers shall be furnished to other persons at a nominal price, to be fixed by the Secretary of Agriculture.

The second class of embarrassing requests come from outside of this country. Many foreign countries maintain experiment stations. It is desirable that reports of the work of these stations should be known in the United States, and in turn that the work of our stations should be known abroad. The field of scientific investigation can not be divided by geographical lines. Much of the work done abroad is as valuable to us as to the countries at whose expense it is carried on. To prevent duplication, to obtain the widest circulation of knowledge, to further voluntary coöperation throughout the whole boundaries of the republic of science, it is highly desirable that the fullest possible accounts of work done should be freely exchanged between countries and between individuals in different countries. The reports of foreign investigation can almost always be obtained by purchase through booksellers. This is especially true of the German and French reports. But an investigator in Germany or France can only obtain our reports as a gift, and it is doubtless true that very many who would gladly purchase our publications do not feel free to ask for them. It seems to me, therefore, very desirable for this reason that the Experiment Station Record and, perhaps, other publications of the office, should be placed on sale through foreign booksellers.

This will bring our documents to the attention of persons who would otherwise never know of them and will also relieve us from an embarrassment which promises soon to be serious. To foreign experiment stations, their officers, and other persons occupying official positions in foreign countries, we have not hesitated to send our publications on request, but when requests come from private individuals in foreign countries we have often felt it difficult to decide whether publications should be sent.

ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The Association of American Agricultural Colleges and Experiment Stations held its sixth annual convention November 15–19, at New Orleans, La., in the lecture hall of Tulane University. There were present nearly one hundred and fifty delegates and representatives of colleges and stations in all the States and Territories, except Idaho, Montana, Oregon, South Dakota, and Virginia, and of the U. S. Departments of Agriculture and the Interior. The unusually large attendance of members of the governing boards of colleges and stations was especially gratifying.

The annual address of the president of the association, W. Le Roy Broun, of the Agricultural and Mechanical College of Alabama, presented suggestive comments on the work of the colleges and stations. The hopeful outlook for the system of technical education represented by the land-grant colleges was clearly portrayed. These institutions should not be narrow in their aims. They are intended for all the industrial classes. It is their function to produce men with trained brains and hands. They are to teach the *why* as well as the *how*. They are not to abridge the opportunity to choose an occupation, but to enable the student to prepare for the life for which he is best adapted. The value of military training as a part of the education of the citizen was insisted on. The investigations of the experiment stations, and the dissemination of information to the masses of farmers through bulletins and institutes, were shown to be increasingly valuable parts of the American plan for the education of the industrial classes.

The convention gave a large share of its time to discussions regarding means for making the colleges more effective in educating men for practical work on the farm. Attention was first drawn to this subject by the report of the committee on college work, read by E. M. Turner, of West Virginia. This indicated that while there was an increase in the number of students and graduates, this was due largely to the increase in the number of students in the courses in the mechanic arts. In the discussion which followed it was urged by some that the standard of admission to the courses in agriculture was too high, and that too little practical instruction was given. To remedy this, shorter courses of instruction and courses in special subjects were advocated. Prof. Henry, of Wisconsin, urged that instead of one professor of agriculture in each institution there should be a number of thoroughly trained specialists in different branches of agriculture, so that the farmers' sons would be impressed with the practical as well as the scientific value of the instruction they received. Attention was also called to the fact that by graduating investigators and teachers in the sciences related to agriculture, and leaders in the practice of advanced methods of agriculture, the colleges were doing a grand work. Since they were organized under law as institutions for higher education, they could not be expected to directly reach the masses of farmers. Through the bulletins of the experiment stations, the farmers' institutes, and the agricultural press, the men educated in these colleges were doing the highest kind of service for the advancement of agriculture.

President G. T. Fairchild, of the Kansas College, read a paper on the relations of technical to general courses of study. To avoid too great narrowness, and a separation of culture from technical training, the system of education should have the single aim of imparting knowledge with reference to its usefulness to humanity. Such a scheme involves the teaching of accurate speech, reckoning, reasoning, elementary analysis of the universe, morals, and history, as related to everyday life. At the Kansas College pupils are admitted from the country schools, and are given instruction in natural sciences, mathematics, surveying, engineering, agriculture, and mechanic arts. They are taught to think along the line of various industries. Every effort is made to interest students in the practical work of life.

In the section on agriculture and chemistry, W. M. Hays read a paper on the details of successful farm education, in which he described the two years' school course, the dairy course, and the farmers' winter course of the University of Minnesota. The school of agriculture, which has now been in operation more than four years, has proved a great success. In this school about half the time of the students is given to academic studies and the rest to agriculture, horticulture, veterinary science, carpentry, and other manual work. The boys go back from this school to the farm. As a result of its establishment the farmers of the State have taken a much greater interest in education in agriculture. The separation of this lower course of instruction from the regular college course makes it possible to raise the standard of the latter at the same time that it affords an opportunity for practical instruction to a great number of students.

What a professor of agriculture should be required to teach was discussed by G. E. Morrow, of Illinois, and P. M. Harwood, of Michigan. Both believed that he should teach the application of science rather than science itself. He should, in general, give instruction on (1) farm equipment, (2) farm processes, and (3) farm management. Advantage should be taken of interesting current events in agriculture to stimulate the interest of the pupil. Prof. Harwood insisted upon the value of manual labor in connection with courses of instruction. The student, however, should be made to feel that he is working not as a drudge, but as a learner of valuable processes. Giving the student laborer charge of some special piece of work will do much to arouse his enthusiasm.

Among the papers read in the general sessions or in the sections were the following:

Experiments with fungicides for apple scab, by E. S. Goff, of Wisconsin; fungicides for potato blight and rot, and antagonistic relations of certain potato rots, by L. R. Jones, of Vermont; a study of fruit rots, quince diseases, New Jersey mildews (*Peronosporeæ*), and weed seeds, by B. D. Halsted, of New Jersey; preliminary notes on a rutabaga and turnip rot, crossing of cucurbits, some experiments in the prevention of *Cercospora ribis* and *Cylindrosporium padi*, and relation of frost to certain plants, by L. H. Pammel, of Iowa; forage plant tests, scope and plan, by C. C. Georgeson, of Kansas; notes on the breeding of fruits, by N. E. Hansen, of Iowa; methods of soil analysis, by E. W. Hilgard, of California; bean anthracnose and its treatment, by S. A. Beach, of New York; a new damping-off fungus, and method of obtaining pure cultures of Pammel's fungus of Texas root-rot of cotton, by G. F. Atkinson, of New York; the field of bulletins, present and prospective, by C. L. Ingersoll, of Nebraska.

The numbering of station bulletins was discussed by W. A. Henry, A. W. Harris, S. W. Johnson, and others. The great desirability of some simple and uniform plan of numbering the station publications was urged. The consecutive numbering of all ordinary bulletins in a single series and the abandonment of special series, fractions, and letters was advised. A committee was appointed to make definite suggestions to the stations regarding this matter.

The relations of the colleges and the Department of the Interior were discussed in a paper by J. W. Holcombe, chief clerk of the Bureau of Education. Attention was called to the fact that the present schedule for the financial reports of the colleges was not satisfactory.

The report of the executive committee was read by H. E. Alvord, and showed that the committee had done efficient service in connection with the work on the college and station exhibit at the World's Columbian Exposition and on other important matters.

In the report of the section on agriculture, presented by C. L. Ingersoll, the bulletins of the year were classified. They showed a wide range of subjects, largely along practical lines, but also indicated that the mistake is often made of trying to settle too many questions in a single experiment.

The report of the section on botany, prepared by G. F. Atkinson, was read by S. M. Tracy. During the year botanists have been added to the station staffs at five stations. A general survey of the work occupying the attention of botanists at the different stations was made. The belief was expressed that bacterial plant diseases offered one of the most promising fields of investigation.

The report of the section on chemistry was presented by M. A. Scovell, of Kentucky. It was shown that the work of the station chemists includes (1) detective work, (2) work relating to farm management, (3) development or improvement of processes, (4) more strictly scientific investigations. While a very large amount of routine work is being done a number of important scientific researches are in progress.

The report of the section on economic entomology, presented by H. Osborn, of Iowa, related to the equipment of the stations for work in this line.

The reports of the committees on the college and station exhibit at the World's Columbian Exposition were presented by H. E. Alvord and H. P. Armsby, respectively. This showed that while much progress had been made in the preparation for the exhibit, it was still necessary that the several stations should contribute time and money to this enterprise to make it thoroughly successful. The outlook for a creditable exhibit was decidedly encouraging.

The report of the committee on the agricultural congresses to be held in connection with the World's Columbian Exposition was made by G. E. Morrow.

A new constitution for the association prepared by the executive committee was adopted, with amendments. In the new constitution the following sections are provided for: (1) College work; (2) agriculture and chemistry; (3) horticulture and botany; (4) entomology; (5) mechanic arts. A bibliographer is added to the list of officers of the association.

An advisory board of nine members, selected from governing boards of the colleges and stations, was appointed to coöperate with the standing committees on the World's Columbian Exposition. The members of this committee are H. Chamberlain, of Michigan; J. A. Beaver, of Pennsylvania; H. Gibson, of Kentucky; R. H. Warder, of Ohio; W. R. Cavitt, of Texas; W. L. Rynerson, of New Mexico; J. R. Cameron, of Mississippi; D. Needham, of Massachusetts; and H. B. Dale, of Wisconsin.

A committee to represent the association on the testing committee for tests of breeds of dairy cows at the World's Columbian Exposition was constituted as follows: M. A. Scovell, I. P. Roberts, S. M. Babcock, and H. P. Armsby.

The following were elected officers of the association for the ensuing year:

Executive officers.—President, W. A. Henry, of Wisconsin; vice-presidents, W. C. Stubbs, of Louisiana; E. W. Hilgard, of California; J. A. Myers, of West Virginia; A. Q. Holladay, of North Carolina; and J. F. Hickman, of Ohio; secretary and treasurer, M. A. Scovell, of Kentucky; bibliographer, S. W. Johnson, of Connecticut; executive committee, H. E. Alvord, of Washington, D. C.; W. L. Broun, of Alabama; J. Neilson, of New Jersey; H. H. Goodell, of Massachusetts; and C. W. Dabney, jr., of Tennessee.

Section on college work.—Chairman, C. W. Dabney, jr., of Tennessee; vice-chairman, G. T. Fairchild, of Kansas; secretary, M. C. Fernald, of Maine.

Section on agriculture and chemistry.—Chairman, W. A. Henry, of Wisconsin; vice-chairman, W. C. Stubbs, of Louisiana; secretary, W. C. Latta, of Indiana.

Section on horticulture and botany.—Chairman, F. Lamson-Scribner, of Tennessee; secretary, E. S. Goff, of Wisconsin.

Section on mechanic arts.—Chairman, C. W. Hall, of Minnesota; secretary, F. P. Anderson, of Kentucky.

The association visited the Sugar Experiment Station at Audubon Park, New Orleans, where the sugarhouse was shown in operation, and the processes of making sugar by the diffusion method were explained. The experimental plats where varieties of sugar cane, cotton, grasses, and other plants are being tested and where experiments in methods of culture and manuring are in progress, were also examined with great interest, as well as the orange grove and other fruit plantations. The system of drainage and irrigation at the station is such that the conditions of soil moisture are very largely under the control of the experimenter.

Through the liberality of the Illinois Central Railroad Company, the association also visited the cane fields and sugar mills between New Orleans and Baton Rouge. At Baton Rouge the association was given a dinner by the citizens, after which a visit was paid the State University, where they were cordially welcomed by the president, J. W. Nicholson, and the battalion of cadets. Addresses expressing the appreciation of the association for the kindly treatment received were made by several members. The citizens of New Orleans also gave the association a trip on a Mississippi River steamer, which enabled them to form some idea of the vast commerce of this city in sugar, cotton, wheat, and other agricultural products.

THE AGRICULTURAL AND MECHANICAL COLLEGES.

The act of 1890, popularly known as the Morrill act, providing for an annual grant of money to be paid to each of the agricultural and mechanical colleges, requires each of these institutions to report annually to the Secretary of Agriculture. The execution of the law is, however, vested in the Secretary of the Interior. This Department has placed the reports upon file and has proposed, from time to time, to collect and collate information in regard to these colleges, with more especial reference to the work which they are doing in agriculture. With this end in view, a circular letter was recently sent out to the college presidents asking for information. The replies are so incomplete and vary so greatly in character and thoroughness that it does not seem possible to collate them. Among the inquiries was one asking for reports regarding the additions to courses of instruction resulting from the appropriation of the United States Government under act of Congress of 1890, from receipt of the first installment to the end of 1892. The following is a brief summary of a number of the replies:

ALABAMA.—*Agricultural and Mechanical College.*—Provision has been made for instruction in electrical engineering, physiology, and veterinary science; laboratories of physics and electrical engineering established, and the departments of mechanic arts, history, and English much extended; and scholarships provided for graduate students in the following departments: Agriculture, chemistry, drawing, physics, mechanic arts, mathematics, English, botany, biology, and electrical engineering. The library also has received large additions.

ARKANSAS.—*Industrial University.*—The course in electrical engineering may be so classed. Several other courses have been added, and certainly the Morrill fund facilitates the work.

State Normal and Industrial School.—Our whole course of study in the department of agriculture, is the outgrowth of the appropriation from the General Government under act of Congress of August 30, 1890.

CALIFORNIA.—*University of California.*—Courses in agricultural, organic, and analytical chemistry, entomology, elementary and cryptogamic botany, culture of native plants, industrial, topographical, structural, and freehand drawing, electrical engineering, and lectures at farmers' institutes.

CONNECTICUT.—*Sheffield Scientific School.*—A broadening of the old courses rather than the establishment of new ones. This applies to the agricultural, the mechanical, and the more purely scientific departments. There have been added to the corps of instruction nine new instructors, and seven of the old corps have been advanced to higher positions, viz: One instructor in biology and vegetable physiology, one in veterinary science and bacteriology, one in English, one in German, one in French, one in mechanical drawing, one in mechanical engineering, one in civil engineering, one in electrical engineering, one in physics, one in chemistry, two in mathematics, two assistants in physiological chemistry, and one assistant in biology. The manufacturing industries are preëminent in this State, and it gives direction to much of our work. In the present senior class, sixty-one are pursuing engineering courses (mechanical, electrical, and civil), and there are one hundred and six in the same courses in the junior class. Private gifts of late have enabled us to greatly increase the accommodations for these courses, and the Congressional grant has enabled us to better supply instruction to the increasing number of students.

DELAWARE.—*Delaware College.*—Additional courses have been added, as follows: Civil engineering, mechanical engineering, electrical engineering, and a full agricultural course.

FLORIDA.—*State Agricultural and Mechanical College.*—The act of 1890 has enabled the trustees (1) to establish a preparatory class with a distinct professor. Special attention is paid to English and mathematics in the preparation of students for college; (2) the chair of history, literature, and English language has been divided into two, and an additional professor appointed; (3) a professorship of pure mathematics has been established, these subjects having been previously taught by the commandant of cadets; (4) a professorship of natural history has been established. The standard for admission has been raised and all the work more thoroughly done.

State Normal and Industrial College for Colored Students.—Courses in agriculture, manual training, and science, under special professors, have been greatly enlarged and strengthened.

GEORGIA.—*State College of Agriculture and Mechanic Arts.*—Additions to courses, etc: (1) School of practical agriculture, professor of agriculture, lectures on dairying, etc., and on veterinary science; (2) course in electrical engineering, assistant professor of physics; (3) course in free-hand drawing, assistant in engineering and drawing; (4) chair of biology, professor of biology; (5) assistant professor of analytical chemistry; (6) fellowships in English, agriculture, chemistry, biology, and engineering; (7) chair of history, professor of history; (8) three months' winter course in agriculture; (9) farmers' institutes; (10) additional courses, equipment, and facilities in agriculture, engineering, chemistry, and biology.

IOWA.—*State College of Agriculture and Mechanic Arts.*—We have established a complete dairy course and two short courses in agriculture. We have strengthened our four years' course in agriculture and added three assistant professors in agriculture.

KANSAS.—*State Agricultural College.*—As we have but one course, and that distinctively agricultural, with mechanical elements, no additional courses have been planned under the act of 1890. We have, however, added greatly to the facilities for instruction in agriculture and mechanic arts, and to the corps of instructors. The plan of our entire course conforms to the requirements of the act of 1890.

KENTUCKY.—*Agricultural and Mechanical College.*—Departments established in veterinary science and mechanical engineering, and the following courses strengthened: Civil engineering, anatomy and physiology, botany, and geology.

LOUISIANA.—*Agricultural and Mechanical College.*—Additions to courses of instruction: Professor of civics, mental and moral science; professor of modern languages; professor of physics and engineering; assistant chemist; assistant professor of horticulture and entomology, and three instructors in preparatory department.

MAINE.—*State College of Agriculture and Mechanic Arts.*—A two years' course in agriculture and a dairy course. Also a toning up and strengthening of all the other courses.

MARYLAND.—*Agricultural College.*—Mechanic arts, agricultural chemistry, advanced botanical work, a thorough department of agricultural work, theoretical and practical.

MASSACHUSETTS.—*Agricultural College.*—A two years' course in agriculture and horticulture, and special courses in veterinary science, entomology, political economy, and forestry.

Institute of Technology.—It is impossible for us to separate out those additions which have been made in consequence of the United States grant of 1890 from the many additions made to our course of instruction during the past three years as a consequence of the general growth of the Institute. In that time we have increased our number of students from 909 to 1,060; have increased laboratory and drawing and recitation room accommodations about 38 per cent, and have added 110 to the 211 different courses of instruction given in the college year 1889-'90.

MICHIGAN.—*Agricultural College.*—We are endeavoring here to conform strictly to the spirit of the Morrill act of 1862, which provides for the endowment of schools where the "leading object" shall be instruction in those branches that relate to agriculture and the mechanic arts. Hence, we have only two courses, the one in agriculture and the other in mechanic arts. We have added no new courses since the appropriation under the act of Congress of 1890, but we have added largely to the facilities for instruction in all of our present departments. It is our purpose to develop our two courses only. We hope to provide for these two courses every thing that is essential to the best instruction.

MINNESOTA.—*College of Agriculture of the University of Minnesota.*—A dairy school has been established. The State erected a fine building. A full equipment for the work of butter-making and cheese-making was secured. An accomplished instructor was placed at its head, and the school is doing excellent work for the dairy interest in the State, a most important interest, but one that had been neglected. The work in teaching in all branches in the school of agriculture has been strengthened by increased time devoted to teaching by the instructors in horticulture, entomology, veterinary science, and agriculture. In mechanic arts, a professorship of electrical engineering has been established, also of mining and assaying, and the work of the mechanic arts college has been broadened by these additions and by a technical instructor in architecture.

MISSISSIPPI.—*Agricultural and Mechanical College.*—What is known as the new Morrill act of Congress has almost doubled our usefulness. Through its instrumentality we have established a department of mechanic arts, taught by one professor and two assistants, with shops and equipment worth $15,000. We have also established a chair of veterinary science, with one professor, and have been able to add several assistants in the other departments of the college. Have also been able to supplement salaries and put the entire faculty of the college on a higher and more permanent basis.

Alcorn Agricultural and Mechanical College.—We have inaugurated the departments of carpentry, painting, and blacksmithing (including wheelwrighting) as results of the new Morrill act of 1890, and have now learning these trades 50 young men in the first department, 15 in painting, and a number in blacksmithing.

MISSOURI.—*College of Agriculture of the University of Missouri.*—(1) Department of mechanic arts, organized with three instructors and complete equipment, $30,000 building furnished by State appropriation; (2) a department of history and political science; (3) a commercial department.

NEBRASKA.—*Industrial College of the University of Nebraska.*—A strong course in electrical and steam engineering, with an unusually fine equipment; a course in manual training and shop work, which will be expanded next year, and may possibly become a definite course in mechanical engineering; the expansion of the agricultural course or group in the industrial college; and additions to the instructional force along the lines contemplated by the act—additions which would have been impossible without the act, and additions which have been rendered imperative by the large number of students seeking instruction in these lines.

NEVADA.—*School of Agriculture of the State University.*—(1) Course in practical mechanics; (2) course in mechanics and mechanical drawing; (3) history and English literature. Besides, a number of courses have been materially strengthened and the teaching force enlarged.

NEW HAMPSHIRE.—*College of Agriculture and Mechanic Arts.*—Courses in agricultural chemistry and entomology.

NEW JERSEY.—*Rutgers Scientific School.*—(1) A full four years' course in agriculture; (2) a full four years' course in biology; (3) a six weeks' winter lecture course in agriculture in 1890-'91 and in 1891-'92; (4) during 1891-'92, six full courses of 12 lectures each and one half-course of 6 lectures in college extension work were given, as follows: Full courses—agriculture, one; astronomy, one; electricity one; chemistry, three. Half-course—botany.

NEW MEXICO.—*Agricultural College.*—We were able to add mechanical engineering, and to enlarge the courses in agriculture and civil engineering—in short, to do good strong work in all departments, when otherwise, we should have been much cramped.

NEW YORK.—*College of Agriculture of Cornell University.*—Three courses of instruction in dairy husbandry, one course in agricultural chemistry, and a short course of eleven weeks open to farm boys over 16 years of age.

OHIO.—*State University.*—(1) A course in advanced agriculture, including animal husbandry, dairy husbandry and rural economy; (2) a full course for degree in horticulture and forestry; (3) the work in botany has been much extended; (4) two courses in economic entomology and one in advanced entomology; (5) four or five new courses in English have been added, and existing courses have been subdivided and extended; (6) two courses in history and political science; (7) several existing courses in mathematics, English, etc., have been opened to a much larger number of students, and the classes have consequently had to be divided into two or more sections. A similar effect has been produced by the increased attendance of students—the increase being 43 per cent in two years, not including the law students.

PENNSYLVANIA.—*State College.*—A short course in agriculture, a dairy course, a creamerymens' course, and a Chautauquan course of home readings in agriculture. The chair of zoölogy has been advanced to a full professorship. The changes produced by the "Morrill act" have not been so much by the establishment of new courses as by the enlargement and strengthening of those already established.

SOUTH DAKOTA.—*Agricultural College.*—There have been no additional courses of study offered since the act of Congress of August 30, 1890, until the present time, when we are offering two short courses of study, one in practical steam engineering, and one in dairying. We have, however, been able to strengthen the courses of study previously existing, and more fully to equip the different departments and to employ additional instructors, by reason of the aid given under the act of Congress above mentioned.

TENNESSEE.—*State Agricultural and Mechanical College of the University of Tennessee.*—Before this appropriation was received, all of the instruction given in literature, history, and economics was attached to the chair of English. This has now been separated from this chair and erected into a separate professorship, called the "associate professorship of history and philosophy." In this school are now taught history, science of government, economics, and pedagogics. Relieved of these subjects, the school of English has been placed upon a much better footing. The professorship of mechanic arts has been separated from that of mechanical engineering and erected into a full professorship, the salary of the teacher being advanced from $1,500 to $2,000 per annum. Two additional instructors have been secured, one for the machine shop and one for the blacksmith shop. A large share of the first annual appropriation was used to fit up the mechanical department as we were never able to do before. The agricultural department having been very well equipped previously, it was thought proper to bring the mechanical department up to a high state of efficiency at once. The wisdom of this step is being illustrated by a large number of students entering that department this session. Heretofore pure and applied mathematics were united under one professorship. They have been separated, and we now have a professor of applied mathematics and civil engineering and another professor of pure mathematics. An instructor in practical agriculture has been added to that department, an instructor in horticulture has been added to the school of botany and horticulture, and an instructor in geology—a subject heretofore poorly provided for—has been secured with the purpose of building this up into a full chair as soon as possible. The board of trustees has established a separate chair of physics, also, and will elect a professor to fill it as soon as the new building, now being erected for a physical laboratory, is completed. Two instructors have been added in the industrial department for colored students, one in the school of agriculture and one in the school of mechanic arts. A new shop and scientific building has been erected for the special use of this department, and is now being thoroughly equipped. This building will contain the chemical and botanical laboratories and shops for work in wood and iron.

VIRGINIA.—*Agricultural and Mechanical College.*—The college was in chaotic condition when reorganized in 1891, and was thoroughly remodeled from top to bottom. The following courses may, however, be considered as added: Organic chemistry, metallurgy, industrial chemistry, agricultural chemistry, veterinary science (two years), general biology, zoölogy, vegetable physiology, systematic botany, horticulture, mycology, higher English, electrical engineering, political economy, two courses in apiculture, landscape gardening, assaying, organic analysis, clinics (veterinary), dissecting (veterinary).

Hampton Normal and Agricultural Institute.—No new courses of study have been added during the past two years, but our receipts from the General Government under act of 1890 have enabled us to enlarge and improve our work of instruction in agriculture and horticulture. Two new men, graduates from agricultural colleges, have been added to our corps of instructors, and much new and improved apparatus and machinery have been secured.

WASHINGTON.—*Agricultural College and School of Science.*—Courses in electrical, mining, and civil engineering, assaying, and chemistry.

WEST VIRGINIA.—*West Virginia University.*—Courses in mechanic arts, mechanical engineering, and agriculture.

WISCONSIN.—*College of Agriculture of the University of Wisconsin.*—Since 1890 we have created the division of animal husbandry, with Prof. Craig in charge. The short course in agriculture has been lengthened to two years, and the dairy course instituted. The above data bears specifically on the agricultural college. Our college of engineering has made marked progress and numbers more students than does the college of agriculture.

WYOMING.—*College of Agriculture of the University of Wyoming.*—One, two, and four years' courses in agriculture and four years' course in mechanic arts.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation in every State and Territory, except Montana and Alaska. During the past year one new experiment station has been established. The legislature of the State of Idaho has accepted the conditions of the act of Congress of March, 1887, and located the station at Moscow as a department of the University of Idaho. Two stations have been moved during the year, that of New Hampshire from Hanover to Durham, and that of Ohio from Columbus to Wooster. There are now in the United States 48 stations receiving the appropriation from the General Government. In each of the States of Alabama, Connecticut, Massachusetts, New Jersey, and New York, a separate station is maintained wholly or in part by State funds, and in Louisiana a station for sugar experiments is maintained mainly by funds contributed by planters. In the States of Alabama, Arkansas, California, Colorado, Florida, Michigan, Mississippi, and Wyoming substations are maintained. Excluding the branch stations, the total number of stations in the United States is 54. The stations, together with the Office of Experiment Stations, received during 1892 a total sum of $1,017,144, of which $709,542 was received from the General Government, the remainder being appropriated by the States and from other sources. The total number of persons engaged in the work of administration and inquiry is 491, and may be classified as follows: Directors, 68; chemists, 115; agriculturists, 54; horticulturists, 59; farm foremen, 21; dairymen, 7; botanists, 36; entomologists, 36; veterinarians, 23; meteorologists, 14; biologists, 9; physicists, 3; geologists, 4; mycologists, 4; irrigation engineers, 3; in charge of substations, 27; secretaries and treasurers, 28; librarians, 4; and clerks, 23. There are also 21 classified under the head "miscellaneous," including superintendents of gardens, grounds, and buildings, foremen of farms and gardens, apiarists, herdsmen, etc. During 1892 the stations have published 50 annual reports and 298 bulletins. At a low estimate a total of 40,000,000 pages, containing information on agricultural topics, have been disseminated by the stations during the year; furthermore, their results and processes have been described in newspapers and periodicals throughout the country. The mailing lists of the stations have largely increased during the year.

Several changes have been made in the working force of the stations during the past year. The frequency of changes is growing less, a fact which must greatly contribute to the usefulness of the station work. The following changes have occurred in the directorship of the stations: In Alabama, B. M. Duggar has succeeded W. H. Newman as assistant director in charge of the Canebrake Station. In Colorado, F. J. Annis has been succeeded by Walter J. Quick, who becomes director of the station and professor of agriculture. In Maryland, H. E. Alvord has been succeeded by R. H. Miller as director of the station, and by R. W. Silvester as president of the college. In Nebraska, C. L. Ingersoll has succeeded H. H. Nicholson, who has become professor of chemistry in the university and chemist of the station. In Oregon, B. L. Arnold, deceased, has been succeeded as president of the college and director of the station by John M. Bloss. In Washington State, George Lilley has been succeeded by John W. Heston; and in Wyoming, A. A. Johnson has succeeded Dice McLaren.

LIST OF PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS.

The following publications of this office are intended for general distribution. Others which were printed for special use, and are not of permanent importance, are not mentioned here.

Experiment Station Record:

Vol. I, 6 numbers, with index, pp. 358; vol. II, 12 numbers, with index, pp. 885; vol. III, 12 numbers, with index, pp. 1097; vol. IV, 5 numbers, pp. 454.

Experiment Station Bulletins:

No. 1.—Organization of the Agricultural Experiment Stations in the United States, issued February, 1889, pp. 82.

No. 2.—Digest of Annual Reports of Stations in the United States for 1888, Part I, issued June, 1889, pp. 258; Part II, issued May, 1891, pp. 173.

No. 3.—Report of Meeting of Horticulturists at Columbus, Ohio, issued July, 1889, pp. 12.

No. 4.—List of Horticulturists of the Agricultural Experiment Stations in the United States, issued November, 1889, pp. 27.

No. 5.—Organization Lists of the Agricultural Experiment Stations and Agricultural Schools and Colleges in the United States, issued March, 1890, pp. 67.

No. 6.—List of Botanists of the Agricultural Experiment Stations in the United States, with an Outline of the Work in Botany at the Several Stations, issued May, 1890, pp. 23.

No. 7.—Proceedings of the Fifth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, Washington, D. C., issued August, 1891, pp. 113.

No. 8.—Lectures on Investigations at Rothamsted Experimental Station, issued June, 1892, pp. 113.

No. 9.—The Fermentations of Milk, issued June, 1892, pp. 75.

No. 10.—Meteorological Work for Agricultural Institutions, issued March, 1892, pp. 23.

No. 11.—A Compilation of Analyses of American Feeding Stuffs, issued December, 1892, pp. 155.

No. 12.—Organization Lists of the Agricultural Experiment Stations and Agricultural Schools and Colleges in the United States, issued June, 1892.

Miscellaneous Bulletins:

No. 1.—Proceedings of Association of American Agricultural Colleges and Experiment Stations at Knoxville, Tenn., January, 1889, issued March, 1889, pp. 123.

No. 2.—Proceedings of Association of American Agricultural Colleges and Experiment Stations at Washington, D. C., issued November, 1889, pp. 142.

No. 3.—Proceedings of Association of American Agricultural Colleges and Experiment Stations at Champaign, Ill., issued November, 1890, pp. 156.

Farmers' Bulletins:

No. 1.—The What and Why of Agricultural Experiment Stations, issued June, 1889, pp. 16.

No. 2.—The Work of the Agricultural Experiment Stations—Better Cows, Fibrin in Milk, Bacteria in Milk, Silos and Silage, Alfalfa, Field Experiments with Fertilizers, issued June, 1890, pp. 16.

No. 9.—Milk Fermentations and their Relations to Dairying, issued July, 1892, pp. 24.

Circulars:

No. 7.—Coöperative Field Experiments with Fertilizers, issued March, 1889, pp. 39. This contains the report of the conference of representatives of stations regarding coöperative field experiments with fertilizers, directions and explanations for soil tests with fertilizers, and suggestions for further experiments.

No. 8.—Explanations and Directions for Soil Tests with Fertilizers, issued March, 1889, pp. 11. This is intended for the use of farmers experimenting under the direction of the stations. It is included in Circular No. 7, but was also printed separately for convenience.

No. 11.—Rules for Naming Vegetables—Report of Committee of Experiment Station Horticulturists, issued September, 1889, pp. 3.

No. 20.—Organization List of the Agricultural Experiment Stations in the United States, pp. 21.

STATISTICS OF AGRICULTURAL SCHOOLS, COLLEGES, AND EXPERIMENT STATIONS.

List of agricultural schools and colleges in the United States.

State.	Name of institution.	Locality.	President.
Alabama	Agricultural and Mechanical College.	Auburn	W. L. Broun.
	State Normal and Industrial School	Normal	W. H. Councill.
Arizona	University of Arizona	Tucson	M. P. Freeman.
Arkansas	Arkansas Industrial University	Fayetteville	E. H. Murfee.
	Branch Normal School	Pine Bluff	J. C. Corbin.
California	College of Agriculture of the University of California.	Berkeley	M. Kellogg.
Colorado	State Agricultural College of Colorado.	Fort Collins	Alston Ellis.
Connecticut	Storrs Agricultural School	Mansfield	B. F. Koons.
	Sheffield Scientific School of Yale University.	New Haven	Timothy Dwight.
Delaware	Delaware College	Newark	A. N. Raub.
	State College for Colored Students	Dover	Wesley Webb.
Florida	Florida State Agricultural and Mechanical College.	Lake City	W. F. Yocum.
	State Normal School	Tallahassee	T. De S. Tucker.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White.
Idaho	College of Agriculture of the University of Idaho.	Moscow	F. B. Gault.
Illinois	College of Agriculture of the University of Illinois.	Champaign	T. J. Burrill.
Indiana	School of Agriculture, Horticulture, and Veterinary Science of Purdue University.	Lafayette	J. H. Smart.
Iowa	Iowa State College of Agriculture and Mechanic Arts.	Ames	W. M. Beardshear.
Kansas	Kansas State Agricultural College	Manhattan	George T. Fairchild.
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson.
	State Normal School	Frankfort	J. H. Jackson.
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	J. W. Nicholson.

List of agricultural schools and colleges in the United States—Continued.

State.	Name of institution.	Locality.	President.
Louisiana	Southern University and Agricultural and Mechanical College.	Camp Parapet	H. A. Hill.
Maine	Maine State College of Agriculture and Mechanic Arts.	Orono	M. C. Fernald.
Maryland	Maryland Agricultural College	College Park	R. W. Silvester.
Massachusetts	Massachusetts Agricultural College.	Amherst	H. H. Goodell.
Michigan	Michigan Agricultural College	Agricultural College.	O. Clute.
Minnesota	College of Agriculture of the University of Minnesota.	Minneapolis	Cyrus Northrop.
	State School of Agriculture of the University of Minnesota.	St. Anthony Park.	W. W. Pendergast.
Mississippi	Agricultural and Mechanical College of Mississippi.	Agricultural College.	S. D. Lee.
	Alcorn Agricultural and Mechanical College.	Rodney	John H. Burrus.
Missouri	College of Agriculture of the University of the State of Missouri.	Columbia	Richard H. Jesse.
	Lincoln Institute	Jefferson City	Inman E. Page.
Nebraska	Industrial College of the University of Nebraska.	Lincoln	J. H. Canfield.
Nevada	School of Agriculture of the Nevada State University.	Reno	S. A. Jones.
New Hampshire	New Hampshire College of Agriculture and the Mechanic Arts.	Hanover	Lyman D. Stevens.
New Jersey	Rutgers Scientific School of Rutgers College.	New Brunswick	Austin Scott.
New Mexico	Agricultural College of New Mexico.	Las Cruces	Hiram Hadley.
New York	College of Agriculture of Cornell University.	Ithaca	J. G. Schurman.
North Carolina	The North Carolina College of Agriculture and Mechanic Arts.	Raleigh	A. Q. Holladay.
	Shaw University	Raleigh	H. M. Tupper.
North Dakota	North Dakota Agricultural College.	Fargo	H. E. Stockbridge.
Ohio	Ohio State University,	Columbus	W. H. Scott.
Oklahoma	Oklahoma Agricultural and Mechanical College.	Stillwater	R. J. Barker.
Oregon	Oregon State Agricultural College.	Corvallis	John M. Bloss.
Pennsylvania	The Pennsylvania State College	State College	George W. Atherton.
Rhode Island	Rhode Island College of Agriculture and Mechanic Arts.	Kingston	J. H. Washburn.
	Department of Agriculture and Mechanic Arts of Brown University.	Providence	E. B. Andrews.
South Carolina	Clemson Agricultural College	Fort Hill	H. A. Strode.
	Claflin University, College of Agriculture, and Mechanic's Institute.	Orangeburg	L. M. Dunton.
South Dakota	South Dakota Agricultural College.	Brookings	L. McLouth.
Tennessee	State Agricultural and Mechanical College of the University of Tennessee.	Knoxville	C. W. Dabney, jr.
Texas	State Agricultural and Mechanical College of Texas.	College Station	L. S. Ross.
	Prairie View Normal School	Prairie View	L. C. Anderson.
Utah	Agricultural College of Utah	Logan	J. W. Sanborn.
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham.
Virginia	Virginia Agricultural and Mechanical College.	Blacksburg	J. M. McBryde.
	Hampton Normal and Agricultural Institute.	Hampton	S. C. Armstrong.
Washington	Washington Agricultural College and School of Science.	Pullman	J. W. Heston.
West Virginia	West Virginia University	Morgantown	E. M. Turner.
	West Virginia Institute	Farm	J. E. Campbell.
Wisconsin	College of Agriculture of the University of Wisconsin.	Madison	C. K. Adams.
Wyoming	College of Agriculture of the University of Wyoming.	Laramie	A. A. Johnson.

Revenue and additions to equipment of the agricultural colleges in the United States receiving aid from the General Government.

Colleges.	Revenue for 1892 from—							
	United States.	State.	Local communities.	Individuals.	Fees.	Farm produce.	Miscellaneous.	Total.
Alabama (Auburn)	$62,384	$13,669			$1,053	$1,505	$579	$79,190
Alabama (Normal)	1,116				150	1,250		2,516
Arizona	22,000				192		6,429	28,621
Arkansas (Fayetteville)	24,000	25,000			1,513	410	10,400	61,323
Arkansas (Pine Bluff)	9,000							9,000
California	8,077						16,175	24,252
Colorado	32,000	50,894			2,286			85,180
Connecticut (New Haven)	23,532						6,911	30,443
Connecticut (Storrs)		14,545						14,545
Delaware (Newark)	33,580	25,000			1,676			60,256
Delaware (Dover)	3,400	8,000						11,400
Florida (Lake City)	32,601				845			33,446
Florida (Tallahassee)	8,000	6,618				177		14,795
Georgia	26,287					300		26,587
Idaho	(*a*)							
Illinois	48,000	27,500			15,341	2,619	14,189	107,649
Indiana	33,000	30,000			6,600	2,311	3,900	75,811
Iowa	77,418	39,989			3,111	34,307	3	154,828
Kansas	46,654	12,500			72	4,027	3,084	66,337
Kentucky (Lexington)	38,115	32,310			3,684		407	74,516
Kentucky (Frankfort)	4,128	3,000						7,128
Louisiana (Baton Rouge)	38,733	27,506					4,463	70,702
Louisiana (Camp Parapet)	9,000	10,000				550		19,550
Maine	38,455	24,500			22,165	2,600		87,720
Maryland	38,142	6,000			7,014	169	232	51,557
Massachusetts (Amherst)	57,537	10,000			4,023	9,864		81,424
Michigan	66,969	22,948			6,663	5,906	2,422	104,908
Minnesota	80,969	80,762			20,038	4,932	26,633	213,334
Mississippi (Agricultural College)	13,747	27,500			845	7,416		49,508
Mississippi (Rodney)	15,057	12,321			182	422		27,982
Missouri	63,681	30,000				4,057		97,738
Nebraska	17,000	121,825			4,417	1,399		144,641
Nevada	17,000	10,000						27,000
New Hampshire	36,800	50,000			1,071	3,455	730	92,056
New Jersey	23,960	1,500			11,174			36,634
New Mexico	17,000	6,600			409		11	24,020
New York	35,000							35,000
North Carolina (A. and M. College)	19,000	10,000			1,200	700		30,900
North Carolina (Shaw Univ.)								
North Dakota	32,000	25,000					2,752	59,752
Ohio	49,692	62,740			15,193		2,010	129,635
Oklahoma	17,000							17,000
Oregon	41,717				1,587	746		44,050
Pennsylvania	42,637	58,110			2,704	4,199	14,526	122,176
Rhode Island (Providence)	3,024		$62,200	$31,754	35,292		700	132,970
Rhode Island (Kingston)		15,000			100			15,100
South Carolina (Fort Hill)	20,296	36,221		3,621				60,138
South Carolina (Orangeburg)	48,300	5,000	5,000		4,000	1,500	4,000	67,800
South Dakota	50,088	6,000			3,318	6,950		66,356
Tennessee	55,760				5,861	1,037	32,779	95,437
Texas (College Station)	27,500	34,280				3,000		64,780
Texas (Prairie View)	4,250	2,500						6,750
Utah	17,000	54,000			1,899	972	389	74,260
Vermont	25,130	6,000		395	6,676		18,893	57,094
Virginia (Blacksburg)	31,992	6,250			2,621		959	41,822
Virginia (Hampton)	15,996			733		23,433	6,774	46,936
Washington	33,000	60,000						93,000
West Virginia (Morgantown)	27,000							27,000
West Virginia (Farm)	3,000				19	220		3,239
Wisconsin	11,633			1,000	600	5,650		18,883
Wyoming	37,751							37,751
Total	1,716,108	1,111,588	67,200	37,503	195,594	136,083	180,350	3,444,426

a College opened September, 1892. No report.

Revenue and additions to equipment of the agricultural colleges in the United States receiving aid from the General Government—Continued.

Colleges.	Value of additions to equipment in 1892.						
	Farm.	Buildings.	Library.	Apparatus.	Live stock.	Miscellaneous.	Total.
Alabama (Auburn)	$1,000	$9,500	$5,000	$12,500	....	$2,000	$30,000
Alabama (Normal)	496	550	15	11	$100	....	1,172
Arizona	3,603	....	932	4,249	....	71	8,855
Arkansas (Fayetteville)	500	600	300	1,000	....	2,500	4,900
Arkansas (Pine Bluff)	....	....	....	....	....	....	....
California	178	....	81	728	....	....	987
Colorado	1,000	19,996	300	2,800	12,000	....	36,096
Connecticut (New Haven)	....	....	....	5,266	....	....	5,266
Connecticut (Storrs)	....	....	300	200	....	....	500
Delaware (Newark)	3,014	25,010	1,818	4,100	....	560	34,502
Delaware (Dover)	5,000	4,000	400	1,500	1,000	4,000	15,900
Florida (Lake City)	(a)	....	....	....	....	....	....
Florida (Tallahassee)	2,940	7,050	300	2,721	888	546	14,445
Georgia	1,509	....	1,200	6,967	200	124	10,000
Idaho	(b)	....	....	....	....	....	....
Illinois	1,500	72,500	5,100	7,500	....	....	86,600
Indiana	116	....	500	5,000	....	2,000	7,616
Iowa	13	20,000	3,000	9,795	1,800	100	34,708
Kansas	....	6,000	1,450	7,500	400	5,200	20,550
Kentucky (Lexington)	....	13,371	909	17,553	....	2,142	33,975
Kentucky (Frankfort)	1,468	....	71	305	....	736	2,580
Louisiana (Baton Rouge)	....	9,698	1,275	5,087	....	1,037	17,097
Louisiana (Camp Parapet)	625	250	42	648	275	....	1,840
Maine	400	3,600	1,600	9,000	480	....	15,080
Maryland	2,000	2,000	1,000	4,000	1,000	2,000	12,000
Massachusetts (Amherst)	277	....	4,221	644	1,576	....	6,718
Michigan	....	2,612	3,650	5,044	....	....	11,306
Minnesota	....	65,000	4,000	....	....	....	69,000
Mississippi (Agricultural College)	410	4,394	191	5,907	....	38,642	49,544
Mississippi (Rodney)	100	....	600	1,400	455	....	2,555
Missouri	812	27,000	1,450	773	109	539	30,683
Nebraska	430	37,000	3,500	25,000	125	....	66,055
Nevada	5,155	....	1,774	2,519	....	2,809	12,257
New Hampshire	88	32,498	619	3,376	29	....	36,610
New Jersey	....	....	....	....	....	....	....
New Mexico	1,986	3,110	2,149	2,442	....	2,671	12,358
New York	....	....	....	....	....	....	....
North Carolina (A. and M. College)	300	6,600	100	600	....	100	7,700
North Carolina (Shaw Univ.)	....	....	....	....	....	....	....
North Dakota	4,821	25,000	766	4,006	1,587	87	36,267
Ohio	....	53,106	1,996	10,420	....	....	65,522
Oklahoma	1,669	....	3,357	4,502	4,184	....	13,712
Oregon	297	578	541	2,939	260	459	5,074
Pennsylvania	4,805	96,445	1,263	4,183	....	275	106,971
Rhode Island (Providence)	1,500	3,950	5,717	1,100	....	500	12,767
Rhode Island (Kingston)	1,000	5,000	300	500	....	....	6,800
South Carolina (Fort Hill)	182	33,000	....	....	....	....	33,182
South Carolina (Orangeburg)	3,000	....	....	2,000	1,000	6,000	12,000
South Dakota	2,086	3,000	785	3,699	2,500	....	12,070
Tennessee	....	33,614	948	312	....	1,054	35,928
Texas (College Station)	....	30,000	500	1,500	1,000	....	33,000
Texas (Prairie View)	750	....	....	....	75	....	825
Utah	200	80,500	500	4,304	1,500	....	87,004
Vermont	....	28,952	3,700	15,406	....	....	48,058
Virginia (Blacksburg)	....	2,800	300	1,000	....	2,500	6,600
Virginia (Hampton)	462	1,230	....	....	1,143	....	2,835
Washington	1,300	52,000	250	3,000	1,500	6,500	64,550
West Virginia (Morgantown)	....	....	....	....	....	....	....
West Virginia (Farm)	3,408	9,546	....	39	300	....	13,293
Wisconsin	290	34,200	757	2,500	500	....	38,247
Wyoming	549	....	1,180	6,449	....	4,315	12,493
Total	61,061	865,260	70,526	223,266	35,986	89,467	1,345,666

a Data not accessible.
b College opened September, 1892. No report.

Statistics of agricultural schools and colleges in the United States.

State.	Date of establishment.	Faculty.	Students in 1892.	Students in agricultural courses in 1892.	Graduates in agricultural courses in 1892.	Total number of graduates in agricultural courses.	Revenue in 1892.	Average expenses of students per year.	Agricultural courses.
Alabama (Auburn)	1872	23	255	13	6	67	$79,190	$154	1, 2, and 4 years.
Alabama (Normal)	1875	7	326	15	0	0	2,516	72	3 years.
Arizona	1891	13	9	9	0	0	28,621	215	4 years and winter lectures.
Arkansas (Fayetteville.)	1871	31	556	49	0	0	61,323	135	2 years.
Arkansas (Pine Bluff)	1875	5	234	......	......	......	......	130	4 years.
California	1868	53	......	17	0	28	......	230	4 years and special lectures.
Colorado	1877	17	175	59	2	16	85,180	166	2, 4 years, and short winter course.
Connecticut (Yale)	1860	48	461	(a)	0	13	92,643	615	2 years.
Connecticut (Storrs)	1881	8	49	49	8	84	14,545	125	3 years.
Delaware (Newark)	1871	12	81	3	0	0	60,256	228	3 years.
Delaware (Dover)	1892	3	20	0	0	0	11,400	80	4 years and short winter course.
Florida (Lake City)	1884	15	92	8	0	0	33,446	125	4 years.
Florida (Tallahassee)	1887	5	70	26	0	0	14,795	85	
Georgia (Athens)	1872	13	142	109	10	125	26,587	170	3 years.
Idaho	1892	6	(b)	......	......	......	......	175	2, 4 years and winter lectures.
Illinois	1868	24	......	40	0	60	107,649	189	4 years.
Indiana	1873	45	......	59	1	15	75,811	135	4 years.
Iowa	1868	30	547	118	15	288	154,929	230	4 years.
Kansas	1863	28	584	275	36	101	66,337	150	4 years.
Kentucky (Lexington).	1880	25	415	(c)	......	......	74,516	180	4 years.
Kentucky (Frankfort)	1888	5	112	23	8	8	7,128	100	2 years.
Louisiana (Baton Rouge).	1877	18	176	15	4	30	70,702	150	4 years.
Louisiana (Camp Parapet).	1880	7	405	87	0	0	19,550	90	2 years.
Maine	1865	18	123	11	0	35	87,720	142	1, 2, and 4 years.
Maryland	1856	15	105	54	8	(d)	51,557	180	4 years.
Massachusetts (Amherst).	1863	13	178	158	22	361	81,424	250	4 years.
Michigan	1857	31	345	140	26	596	104,908	130	4 years.
Minnesota (Minneapolis).	1868	7	......	6	0	3	213,334	125	4 years.
Minnesota (St. Anthony Park).	1888	11	136	136	9	41	22,165	80	3 years.
Mississippi (Agricultural College).	1878	23	310	195	23	137	49,508	100	4 years.
Mississippi (Rodney)	1878	13	278	123	10	58	27,982	80	4 years.
Missouri (Columbia).	1870	18	......	205	1	(d)	97,738	90	2, 4 years, post graduate, and farmers' lecture course.
Missouri (Jefferson City).	1866	8	182	......	......	......	......	90	
Nebraska	1869	37	117	10	1	8	144,641	165	2 years, and farmers' short course.
Nevada	1887	15	......	8	2	2	27,000	225	4 years.
New Hampshire	1866	16	......	12	2	112	92,056	150	4 years.
New Jersey	1864	28	251	75	15	216	36,634	310	3 years, winter lectures.
New Mexico	1891	10	29	14	......	......	24,020	175	4 years.
New York	1868	11	......	105	11	90	35,000	320	4 years.
North Carolina (A. and M. College).	1888	8	......	......	......	......	......	130	4 years.
North Carolina (Shaw University).	......	......	......	......	......	......	......	......	

(a) There are 48 students regularly pursuing some of the distinctively agricultural studies. There were no graduates in agricultural courses in 1892. Thirty-four of the graduates had, however, taken some of the distinctively agricultural studies as a part of their regular curriculum, and passed their examinations on them.
(b) College opened in September, 1892. No report.
(c) Number of students entered in courses of study relating to agriculture were as follows: Botany, 23; Zoölogy, 18; Entomology, 1; Chemistry, 61; Veterinary science, 4. The total number of graduates in courses of study relating to agriculture, about 100.
(d) Records incomplete and number can not be given.

Statistics of agricultural schools and colleges in the United States—Continued.

State.	Date of establishment.	Faculty.	Students in 1892.	Students in agricultural courses in 1892.	Graduates in agricultural courses in 1892.	Total number of graduates in agricultural courses.	Revenue in 1892.	Average expenses of students per year.	Agricultural courses.
North Dakota	1891	13	122	81	28	58	$59, 752	$165	4 years, short winter course.
Ohio	1870	49	422	44	3	10	129, 635	225	2 and 4 years.
Oklahoma	1891	6	127	116	0	0	17, 000	120	4 years.
Oregon	1885	14	277	277	15	126	45, 967	150	3 years.
Pennsylvania	1874	33	135	19	1	52	122, 176	195	4 years, short course.
Rhode Island (Providence).	1867	59	......	9	8	200	132, 970	......	One term. (*a*)
Rhode Island (Kingston).	1890	16	95	47	0	0	15, 100	140	3 years.
South Carolina (Fort Hill).	(*b*)	......	......	......	....	......	60, 138	......	
South Carolina (Orangeburg).	1872	11	605	50	0	0	67, 800	75	
South Dakota	1883	18	188	120	9	39	66, 356	125	4 years.
Tennessee	1879	23	......	75	0	(*d*)	95, 437	290	3 years.
Texas (College Station).	1876	28	318	47	7	41	64, 780	145	4 years.
Texas (Prairie View).	1879	11	176	35	0	0	....	100	2 years.
Utah	1888	19	290	27	0	0	74, 260	138	3, 4 years, and short lecture course.
Vermont	1865	17	448	12	1	1	57, 094	240	4 years, short course, and dairy course.
Virginia (Blacksburg).	1872	19	174	30	1	(*c*)	41, 822	94	4 years.
Virginia (Hampton).	1868	34	686	28	1	288	46, 936	75	3 years.
Washington	1891	9	275	30	0	0	93, 000	175	4 years.
West Virginia (Morgantown).	1867	21	224	......	....	......	....	160	3 years, and short winter course.
West Virginia (Farm)	1892	5	33	17	0	0	3, 239	100	3 years.
Wisconsin	1866	21	......	164	17	24	18, 883	140	2, 4 years, graduate and dairy courses.
Wyoming	1891	10	......	6	0	0	37, 751	170	1, 2, 4 years, and post-graduate course.
Total		1, 159	11, 358	3, 460	311	3, 333	3, 432, 907		

(*a*) Running through about one-third of one year.
(*b*) The institution has not yet been opened.
(*c*) Records incomplete and number can not be given.

The legal names, locations, and directors of the agricultural experiment stations in the United States.

State.	Name of station.	Location.	Director.
Alabama	Agricultural Experiment Station of the Agricultural and Mechanical College of Alabama.	Auburn	W. L. Broun.*a*
	Canebrake Agricultural Experiment Station.	Uniontown	B. M. Duggar.*b*
Arizona	Agricultural Experiment Station of the University of Arizona.	Tucson	F. A. Gulley.
Arkansas	Arkansas Agricultural Experiment Station. (Substations at Newport and Pine Bluff.)	Fayetteville	R. L. Bennett.
California	Agricultural Experiment Station of the University of California. (Substations at Fresno, Menlo Park, Jackson, Mission San Jose, Paso Robles, Pomona, and Tulare.)	Berkeley	E. W. Hilgard.
Colorado	Agricultural Experiment Station. (Substations at Monte Vista, Table Rock, and Rocky Ford.)	Fort Collins	W. J. Quick.
Connecticut	The Connecticut Agricultural Experiment Station.	New Haven	S. W. Johnson.
	Storrs School Agricultural Experiment Station.	Storrs	W. O. Atwater.
Delaware	The Delaware College Agricultural Experiment Station.	Newark	A. T. Neale.
Florida	Agricultural Experiment Station of Florida. (Substations at De Funiak Springs and Fort Myers.)	Lake City	J. P. De Pass.
Georgia	Georgia Experiment Station	Experiment*c*	R. J. Redding.
Idaho	Agricultural Experiment Station of the University of Idaho.	Moscow	R. Milliken.
Illinois	Agricultural Experiment Station of the University of Illinois.	Champaign	G. E. Morrow.*a*
Indiana	Agricultural Experiment Station of Indiana.	LaFayette	C. S. Plumb.
Iowa	Iowa Agricultural Experiment Station.	Ames	James Wilson.
Kansas	Kansas Agricultural Experiment Station.	Manhattan	G. T. Fairchild.*d*
Kentucky	Kentucky Agricultural Experiment Station.	Lexington	M. A. Scovell.
Louisiana	No. 1. Sugar Experiment Station	Audubon Park, New Orleans.	W. C. Stubbs.
	No. 2. State Experiment Station	Baton Rouge	W. C. Stubbs.
	No. 3. North Louisiana Experiment Station.	Calhoun	W. C. Stubbs.
Maine	Maine State College Agricultural Experiment Station.	Orono	W. H. Jordan.
Maryland	Maryland Agricultural Experiment Station.	College Park	R. H. Miller.
Massachusetts	Massachusetts State Agricultural Experiment Station.	Amherst	C. A. Goessmann.
	Hatch Experiment Station of the Massachusetts Agricultural College.	Amherst	H. H. Goodell.
Michigan	Experiment Station of Michigan Agricultural College.	Agricultural College.	O. Clute.
Minnesota	Agricultural Experiment Station of the University of Minnesota.	St. Anthony Park.	C. D. Smith.
Mississippi	Mississippi Agricultural Experiment Station.	Agricultural College.	S. M. Tracy.
Missouri	Missouri Agricultural College Experiment Station.	Columbia	E. D Porter.
Nebraska	Agricultural Experiment Station of Nebraska.	Lincoln	C. L. Ingersoll.
Nevada	Nevada Agricultural Experiment Station.	Reno	S. A. Jones.
New Hampshire	New Hampshire Agricultural Experiment Station.	Durham	G. H. Whitcher.
New Jersey	New Jersey State Agricultural Experiment Station.	New Brunswick	J. Neilson.*e*
	New Jersey Agricultural College Experiment Station.	New Brunswick	J. Neilson.*e*
New Mexico	Agricultural Experiment Station of New Mexico.	Las Cruces	H. Hadley.

a President of board of direction.
b Assistant director in charge.
c Freight and express office, Griffin.
d Chairman of council.
e Acting director.

The legal names, locations, and directors of the agricultural experiment stations, etc.—Continued.

State.	Name of station.	Location.	Director.
New York	New York Agricultural Experiment Station.	Geneva	P. Collier.
	Cornell University Agricultural Experiment Station.	Ithaca	I. P. Roberts.
North Carolina	North Carolina Agricultural Experiment Station.	Raleigh	H. B. Battle.
North Dakota	North Dakota Agricultural Experiment Station.	Fargo	H. E. Stockbridge.
Ohio	Ohio Agricultural Experiment Station.	Wooster	C. E. Thorne.
Oklahoma	Oklahoma Agricultural Experiment Station.	Stillwater	J. C. Neal.
Oregon	Oregon Experiment Station	Corvallis	J. M. Bloss.
Pennsylvania	The Pennsylvania State College Agricultural Experiment Station.	State College	H. P. Armsby.
Rhode Island	Rhode Island Agricultural Experiment Station.	Kingston	C. O. Flagg.
South Carolina	South Carolina Agricultural Experiment Station.	Fort Hill	J. S. Newman.
South Dakota	South Dakota Agricultural Experiment Station.	Brookings	L. Foster.
Tennessee	Tennessee Agricultural Experiment Station.	Knoxville	F. Lamson-Scribner.
Texas	Texas Agricultural Experiment Station.	College Station	G. W. Curtis.
Utah	Agricultural Experiment Station of Utah.	Logan	J. W. Sanborn.
Vermont	State Agricultural Experiment Station.	Burlington	W. W. Cooke.
Virginia	Virginia Agricultural and Mechanical College Experiment Station.	Blacksburg	J. M. McBryde.
Washington	Washington Agricultural Experiment Station.	Pullman	J. W. Heston.
West Virginia	West Virginia Agricultural Experiment Station.	Morgantown	J. A. Myers.
Wisconsin	Agricultural Experiment Station of the University of Wisconsin.	Madison	W. A. Henry.
Wyoming	Wyoming Agricultural Experiment Station.	Laramie	A. A. Johnson.

Revenue of the agricultural experiment stations in 1892.

Stations.	Revenue for 1892 from—							
	United States.	States.	Local communities.	Individuals.	Fees.	Farm products.	Miscellaneous.	Total.
Alabama (College)	$15,000	$6,835				$1,505		$23,340
Alabama (Canebrake)		2,500				1,000		3,500
Arizona	15,000							15,000
Arkansas	15,000							15,000
California	15,000	11,160						26,160
Colorado	15,000					1,280		16,280
Connecticut (State)	7,500	8,000			$3,250		$49	18,799
Connecticut (Storrs)	7,500			$125		228		7,853
Delaware	15,000							15,000
Florida	15,000					61		15,061
Georgia	15,000	5,000				2,000		22,000
Idaho								
Illinois	15,000							15,000
Indiana	15,000					1,553		16,553
Iowa	15,000					350		15,350
Kansas	15,000							15,000
Kentucky	15,000				2,685	524	300	18,509
Louisiana	15,000	14,400		1,000	2,000	2,500		34,900
Maine	15,000					353		15,353
Maryland	15,000							15,000
Massachusetts (State)		10,000			2,000	1,000	600	13,600
Massachusetts (Hatch)	15,000					76	28	15,104
Michigan	15,000				800	131	123	16,054
Minnesota	15,000	4,905				2,841		22,746
Mississippi	15,000					153	1,037	16,190
Missouri	15,000					4,057		19,057
Nebraska	15,000					176		15,176
Nevada	15,000					66		15,066
New Hampshire	15,000							15,000
New Jersey (State)		11,000						11,000
New Jersey (College)	15,000							15,000
New Mexico	15,000					51	20	15,071
New York (State)		68,500						68,500
New York (Cornell)	15,000					300		15,300
North Carolina	15,000	8,000				400		23,400
North Dakota	15,000					2,887		17,887
Ohio	15,000	872	$85,000			6,019	225	107,116
Oklahoma	15,000							15,000
Oregon	15,000							15,000
Pennsylvania	15,000				6,670	1,330		23,000
Rhode Island	15,000	875				741	62	16,678
South Carolina	14,542							14,542
South Dakota	15,000							15,000
Tennessee	15,000							15,000
Texas	15,000					3,212	328	18,540
Utah	15,000					972		15,972
Vermont	15,000					3,500	1,500	20,000
Virginia	15,000					2,527		17,527
Washington	15,000							15,000
West Virginia	15,000				4,430	73	401	19,904
Wisconsin	15,000							15,000
Wyoming	15,000					156		15,156
Total	689,542	152,047	85,000	1,125	21,835	42,022	4,673	997,244

Additions to the equipment of the agricultural experiment stations in 1892.

Stations.	Value of additions to equipment in 1892.						
	Farm.	Buildings.	Library.	Apparatus.	Live stock.	Miscellaneous.	Total.
Alabama (College)	$1,000	$5,025	$600	$1,150	$120		$7,895
Alabama (Canebrake)	500	1,000	550	150	250	$125	2,575
Arizona	57	234	2	247		26	566
Arkansas	89	681	74	549		398	1,791
California	200	244	51	933		638	2,066
Colorado	300			500			800
Connecticut (State)			400				400
Connecticut (Storrs)				335			335
Delaware		689	544	477			1,710
Florida	129	750	177	344			1,400
Georgia	500	1,000			500		2,000
Idaho							
Illinois	100	300	700	350			1,450
Indiana	97		148	398	350		993
Iowa							
Kansas	78		28	285	17	60	468
Kentucky	128	241	225	360	450	894	2,298
Louisiana	1,000	1,200	500	1,500	700	1,500	6,400
Maine	10		125	478			613
Maryland	332	750	363	217	30	85	1,777
Massachusetts (State)			450	400		100	950
Massachusetts (Hatch)			141	285			426
Michigan		1,377	1,097	560			3,034
Minnesota	41	2,000		91	425		2,557
Mississippi	283	750	169	130	250		1,582
Missouri	812	339	50		109		1,310
Nebraska		750		483			1,233
Nevada	380	491	47	575	2,413		3,906
New Hampshire							
New Jersey (State)							
New Jersey (College)							
New Mexico	184	750	113	242		2,027	3,316
New York (State)		8,500					8,500
New York (Cornell)						500	500
North Carolina	350		100	325	175	125	1,075
North Dakota	42	883		212			1,137
Ohio	263	759	341	450	115	252	2,180
Oklahoma	1,332	3,000	230	1,360	300	1,487	7,709
Oregon							
Pennsylvania							
Rhode Island	642		1,214	576	823	451	3,706
South Carolina	404	750	130	797	234	166	2,481
South Dakota		746	13	238		46	1,043
Tennessee		200	75	300			575
Texas	100	350	600	200			1,250
Utah	50	1,950	25	250	1,200	200	3,675
Vermont	100	800	50	125	1,600	300	2,975
Virginia	345		11	1,328	498		2,182
Washington							
West Virginia	229	195	410	996		756	2,586
Wisconsin							
Wyoming		766		287		1,830	2,883
Total	10,077	37,470	9,753	14,483	10,559	11,966	98,308

Table showing the total number of members in the working staffs of experiment stations in the United States and the number of such officers pursuing different specialties.

NOTE.—A capital letter signifies that one of the number which it follows represents an officer who, having two titles and belonging by his first title in the column for which the letter stands, has already been entered there. Thus the entry 1 H under entomologists and opposite Florida means that one officer is known as "botanist and entomologist, and has already been entered by his first title in the H or botanists' column. Two letters indicate that two of the preceding number have been entered elsewhere.

Stations.	Number in staff.	A Directors.	B Secretaries and treasurers.	C Librarians.	D Clerks.	E In charge of substations.	F Agriculturists.	G Biologists.	H Botanists.	I Chemists.	K Entomologists.	L Geologists.	M Horticulturists.	N Irrigation engineers.	O Meteorologists.	P Mycologists.	Q Physicists.	R Veterinarians.	S Dairymen.	T Farm foremen.	U Miscellaneous.
Alabama (College)	10	1			1		2	1 F	2 D	4					1 H			1			
Alabama (Canebrake)	3	2	1																		
Arizona	10	1			1	1			1	2	1 H		2	1	1 I						*a* 1
Arkansas	7	1				2	1 A			2			1					1			
California	23	1			1	*b* 11	3		1	4 A L	1	2 A									*c* 3
Colorado	16	1	1		1	3	2 A	1	1	2	2 G		2 H	2 O	2						
Connecticut (State)	11	2		1	1 C					5 A						1					*d* 3
Connecticut (Storrs)	4	2					2			1 A											
Delaware	5	1								1	1 M		1		1	1					
Florida	7	1				2	1		1	1	1 H							1			
Georgia	6	2	1 M				1			2 A			1		1 I				1		
Idaho	4	1	1				1 A		1 I	1	1 *e*		1 A F								*f* 1
Illinois	10	1	1				2 A		2 M	2	1		2					1			
Indiana	9	1					1		2	3			1		1 I			1			
Iowa	12	2					1		2	1	2		2								
Kansas	13	1	1				2		2	2	2 N		2					1		1	*g* M 1
Kentucky	9	1			1				2 K K	2	2		1					1		1	
Louisiana (Sugar)	6	1	1							1								1		1	*h* 2
Louisiana (State)	8	2							1	2	1		1 K					1		1	
Louisiana (North)	6	2								1		1								1	*j* 1
Maine	12	1			1		1		2	2	2 H H		2		1			1		1	
Maryland	6	1	1		1		1 A			1			1								*k* 1
Massachusetts (State)	8	1								6 A										1	*l* 1
Massachusetts (Hatch)	10	1	1				2				1		3		1						*m* 1
Michigan	17	1	1	1	1		4	1	1	3			3					1			
Minnesota	8	1	1				1		1 K	1	1		1					1	1		
Mississippi	12	2	1			3	1			2	1		1		1 K			1			
Missouri	8	1	2				1 A			2			1					1		1	
Nebraska	12	1	1				1 A	1	1	3	1		1				2			1	

Nevada	6	1			1		1		1 K	1	1		1 F							1	
New Hampshire	10	1						1		3	1					1			1	1	*n* 1
New Jersey (State)	6	1			1					3											*o* 1
New Jersey (College)	9	1		1 D	2			1	1	2	1		1 H							1	
New Mexico	8	1			1		2 M	1 K		2	1		2 K		1						
New York (State)	13	2			1		1			7			2								
New York (Cornell)	16	2	2 A				2 A		2	2	2		3					1	1	1	
North Carolina	12	1	1				1		1	5 A	1 H		2		2						
North Dakota	11	1	1				1		1	2			2					1		1	*p* 1
Ohio	8	2	2				1			1	1		2 A								
Oklahoma	4	1					1			1			1 F				1 I			1	
Oregon	6	1					1		1	1	1		1								
Pennsylvania	13	2			1		2		1	5 A			1							1	*q* 1
Rhode Island	8	1			1		2 A			2			1							1	*g* 1
South Carolina	7	1	1				1 A			4			1								
South Dakota	6	1					1 A		1	2			1						1		
Tennessee	7	2		1 D	1				2 A	2			1								
Texas	8	1			1		2 A			3 O			1		1			1			
Utah	9	1	2		1			1		1	1 M		1					1		1	
Vermont	10	1	1		1				1	2	1							1	1	1	
Virginia	8	2	1				1	1		2	1 A M		1 A			*r* 1		1			
Washington	6	1					1			1	1		1					1			
West Virginia	7	1	1		1		1			1	1		1								*s* M 1
Wisconsin	9	1			1					2			1					1	1	1	
Wyoming	12	1	1			5	1 K		1	1	1	1	1							1 K F	
Total	491	68	28	4	23	27	54	9	36	115	36	4	59	3	14	4	3	23	7	21	21

a Engineer.
b Seven patrons and four foremen of substations.
c Inspector of stations, foreman of grounds, and foreman of cellar.
d Grass agent, foreman in charge of buildings and grounds, and laboratory assistant.
e The director is also agriculturist, horticulturist, and entomologist.
f Civil engineer.
g Foreman of garden.
h Machinist, sugar-maker.
j In charge of stock.
k Machinist.
l Assistant in field experiments, and stock-feeding.
m Auditor.
n Laboratory assistant.
o Janitor and laboratory attendant.
p Arboriculturist.
q Apiarist and poultry manager.
r The vice-director is also horticulturist, entomologist, and mycologist.
s Microscopist.

The lines of work pursued at the agricultural experiment stations in the United States.

[The ○ indicates specialties.]

Stations	Chemistry.		Systematic and physiological botany.	Meteorology and climatology.	Soil.		Fertilizers.			Crops.				Horticulture.					Forestry.	Diseases of plants.	Seeds.	Weeds.	Feeding stuffs.		Silos and silage.	Feeding of animals.				Aviculture.	Veterinary science and practice.	Entomology.	Apiculture.	Dairying.				Technology—sugars, wines, etc.	Agricultural engineering.	
	Special analyses.	Methods of analysis.			Geology, physics, and chemistry.	Tillage.	Analyses without control.	Analyses with control.	Field experiments.	Composition.	Manuring and cultivation.	Rotation.	Varieties.	Vegetables.	Small fruits.	Grapes.	Orchard fruits.	Nuts.					Composition.	Digestibility.		For milk.	For beef.	For mutton.	For pork.					Chemistry of milk and its products.	Bacteria of milk.	Creaming of milk.	Butter-making and creameries.		Drainage.	Irrigation.
Alabama (College)			⊙	⊙	⊙				⊙		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙			⊙	⊙		⊙	⊙	⊙										⊙	⊙	⊙	⊙	
Alabama (Canebrake)				⊙		⊙			○		○	⊙	⊙		⊙	⊙	⊙			⊙					⊙		⊙												⊙	
Arizona	○		⊙	⊙	⊙	⊙			○		⊙			⊙	⊙	⊙	⊙	⊙									⊙													○
Arkansas	○	⊙		⊙	⊙	○			⊙	⊙	○	○	○	○	○	○	○			○			⊙			○					○	⊙					⊙	○		
California	○	○	⊙	⊙	○					○			○	⊙		○	○	○	⊙	○		⊙	○									○						○	○	○
Colorado	○	○		○		○	⊙	⊙	⊙		○	○	○	○	○	⊙	○			⊙	⊙	○	⊙	⊙		○	⊙	○	⊙			○	○	⊙				⊙		○
Connecticut (State)	○	○					○	○	○	○	⊙									○	⊙		⊙			⊙								⊙						
Connecticut (Storrs)	○	○		○		⊙			○	⊙	⊙	⊙											⊙			⊙		○						⊙	○		⊙			
Delaware	⊙	⊙	⊙	⊙		⊙			⊙		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙		⊙	⊙	⊙	⊙		⊙	⊙					⊙	⊙		⊙	⊙	⊙	⊙			
Florida	⊙		⊙																	○											○	○						○		
Georgia	⊙			⊙		○			○		○	⊙	⊙	⊙	⊙	○	○	⊙							⊙											⊙	⊙			
Idaho																																								
Illinois	○	○	○	⊙		⊙	⊙		⊙	⊙	○	⊙	○	○	○	○	○	⊙	○	○	⊙		○		⊙	○	○		○					○	⊙	○				
Indiana	⊙	○	○	⊙		○			○	⊙	○	○	○	⊙	⊙	⊙	⊙	⊙		○		○	⊙		○	⊙	⊙		⊙		⊙			⊙		○				
Iowa	○		⊙			○					⊙	⊙	⊙	⊙			⊙			⊙			⊙		⊙							⊙		⊙		⊙		⊙		
Kansas	⊙	⊙	○						⊙	○	○	○	○	○	○	○	○		⊙	○	⊙	○	○		⊙		○				○	○	⊙							
Kentucky	⊙	⊙	⊙	⊙		⊙		⊙	○	⊙	⊙		○	⊙	⊙	⊙	⊙			○		⊙	⊙			⊙						○		⊙		○	⊙		○	
Louisiana (Sugar) Louisiana (State) Louisiana (North)	○	⊙	⊙	○	○	○		○	○	⊙	○	○	○	⊙	⊙	⊙	○	⊙		○	○										○	○						○	○	○
Maine	⊙	⊙						⊙	○	⊙				⊙	⊙		○			○			⊙	○		○			○			⊙		⊙						
Maryland	⊙	○			⊙	⊙	⊙		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙		⊙	⊙			⊙	⊙	⊙		⊙		⊙			⊙		⊙					⊙	
Massachusetts (State)	○	⊙	⊙	⊙		⊙	○	○	○	○	○	○	○	⊙	⊙	⊙	○		⊙	○	⊙	⊙	○	⊙	○	○	○	○	○										⊙	
Massachusetts (Hatch)				○							○		○	○	○	○	○		⊙	⊙						⊙						○								
Michigan	⊙			⊙	⊙	⊙		⊙	⊙	○	○	⊙	○	○	○	⊙	○	⊙	⊙		⊙	⊙			○	○		○				⊙	○				⊙	○		
Minnesota	○	⊙				⊙					⊙		○	⊙	○	○	○		○				○	○	○	○	○	⊙	⊙					○		○	○			
Mississippi	○	○	○	⊙		○	⊙		○	⊙	○	⊙	○	⊙	⊙	○	⊙			○			⊙	○		○					⊙	○				⊙	⊙		⊙	
Missouri	○					○			○	○	○	○	○	○	○	○	○		⊙	⊙	⊙		⊙			○	○	○	○		○						○		○	
Nebraska	⊙		⊙	⊙	⊙	⊙			⊙	⊙	⊙	⊙	⊙		⊙	⊙	⊙		⊙	⊙	⊙	⊙				⊙					⊙	⊙						⊙		

Nevada	⊙	⊙	...	...	○	...	⊙	...	...	⊙	...	...	⊙	○	⊙	⊙	⊙	⊙	...	...	○	○	⊙	○	...	...	...	...	...	...	...	○	...	○	...	...	○	...	...	⊙
New Hampshire	⊙	⊙	...	...	...	⊙	⊙	...	⊙	⊙	○	...	⊙	...	...	...	...	...	...	...	...	...	⊙	...	○	○	...	...	⊙	...	...	...	...	○	...	○	○	...	...	...
New Jersey (State) / New Jersey (College)	○	○	⊙	...	...	...	⊙	○	○	⊙	⊙	⊙	...	...	...	...	...	...	...	○	⊙	○	○	...	...	⊙	...	...	⊙	...	...	○	...	⊙	...	...	⊙	⊙	...	...
New Mexico	⊙	...	⊙	⊙	...	⊙	...	...	...	...	...	...	⊙	⊙	⊙	○	○	...	...	...	...	...	...	...	...	...	...	...	...	...	...	○	...	...	...	...	...	...	...	⊙
New York (State)	○	○	...	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙	...	○	⊙	○	○	○	...	...	○	...	...	⊙	⊙	⊙	○	⊙	...	○	...	...	...	...	○	...	...	○	...	...	...
New York (Cornell)	⊙	⊙	⊙	...	...	○	...	...	⊙	⊙	⊙	⊙	⊙	○	○	○	○	○	...	⊙	...	⊙	⊙	...	⊙	○	...	○	⊙	⊙	...	○	...	⊙	...	○	⊙	...	...	...
North Carolina	⊙	...	...	○	...	⊙	...	○	○	○	○	⊙	⊙	⊙	⊙	○	⊙	...	...	○	○	○	○	○	○	⊙	○	...	...	...	...	○	...	...	...	⊙	○	⊙	...	...
North Dakota	○	○	○	...	⊙	...	...	...	...	○	...	○	○	○	...	...	...	...	○	○	○	○	⊙	...	...	...	...	...	...	...	○	...	...	⊙	...	...	...	...	...	...
Ohio	⊙	...	⊙	⊙	⊙	⊙	...	...	○	⊙	⊙	○	○	⊙	⊙	⊙	○	...	...	○	...	...	⊙	...	⊙	⊙	...	...	...	...	...	○	...	⊙	...	...	...	...	...	○
Oklahoma	○	...	...	...	⊙	...	...	...	...	...	...	...	⊙	⊙	⊙	○	...	...	...	...	...	○	...	...	...	...	...	...	...	...	...	⊙	...	...	...	...	...	...	...	...
Oregon	⊙	...	⊙	⊙	⊙	...	⊙	...	...	⊙	⊙	...	⊙	⊙	⊙	⊙	⊙	⊙	...	...	...	...	⊙	...	...	...	⊙	⊙	...	...	...	⊙	...	...	...	...	...	...	...	...
Pennsylvania	⊙	⊙	...	⊙	⊙	...	○	...	⊙	...	⊙	...	⊙	⊙	⊙	⊙	⊙	...	⊙	...	⊙	...	○	○	○	○	...	...	...	...	⊙	...	...	...	...	○	○	...	...	...
Rhode Island	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙	...	○	⊙	⊙	⊙	○	⊙	⊙	...	⊙	○	○	○	...	...	...	...	...	...	...	○	...	...	⊙	...	...	...	...	...	...	...
South Carolina	...	...	...	...	⊙	○	...	...	○	○	○	⊙	○	○	○	○	○	⊙	...	...	...	...	○	...	⊙	...	...	...	...	...	...	...	...	...	...	...	...	...	○	...
South Dakota	○	⊙	⊙	○	⊙	○	...	...	...	...	○	○	○	⊙	○	⊙	○	...	○	○	⊙	○	○	...	...	...	...	○	○	...	...	○	⊙	...	...	⊙	○	...	...	...
Tennessee	⊙	...	○	...	⊙	...	⊙	...	...	...	⊙	...	...	⊙	⊙	⊙	⊙	...	...	⊙	...	...	...	...	⊙	○	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Texas	⊙	...	...	⊙	⊙	⊙	⊙	...	⊙	⊙	⊙	⊙	⊙	...	⊙	⊙	⊙	...	...	○	...	...	⊙	⊙	○	○	○	...	○	...	⊙	⊙	...	...	...	○	○	...	○	⊙
Utah	...	...	...	⊙	...	○	...	...	⊙	...	○	○	⊙	○	○	○	○	...	○	...	...	...	⊙	⊙	⊙	...	○	○	○	...	⊙	⊙	...	...	...	...	...	...	...	○
Vermont	⊙	⊙	⊙	...	...	...	⊙	○	⊙	○	⊙	...	⊙	⊙	⊙	⊙	⊙	...	...	○	...	⊙	⊙	...	○	○	...	...	○	...	○	⊙	⊙	⊙	⊙	○	○	○	...	...
Virginia	○	⊙	...	...	...	⊙	⊙	...	○	○	○	...	⊙	○	⊙	⊙	⊙	⊙	...	⊙	⊙	...	...	...	⊙	⊙	...	...	...	...	⊙	⊙	⊙	...	...	...	⊙	...	⊙	...
Washington	○	...	○	○	○	⊙	...	...	○	...	⊙	...	○	⊙	○	⊙	○	⊙	○	○	⊙	⊙	...	...	...	⊙	⊙	...	...	...	⊙	⊙	...	...	...	...	⊙	...	...	⊙
West Virginia	⊙	○	○	⊙	⊙	...	...	○	○	⊙	...	...	⊙	⊙	⊙	⊙	⊙	...	○	⊙	⊙	○	...	...	...	...	...	...	...	...	...	○	...	...	...	...	...	⊙	...	...
Wisconsin	...	⊙	...	...	⊙	⊙	...	...	...	⊙	⊙	...	⊙	...	⊙	⊙	⊙	...	...	⊙	...	...	⊙	...	⊙	⊙	...	⊙	⊙	...	...	...	...	○	...	⊙	○	...	⊙	...
Wyoming	⊙	...	○	⊙	○	...	...	...	...	○	⊙	○	○	⊙	○	⊙	⊙	...	⊙	○	...	○	○	...	...	...	...	...	...	...	...	⊙	...	...	...	...	...	...	...	○
Total	44	29	27	31	24	33	17	13	36	32	42	29	43	41	42	42	43	15	18	36	21	22	34	13	25	30	16	18	17	2	16	31	7	20	4	18	23	13	13	11

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

SIR: I have the honor of transmitting herewith a report on the work of the Weather Bureau during the year 1892.

MARK W. HARRINGTON,
Chief.

Hon. J. M. RUSK,
Secretary.

WORK OF THE YEAR.

IMPROVEMENT OF FORECASTS AND THEIR DISTRIBUTION.

In my annual report for 1891 I said:

The value of the work of the Weather Bureau to the country depends largely upon its ability to distribute promptly the information collected at central points from its system of telegraph stations. The daily weather forecasts issued by the Bureau have always been recognized as of sufficient importance to be telegraphed by the Associated Press as items of news, and they are therefore distributed without expense to the service to the centers of population, and have appeared regularly in the daily journals of the country. Many efforts have been made to reach the more thinly settled portions of the country, and with the transfer of the Weather Bureau to the Agricultural Department renewed efforts are being made to extend the weather forecasts to agricultural communities. The most thorough distribution of the forecasts possible would be by telegraph daily to every telegraph office in the country, where means should be provided for the display of reports in bulletin form. Such a system can not at present be utilized, owing to the small appropriations made for telegraph purposes, although it has been strongly urged by agricultural organizations throughout the country, and Congress has been petitioned repeatedly for appropriations to bear the expense attending such telegraph service. Those most interested in agriculture will not be satisfied without additional appropriations for this feature of Weather Bureau work, and it will be in the interest of the general public, including all classes, if arrangements can be made which will place the daily weather bulletin at every telegraph office in the country.

I am happy to be able to say, at the end of this first year, that this our first care—the improvement of the forecasts and their extended distribution—has met some measure of success. The yearly percentages of verifications for all stations east of the Rocky Mountains are: For twenty-four-hour forecasts, weather, 83.6; temperature, 81.9; weather and temperature combined, 82.9 Beginning with January, 1892, the percentages of forecasts have in addition to the groupings by States and elements heretofore followed been determined by classes of forecasts, *i. e.*, predictions of "fair weather," "rain," or "snow;" "warmer" or "colder" and "stationary" temperature have been grouped together and the percentages of verifications of each class computed. The result shows that of the total number of twenty-four-hour forecasts of weather made during the period considered, for the districts east of the Rocky Mountains, 71.3 per cent were for fair weather; and of these 88.8 per cent were verified. Of rain or snow forecasts 70.5 per cent were verified. Of the temperature forecasts 62.0 per cent were for warmer or colder; and 82.8 per cent of these were verified. Of the stationary forecasts, 79.2 per cent were verified.

Percentages of verifications of 8 p. m. 24-hour forecasts of weather and temperature for the six months ending December 31, 1891.

[The percentages of verification for the first half of 1891 will be found in the annual report of the Secretary of War, 1892, Volume IV, page 53.]

States.	1891.																		Yearly average.*
	July.			August.			September.			October.			November.			December.			
	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather and temperature combined.
Maine	88.7	68.4	80.6	84.2	65.2	76.6	84.3	85.3	84.7	93.9	83.7	91.8	90.7	84.7	88.3	88.4	87.1	87.9	83.5
New Hampshire	83.9	76.8	81.1	83.5	67.7	77.2	87.3	82.0	85.2	91.3	88.4	90.1	92.3	82.7	88.5	85.8	86.8	86.2	82.6
Vermont	86.5	69.0	79.5	80.6	65.2	74.4	89.7	85.3	87.9	85.8	90.6	87.7	92.7	86.0	90.0	86.1	91.9	88.4	83.0
Massachusetts	91.3	73.9	81.3	82.3	68.4	76.7	88.3	87.0	87.8	90.0	89.0	89.6	92.3	80.3	87.5	87.7	90.6	88.9	84.6
Rhode Island	91.3	76.8	85.5	82.3	84.8	83.3	94.3	79.0	88.2	88.1	88.4	88.2	93.7	78.0	87.4	89.0	94.5	91.2	85.8
Connecticut	86.8	71.6	80.7	80.6	77.7	79.4	92.7	83.3	88.9	86.5	86.5	86.5	91.7	77.0	85.8	87.7	87.7	87.7	84.9
Eastern New York	87.7	69.0	80.2	85.8	74.2	81.2	92.7	83.3	83.9	90.0	84.8	87.9	89.7	87.0	88.6	86.8	91.9	88.8	85.4
Western New York	82.6	71.3	78.1	87.7	80.6	84.9	91.7	94.0	92.6	89.0	85.8	87.7	91.0	84.3	88.3	88.4	90.0	89.0	84.3
Eastern Pennsylvania	83.2	66.5	76.5	81.0	64.2	74.3	90.3	84.3	87.9	88.1	82.9	86.0	91.7	88.0	90.2	89.4	83.5	87.0	85.2
Western Pennsylvania	83.2	80.6	82.2	81.6	81.9	81.7	88.3	87.0	87.8	90.0	81.6	86.6	89.0	81.0	85.8	83.9	93.5	87.7	83.6
New Jersey	79.7	65.8	74.1	84.2	74.5	80.3	91.3	80.0	86.8	86.1	83.9	85.2	88.7	94.0	90.8	90.3	86.8	88.9	84.8
Delaware	80.3	78.1	79.4	83.2	72.3	78.8	92.7	79.3	87.3	87.4	90.6	88.7	88.7	88.3	88.5	88.7	85.5	87.4	85.5
Maryland	82.0	73.5	78.6	82.9	75.2	79.8	89.0	76.7	84.1	87.7	88.1	87.9	85.7	85.7	85.7	88.1	86.5	87.5	84.9
District of Columbia	77.7	77.4	77.6	73.5	71.9	72.9	89.3	71.7	82.3	85.8	87.1	86.3	86.0	83.3	84.9	88.4	85.5	87.2	83.5
Virginia	83.9	77.4	81.3	80.3	73.5	77.6	89.3	80.3	85.7	92.3	73.2	84.7	88.3	87.3	87.9	89.4	89.4	89.4	84.4
North Carolina	80.6	79.4	80.1	78.7	74.2	76.9	97.3	83.3	91.7	94.8	68.4	84.2	89.7	85.7	88.1	92.3	87.7	90.5	83.9
South Carolina	86.8	78.1	83.3	77.1	82.6	79.3	93.7	86.7	90.9	92.6	73.9	85.1	88.7	81.7	85.9	87.7	88.1	87.9	85.0
Georgia	91.6	88.7	90.4	85.2	88.7	86.6	90.0	85.0	88.0	97.1	70.6	86.5	89.0	79.7	85.3	91.6	81.9	87.7	86.0
Eastern Florida	75.8	92.3	82.4	87.1	92.3	89.2	90.7	96.7	93.1	92.3	85.8	89.7	88.0	81.0	85.2	87.7	91.0	89.0	88.0
Western Florida	85.2	94.5	88.9	80.3	90.3	84.3	87.0	97.3	91.1	95.5	86.5	91.9	89.3	80.7	85.9	85.2	94.5	88.9	87.8
Alabama	90.0	88.4	89.4	91.9	85.5	89.3	93.7	84.7	90.1	97.1	78.7	89.7	90.3	89.7	90.1	90.0	93.2	91.3	87.6
Mississippi	88.4	89.4	88.8	90.6	89.4	90.1	93.3	85.0	90.0	96.8	77.4	89.0	88.3	85.7	87.3	87.4	91.6	89.1	86.5
Louisiana	83.2	83.5	83.3	92.6	95.8	93.9	90.7	91.0	90.8	95.5	91.6	93.9	85.7	78.3	82.7	89.0	91.0	89.8	85.9
Eastern Texas	88.7	83.9	87.1	90.3	96.1	92.6	89.0	91.3	89.9	95.8	83.5	90.9	91.7	81.3	87.5	93.9	91.0	92.7	86.5
Arkansas	83.2	74.5	79.7	86.8	87.1	86.9	90.3	93.3	91.5	97.1	85.8	92.6	81.7	89.0	84.6	92.9	89.7	91.6	85.3
Tennessee	84.2	79.7	82.4	88.4	89.4	88.8	95.0	90.0	93.0	97.4	87.4	93.4	91.0	82.0	87.4	92.3	82.9	88.5	85.3
Kentucky	90.6	82.9	87.5	88.1	91.3	89.4	96.3	92.3	94.7	97.7	90.3	94.7	90.3	78.7	85.7	91.3	83.2	88.1	86.2
Ohio	91.6	81.9	87.7	81.9	79.7	81.0	95.3	87.7	92.3	93.2	85.2	90.0	88.0	81.3	85.3	88.7	85.2	87.3	84.6
West Virginia	92.9	75.2	86.4	77.7	78.4	78.0	92.7	70.3	83.7	93.9	81.6	89.0	88.0	77.7	83.9	92.3	89.7	91.3	84.4
Indiana	94.2	81.9	89.3	88.1	78.1	84.1	95.0	88.3	92.3	94.2	82.9	89.7	88.7	78.0	84.4	92.9	91.9	92.5	86.5
Illinois	89.4	80.6	85.6	79.4	73.5	77.0	95.0	91.7	93.7	92.6	84.2	89.2	87.3	76.0	82.8	88.1	85.2	86.9	85.7
Lower Michigan	86.8	81.0	84.5	80.3	74.5	78.0	91.3	88.0	90.0	87.1	81.3	84.8	94.0	87.7	91.5	88.4	91.3	89.6	84.3
Upper Michigan	81.9	72.6	78.2	81.6	68.7	76.4	85.7	83.3	84.7	84.8	77.7	82.0	86.0	80.3	83.7	91.6	78.1	86.2	81.6

Wisconsin	86.5	75.2	82.0	82.9	75.8	80.1	92.7	86.3	90.1	93.2	83.5	89.3	91.0	85.3	88.7	89.4	85.8	88.0	85.2
Minnesota	90.3	70.0	82.2	88.7	81.3	85.7	88.0	75.0	82.8	94.2	85.5	90.7	83.0	78.7	81.3	93.5	91.9	92.9	84.5
Iowa	89.7	81.6	86.5	83.2	80.6	82.2	97.3	84.0	92.0	95.5	79.4	89.1	83.3	80.0	82.0	89.0	87.1	88.2	85.3
Kansas	83.2	73.5	79.3	90.0	73.2	83.3	96.3	87.2	92.7	96.1	83.2	90.9	87.0	79.0	83.8	86.1	75.2	81.7	83.8
Nebraska	87.4	78.4	83.8	84.5	75.2	80.8	96.0	74.7	87.5	96.1	79.4	89.4	85.3	76.3	81.7	91.6	77.4	85.9	84.3
Missouri	90.3	78.4	85.5	89.7	82.6	86.9	96.7	88.7	93.5	94.5	85.5	90.9	82.7	79.7	81.5	91.0	77.4	85.6	86.8
Colorado	89.4	61.6	78.3	93.2	71.0	84.3	85.0	74.3	80.7	98.4	82.3	92.3	93.0	75.3	85.9	86.8	81.0	84.5	82.4
North Dakota	88.1	82.9	85.0	89.0	73.9	83.0	92.3	71.7	84.1	92.6	81.3	88.1	84.7	64.7	76.7	84.8	86.8	85.6	82.2
South Dakota	88.4	77.1	83.9	82.3	76.1	79.8	93.3	73.0	85.2	93.2	81.3	88.4	83.7	71.7	78.9	90.6	83.5	87.8	82.8
Monthly average	86.4	77.7	82.9	84.4	78.7	82.1	91.7	84.3	88.7	92.4	83.4	88.8	88.6	81.7	85.8	89.1	87.3	88.4	84.9

*Includes the twelve months of 1891.

Percentages of verifications of 8 p. m. 24-hour forecasts of weather and temperature for the year ending December 31, 1892.

States.	1892.																	
	January.			February.			March.			April.			May.			June.		
	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.	Weather.	Temperature.	Weather and temperature combined.
Maine	70.3	77.7	73.3	81.7	77.6	80.1	84.8	91.3	87.4	81.0	73.7	78.1	80.3	72.3	77.1	76.0	76.0	76.0
New Hampshire	65.2	81.3	71.6	87.9	81.0	85.1	89.0	89.7	89.3	74.3	73.0	73.8	90.3	61.9	78.9	72.3	75.3	73.5
Vermont	64.8	79.4	70.6	90.3	81.7	86.9	91.0	82.6	87.6	75.3	73.3	74.5	71.9	67.7	70.2	71.0	79.3	74.3
Massachusetts	69.0	82.9	74.6	87.6	87.2	87.4	90.0	93.9	91.6	70.3	73.3	71.5	87.7	72.3	81.5	73.0	81.3	76.3
Rhode Island	62.3	77.7	68.5	85.2	92.4	88.1	91.9	98.4	94.5	75.0	62.7	70.1	87.1	73.2	81.5	78.3	67.3	70.9
Connecticut	63.5	82.3	71.0	86.6	91.7	88.6	91.3	93.5	92.2	75.0	71.0	73.4	90.0	66.1	80.4	74.3	74.7	74.5
Eastern New York	81.0	81.0	81.0	85.2	78.6	82.6	85.8	87.7	86.6	75.7	79.7	77.3	82.9	65.2	75.8	68.3	77.0	71.8
Western New York	90.0	84.5	87.0	89.3	84.5	86.9	85.2	91.9	87.9	79.0	86.3	81.9	69.7	66.8	68.5	82.0	68.7	75.7
Eastern Pennsylvania	87.4	84.2	86.1	88.3	76.6	83.6	88.4	87.7	88.1	85.0	80.3	83.1	83.5	79.7	82.0	77.0	92.7	83.3
Western Pennsylvania	88.4	97.7	92.1	87.6	80.0	84.6	88.4	96.1	91.5	74.7	82.3	77.7	80.6	64.2	74.0	84.7	69.0	78.4
New Jersey	89.0	90.6	89.6	87.6	75.2	82.6	86.1	91.6	88.3	82.0	67.3	76.1	81.3	75.2	78.9	73.3	82.7	77.1
Delaware	86.5	96.8	90.6	81.0	71.7	77.3	81.9	93.5	86.5	84.0	76.0	80.8	85.2	77.4	82.1	79.0	85.0	81.4
Maryland	85.5	96.1	89.7	83.4	73.1	79.3	83.9	85.5	84.5	85.0	80.7	83.3	77.4	75.5	76.6	78.0	89.3	82.5
District of Columbia	86.5	91.9	88.7	80.3	75.9	78.5	83.9	83.9	83.9	83.3	73.3	79.3	82.3	77.4	80.3	68.3	90.0	77.0
Virginia	86.8	91.0	88.5	81.7	75.5	79.2	88.1	85.2	86.9	82.0	71.3	77.7	82.3	66.5	76.0	77.3	85.7	80.7
North Carolina	90.3	80.0	86.2	81.0	75.9	79.0	89.4	87.7	88.7	77.3	73.0	75.6	82.3	79.4	81.1	84.3	78.7	82.1
South Carolina	86.8	77.1	82.9	86.2	82.8	84.8	95.5	83.9	90.9	81.7	70.3	77.1	85.2	82.9	84.3	80.0	80.3	80.1
Georgia	84.5	80.6	82.9	90.0	79.0	85.6	95.5	80.6	89.5	80.7	72.3	77.3	82.3	78.1	80.6	74.3	82.7	77.7
Eastern Florida	81.6	85.5	83.2	82.8	82.4	82.6	86.5	86.8	86.6	99.7	89.0	95.4	89.7	94.2	91.5	90.3	95.0	90.2
Western Florida	91.6	83.9	88.5	98.3	95.9	97.3	94.5	80.6	88.9	84.0	90.7	86.7	87.1	96.1	90.7	76.7	90.3	82.1
Alabama	92.9	85.5	89.9	92.4	84.1	89.1	91.3	83.5	88.2	80.0	76.7	78.7	79.0	83.9	81.0	78.7	92.3	84.1
Mississippi	92.6	85.2	89.6	89.7	86.6	88.5	86.8	85.5	86.3	77.3	74.7	76.3	81.9	80.0	81.1	84.0	89.0	86.0
Louisiana	91.3	90.6	91.0	87.6	92.4	89.5	90.3	89.4	89.9	71.3	83.3	76.1	86.5	91.0	88.3	92.7	92.7	92.7
Eastern Texas	81.3	81.9	81.5	82.1	77.2	80.1	86.1	85.5	85.9	83.0	77.3	80.7	83.2	80.3	82.0	91.3	93.0	92.0
Arkansas	86.1	88.7	87.1	82.8	80.0	81.7	85.5	82.3	84.2	80.3	78.7	79.7	76.1	79.0	77.3	80.0	84.3	81.7
Tennessee	85.5	84.5	85.1	91.4	71.4	83.4	94.5	78.4	88.1	81.0	74.3	78.3	65.8	76.8	70.2	74.0	78.0	75.6
Kentucky	81.0	91.9	85.4	84.8	75.5	81.1	92.3	80.3	87.5	78.0	82.0	79.6	74.5	74.2	74.4	76.7	78.3	77.3
Ohio	82.9	93.5	87.1	85.2	84.1	84.8	80.3	86.5	82.8	78.7	73.0	76.4	74.8	66.1	71.3	82.3	81.0	81.8
West Virginia	81.3	93.2	86.1	85.9	83.8	85.1	84.8	83.2	84.2	75.7	79.0	77.0	78.7	63.9	72.8	68.3	85.7	75.3
Indiana	77.7	84.8	80.5	86.6	86.2	86.4	82.9	81.3	82.3	80.3	67.7	75.3	80.0	60.0	72.0	82.0	82.0	82.0
Illinois	76.1	88.1	80.9	83.4	89.0	85.6	84.5	91.0	87.1	84.3	77.0	81.4	84.2	72.9	79.7	75.7	82.3	78.3
Lower Michigan	79.7	90.3	83.9	96.6	89.3	93.7	81.3	83.5	82.2	82.3	71.7	78.1	71.6	57.7	66.0	72.7	76.3	74.1
Upper Michigan	77.4	79.7	78.3	84.1	76.9	85.2	68.4	90.3	77.2	79.7	64.3	73.5	67.7	64.8	66.5	73.7	66.7	68.9
Wisconsin	82.3	84.8	83.3	82.1	83.4	82.6	84.2	92.6	87.6	78.0	75.7	77.1	66.5	65.5	66.1	71.7	78.0	74.2
Minnesota	79.7	82.6	80.9	84.8	72.1	79.7	77.7	81.9	79.4	86.7	79.0	83.6	76.1	68.7	73.1	68.7	75.3	71.3

Iowa	83.5	86.8	84.8	82.1	74.1	78.9	81.0	91.9	85.4	78.0	79.3	78.5	81.3	66.5	75.4	70.7	77.8	73.3
Kansas	89.7	81.0	86.2	79.3	79.7	79.5	77.1	85.5	80.5	73.3	70.7	72.3	75.5	60.6	69.5	79.0	73.7	76.9
Nebraska	74.5	77.7	75.8	83.1	69.3	77.6	82.6	83.9	83.1	71.3	63.7	68.3	70.0	60.3	66.1	81.0	79.0	80.2
Missouri	85.2	86.8	85.8	77.9	82.8	79.9	87.1	91.9	89.0	73.3	73.7	75.5	81.5	68.1	77.9	78.0	85.0	80.8
Colorado	82.9	74.2	79.4	89.3	83.1	86.3	78.4	81.3	79.6	76.0	70.3	73.7	73.5	64.5	69.9	83.3	77.7	81.1
North Dakota	81.3	74.8	78.7	83.1	85.5	84.1	81.6	80.3	81.1	92.3	79.7	87.3	71.9	66.5	69.7	62.7	65.0	75.6
South Dakota	78.7	81.0	79.6	91.4	81.7	87.5	86.8	88.1	87.3	78.7	72.7	76.3	68.1	60.6	65.1	79.7	66.3	74.3
Monthly average	81.8	85.0	83.1	85.9	81.1	84.0	86.1	86.9	86.4	79.6	75.3	77.9	79.3	72.0	76.4	77.3	80.5	78.6

Percentages of verifications of 8 p. m. 24-hour forecasts of weather and temperature for the year ending December 31, 1892—Continued.

States.	July.			August.			September.			October.			November.			December.			Yearly average.		
	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.	Weather.	Temperature.	Combined.
Maine	85.8	70.3	80.6	80.6	82.6	81.4	84.3	90.0	86.6	78.1	89.7	82.7	87.7	93.3	89.9	76.8	82.9	79.2	80.6	81.4	80.9
New Hampshire	81.9	76.1	79.6	84.8	87.7	86.0	81.0	91.3	85.1	79.0	91.6	84.0	85.3	90.0	87.2	76.1	82.6	78.7	80.6	81.8	91.1
Vermont	79.4	73.5	77.0	83.2	86.1	84.4	84.3	89.3	86.3	85.8	82.9	84.6	88.3	89.3	88.7	70.3	88.4	77.5	79.6	81.1	80.4
Massachusetts	79.0	77.1	78.2	88.4	93.2	90.3	91.3	89.3	90.5	88.4	94.5	90.8	96.0	92.7	94.7	77.1	81.0	78.7	83.2	84.9	83.9
Rhode Island	77.0	78.7	78.1	88.1	86.5	87.5	94.0	88.3	91.7	87.1	96.5	99.9	91.3	96.3	93.3	74.2	78.7	76.0	82.6	83.1	82.8
Connecticut	84.2	81.6	83.2	91.0	89.0	90.2	93.3	87.7	91.1	90.3	92.9	91.3	94.7	95.0	94.8	76.5	85.8	80.2	84.2	84.3	84.2
Eastern New York	77.4	81.3	79.0	88.4	90.3	89.2	91.0	82.0	87.4	91.6	82.6	88.0	91.3	94.0	92.4	86.5	85.2	86.0	83.8	82.0	83.1
Western New York	79.0	84.2	81.1	75.8	71.6	74.1	84.0	79.3	82.1	87.4	92.3	89.4	91.3	81.0	87.2	88.7	81.3	85.7	83.4	81.0	82.4
Eastern Pennsylvania	80.3	81.3	80.7	87.4	91.3	87.0	92.7	85.3	89.7	94.2	88.7	92.0	93.3	84.0	89.6	85.5	85.5	85.5	86.8	84.8	86.0
Western Pennsylvania	80.0	78.1	79.2	77.4	79.4	78.2	82.7	79.3	81.1	91.9	90.6	91.4	81.3	79.0	80.4	75.2	86.1	79.6	82.7	81.8	82.1
New Jersey	82.9	77.1	80.6	89.0	85.5	87.6	95.0	81.7	89.7	95.5	79.7	89.2	88.7	86.0	87.6	86.1	85.2	85.7	86.4	81.3	84.4
Delaware	75.2	90.3	79.2	90.3	88.7	89.7	95.0	81.7	89.7	98.4	87.1	93.9	86.3	85.0	85.8	90.3	82.3	87.1	86.1	84.6	85.5
Maryland	85.5	87.1	86.1	85.2	91.9	87.9	89.7	85.0	87.8	98.4	95.8	97.4	87.3	86.7	87.1	88.1	85.5	87.1	85.6	86.0	85.8
District of Columbia	79.0	83.9	81.0	83.9	80.6	82.6	88.3	86.7	87.7	98.4	96.8	97.8	85.0	86.7	85.7	79.0	83.9	81.0	83.2	84.2	83.6
Virginia	84.8	86.8	85.6	83.5	81.3	82.6	88.7	89.3	88.9	97.1	90.6	94.5	92.3	81.3	87.9	87.4	84.8	86.4	86.0	82.4	84.6
North Carolina	80.6	82.3	81.3	71.6	77.7	74.0	86.3	91.0	88.2	93.9	86.5	90.9	88.7	94.0	90.8	85.2	86.8	85.8	84.2	82.8	83.6
South Carolina	74.2	82.3	77.4	69.7	71.9	70.6	93.3	95.7	94.3	96.5	92.9	95.1	92.0	95.7	93.5	85.5	89.4	87.1	85.5	83.8	84.8
Georgia	88.1	87.1	87.7	89.7	86.1	88.3	90.3	87.0	89.0	95.8	92.3	94.4	92.3	89.7	91.3	78.4	85.5	81.2	86.8	83.4	85.4
Eastern Florida	74.5	96.5	83.3	88.1	86.5	87.5	89.3	99.7	93.5	85.8	95.2	89.6	97.3	90.7	94.7	77.1	87.4	81.2	86.9	90.7	88.4
Western Florida	73.9	97.4	83.3	68.1	88.1	76.1	73.3	94.3	81.7	95.2	93.9	94.7	91.3	99.0	94.4	82.3	79.4	81.1	84.7	90.8	87.1
Alabama	84.8	86.8	85.6	85.5	79.4	83.1	92.0	93.7	92.7	90.0	88.1	89.2	89.0	85.3	87.5	88.1	80.0	84.9	87.0	84.9	86.2
Mississippi	85.2	82.3	84.0	87.1	78.7	83.7	84.3	92.7	87.7	90.3	89.7	90.1	89.3	81.3	86.1	86.1	81.9	84.4	86.2	84.0	85.3
Louisiana	78.4	87.4	82.0	78.7	75.8	77.5	87.7	95.3	90.7	85.5	87.4	86.3	92.0	88.3	90.5	81.6	88.4	84.3	85.3	88.6	86.6
Eastern Texas	84.2	91.3	87.0	82.6	74.2	79.2	90.3	94.3	91.9	84.8	91.6	87.5	85.0	84.0	84.6	81.3	76.8	79.5	84.6	84.0	84.4
Arkansas	84.5	87.4	85.7	84.2	66.8	77.2	96.0	81.3	92.1	85.8	88.4	86.8	91.3	87.7	89.9	71.6	80.0	75.0	83.7	82.0	83.0
Tennessee	81.0	80.0	80.6	84.8	68.7	78.4	92.3	88.7	90.9	93.2	91.9	92.7	86.0	74.7	81.5	80.6	89.7	84.2	84.2	79.8	82.4
Kentucky	86.8	82.9	85.2	87.4	70.0	80.4	93.7	87.0	91.0	91.3	89.4	90.5	88.7	77.3	84.1	80.3	89.4	83.9	84.6	81.5	83.4
Ohio	78.7	79.0	78.8	85.2	80.6	81.4	90.0	79.0	85.6	88.7	92.9	90.4	81.7	85.3	83.1	85.5	81.9	84.1	82.8	81.9	82.4
West Virginia	80.3	87.7	83.3	86.1	71.0	80.1	86.0	83.7	85.1	89.4	81.0	86.0	75.3	84.3	78.9	71.6	86.1	77.4	80.3	81.9	80.9
Indiana	75.5	76.5	75.9	88.4	72.6	82.1	88.3	77.0	83.8	92.6	88.1	90.8	84.0	76.7	81.1	91.3	87.1	89.6	84.1	78.3	81.8
Illinois	83.9	77.7	81.4	76.1	77.4	76.6	88.7	78.7	84.7	95.5	87.4	92.3	92.7	68.3	82.9	88.4	81.3	85.6	84.5	80.9	83.1
Lower Michigan	87.7	84.2	86.3	80.0	74.8	77.9	86.7	82.3	84.9	89.4	89.0	89.2	86.7	88.0	87.2	86.1	79.7	83.5	83.4	80.6	82.3
Upper Michigan	84.8	71.6	79.5	83.9	76.5	80.9	81.7	81.3	81.5	81.6	80.0	81.0	87.7	87.7	82.7	89.4	84.2	87.3	80.0	78.0	79.2
Wisconsin	84.8	81.6	83.5	78.7	75.2	77.3	85.0	80.7	83.3	87.7	73.5	82.0	92.0	80.3	87.3	81.9	83.2	82.4	81.2	79.5	80.5
Minnesota	81.3	77.6	79.6	75.8	66.5	72.1	77.3	80.3	78.5	90.6	75.2	84.4	94.3	80.3	88.7	78.4	80.6	79.3	81.0	75.8	78.9
Iowa	86.1	81.6	84.3	76.5	71.0	74.3	80.7	79.7	80.3	92.6	77.7	86.6	99.7	73.3	89.1	85.5	75.5	81.5	83.2	77.9	81.1
Kansas	80.0	78.7	79.5	78.7	71.6	75.9	90.3	85.3	88.3	89.7	85.8	88.1	93.0	80.7	88.1	76.5	78.4	77.3	81.8	77.6	80.1

Nebraska	72.3	80.6	75.6	75.8	75.8	75.8	84.0	89.0	86.0	94.2	81.9	89.3	96.7	65.3	84.1	76.5	78.7	77.4	80.2	75.4	78.3
Missouri	82.6	84.8	83.5	79.4	73.2	76.9	83.7	85.7	84.5	83.2	88.1	85.2	95.3	71.0	85.6	78.4	75.2	77.1	82.4	80.5	81.6
Colorado	82.9	77.7	80.8	78.4	63.9	72.6	91.7	90.0	91.0	94.2	76.8	87.2	97.0	86.3	92.7	68.7	73.9	70.8	83.0	76.8	80.5
North Dakota	84.2	82.6	83.6	75.8	79.7	77.4	87.7	80.0	84.6	89.7	77.7	84.9	89.3	77.7	84.7	78.4	77.4	78.0	81.5	77.3	79.8
South Dakota	86.1	79.7	83.5	81.0	71.6	77.2	77.3	79.0	78.0	89.7	80.0	85.8	98.3	72.0	87.8	83.5	77.4	81.1	83.3	76.7	80.7
Monthly average	81.4	82.2	81.7	82.2	78.8	80.8	87.7	86.1	87.1	90.4	87.5	89.3	90.2	84.4	87.9	81.3	82.7	81.9	83.6	81.9	82.9

LOCAL FORECAST OFFICIALS.

Up to a comparatively recent date the authority to issue official predictions was restricted entirely to the officials on duty at Washington. With some little uncertainty as to the immediate results of the experiment, a radical departure from the established policy of the Bureau, a number of competent observers were directed to make forecasts for their stations and immediate vicinity. In the first appropriation for the Weather Bureau provision was made for twenty local forecast officials. The favor with which this movement is looked upon is evidenced by the fact that there have been the most urgent applications for the assignment of such officials at cities which could not be provided for. The last Congress appropriated for six additional officials and the number will doubtless have to be increased to meet the demand. These local forecast officials have the advantage of a personal knowledge of the topography, climatology, etc., of their districts and ought to be able to make more accurate predictions for their individual districts than has been possible for the officials at this office who have had but a limited time for all the States and Territories. With each year's experience there should be increased knowledge of the meteorological conditions. No efforts have been spared to give these forecast officials a sufficiently great number of reports for the purpose in hand and to encourage in every way systematic study and investigation of local weather problems.

THE WEATHER MAP.

The weather map is based on observations made morning and evening at 8 o'clock, seventy-fifth meridian time, at one hundred and sixty places throughout the United States and the Dominion of Canada, and is issued twice a day. Data as to the condition of the weather are thus gathered from an extent of more than 3,500,000 square miles of the earth's surface, about one-fortieth part of the whole surface of the globe. Information is also received from the West Indies at times when severe storms prevail there, and occasionally also from Bermuda Islands.

The observations taken at a place comprise the pressure of the air; the temperature at time of observation; the highest temperature of the day and the lowest; the moisture; the wind direction; the velocity of wind for five minutes at the time of observation; the depth of rainfall for the preceding twelve hours when the observation is made in the evening, and for the preceding twenty-four hours when the observation is made in the morning; the condition of the weather at the time of observation, whether clear, raining, snowing, foggy, or hazy; the condition of the sky as to clouds and the kind of clouds; the direction of their motion and the proportion of sky covered.

These observations are telegraphed to the central office of the Weather Bureau at Washington, D. C., with the aid of a cipher code designed for the purpose of saving time and expense in the transmission of the messages. As a rule, a message consists of six words. The cipher is so constructed that a person familiar with the key can quickly translate the message without reference to the key and without consulting an index of words. As the cipher messages are received a skilled translator reads each of them in the terms expressed by the cipher. An assistant enters the data upon a map of the country near the location of the particular place. When all the data are entered on the map, it is generalized by lines representing graphically the various conditions of the air and the changes going on.

This map, made up from observations at 8 o'clock, is issued two hours and a half later in a number of the large cities throughout the country, aud is posted in post-offices, custom-houses, boards of trade, and maritime exchanges. In the aggregate, 5,000 copies of the weather map are issued daily, except Sundays, at sixty-three cities.

On the printed weather map issued at Washington the principal data for the various stations are given in figures, in tabular form, on the side of the map.

WEATHER MAPS ISSUED AT STATIONS.

The total number of weather maps issued daily at all stations on June 30, 1891, was 3,100; during the year just ended 6,800 were issued, or more than double. Observers have been required to improve the appearance of the maps by paying greater attention to the mechanical details. By the milleograph process—developed and improved for this special purpose—the stations print and issue within a very short time from the receipt of the reports, maps showing the existing conditions. The maps are posted without delay in conspicuous places, and dispatched to all points which can be reached within twenty-four hours. They contain not only the data necessary, but the forecast for thirty-six hours or longer and a synopsis of the storm movement, etc.

It is hardly necessary to point out that such maps enable those who are students of meteorology to draw their own conclusions as to the probable weather; and that they are the greatest helps to a better understanding by the public, of the real value and significance of the forecasts. The rule is to furnish these maps, which cost the Bureau less than half a cent apiece, to all who will display them for the information of the public; but they are also furnished to many schools and colleges where instruction in meteorology is given. The policy of the Bureau is to be as liberal as possible in their distribution.

An effort has been made during the past year to induce newspapers in all large cities to print a facsimile map (reduced), with the gratifying result that many papers with large circulations now publish the map regularly. Hundreds of thousands are thus reached daily without expense to the Bureau other than the assistance of the men at the several stations in the preparation of the data. An "Explanation of the Weather Chart," including a brief general statement of the laws governing the motions of storms in the United States, for popular reading in connection with the map has been printed and freely distributed.

WIND SIGNALS.

Up to January 1, 1892, authority to direct the hoisting of "Storm," "Cautionary," and "Information" signals was confined to the officials at the Washington office; but on that date the authority was conferred on the local officials and specially selected observers at important stations on the Atlantic and Gulf coasts, and along the Great Lakes. Whenever, in their judgment, winds dangerous to shipping were likely to occur, they were authorized to display signals, advising the central office of their action. All observers on the coasts mentioned have been instructed to notify the officials on duty at Washington by telegraph whenever local conditions seem to indicate the likelihood of dangerous winds.

SPECIAL WIND-SIGNAL STATIONS.

Around many of the regular stations are grouped subsidiary ones called special display stations. When directed by the observer in charge of the regular station, the officially designated displaymen hoist signals. The compensation for this service is very small, but during the past year it has been impracticable to establish stations of this class at all of the places at which they were needed, except under agreement that the signals be displayed without pay. Fourteen stations have been thus established at which no compensation is given the displayman.

COTTON REGION SERVICE.

The Bureau has continued to render important information to cotton-growers. After consultation with the observers in charge of the several centers and upon the urgent requests of the commercial exchanges, the time for taking and reporting the observations was extended, and these are now made from April 16 to November 30 of each year. Many requests for the establishment of new stations have been received, but it has been practicable to open but two. In order to establish nine stations of a somewhat similar character in the sugar and rice growing districts, and to keep within the appropriation, it was necessary to discontinue nine of the less important cotton region stations.

WEATHER REPORTS FROM THE WEST INDIES.

We have continued to receive reports from the paid observers at San Domingo, Kingston, St. Thomas, and Santiago de Cuba; and from P. Benito Viñes, S. J., Belen College Observatory, Havana, and General Russell Hastings, voluntary observer at Bermuda, during the hurricane season, *i. e.*, from July 1 to October 1. But in order to reduce telegraphic expenses, the instructions previously issued requiring daily telegraphic reports have been modified so that while observations are taken twice daily and a record kept and monthly reports forwarded by mail to this office, the observations are not telegraphed to the observer at Key West, Fla., unless an unusual meteorological condition prevails, or information is received of an approaching storm, either at the time of the regular observation or during the interval between the two observations.

By an arrangement with the governor of the Bahama Islands, daily reports from Nassau are telegraphed to Jupiter without expense to the Weather Bureau; and in return the Jupiter office transmits reports once a day to Nassau, giving the observations at ten Weather Bureau stations, and also telegraphs warning of storms likely to prove dangerous to shipping.

FLOOD PREDICTIONS.

There are now in active operation 166 special river stations and 59 special rainfall stations. These are arranged in groups or sections under the supervision of central stations. The river observers record the rainfall also. River bulletins are issued at 22 places. Stage predictions of some of the principal rivers are made daily at Washington. The observer at Chattanooga is authorized to predict for the river there.

The special bulletin of April 21 in relation to an expected flood along the Lower Mississippi was of great value, and was verified in all details. Small maps showing the location of certain river gauges have been issued with the river bulletins, for the better understanding of the warnings. A beginning has been made in the measurement of river discharges. Our purpose at present is to improve the predictions for Cairo, Ill., by measurements of the discharge there. Cairo is the key to the situation in the Lower Mississippi Valley, and any improvement at that point will be followed by improvements at all places below.

Measurements have been made at Parkersburg, Cincinnati, and Henderson, on the Ohio River; at Nashville, on the Cumberland; at Chattanooga and Johnsonville, on the Tennessee; at Mount Carmel, on the Wabash; Charleston, on the Kanawha; Louisa, on the Big Sandy; Frankfort, on the Kentucky; and Rockport, on the Green River. Apparatus for velocity measurement has been procured, and the investigation will be carried on as opportunity permits.

Some study has been made of the relation of rainfall in the river basin above Pittsburg to the height of the water at Pittsburg. The result for this particular case seems to be that rainfall observations are of small value in estimating river rise. A somewhat similar study made for St. Louis shows that in this case the rainfall can be advantageously used with the changes of the up-river gauges in forecasting the river rise.

ADVANCED SCIENTIFIC WORK—PUBLICATIONS.

During the past four or five months, something like 400,000 Annual Reports and extracts from the same, professional papers, and other publications, including weather maps, have been sent out by the Publications Section. Four Bureau bulletins have been published and widely distributed. Others are in preparation. Bulletin No. 1 has for its title "Notes on the Climate and Meteorology of Death Valley, California," by Mark W. Harrington, Chief of the Weather Bureau. This bulletin has 50 pages, and treats of (1) physical features of the valley; (2) station and instruments; (3) discussion of observations; (4) the weather in the valley; (5) the automatic registers; (6) deductions, with tables of the daily pressure, temperature, relative humidity, wind directions and velocities, five-day means, and hourly wind velocities, temperature, and pressure. The principal features of popular interest in Death Valley are its excessive heat and dryness. The temperature rises occasionally in the shade to 122°, rarely falls at any time in the five hot months below 70°, and averages 94°. It is not only hot in summer, but consistently hot, and the heat is increased by occasional hot blasts from the desert to the south. The air is not stagnant, but in unusually active motion. Gales of a few hours' duration are very common, and sometimes they produce sand whirls and sand storms. Rains may fall frequently in the mountains and occasionally in the valley; clouds are by no means lacking, and water can probably always be found in the soil at the depth of a few feet, yet the heat and wind together keep the surface very dry and the relative humidity low. Animal and plant forms are comparatively few, and the former are usually nocturnal to avoid the heat.

Both heat and aridity are increased by the character of the valley. It is narrow and deep, apparently the bed of an old sea, inclosed by high and dry mountains. The white and shifting sands become much heated under the noonday sun; the rest of the surface is in part salt and alkali, in part pebbly wash from the mountains and in part a loose spongy earth over which it is difficult to move. With the exception of a few springs, the water is bitter and unwholesome.

The meteorological features of interest lie for the most part in those modifications of diurnal changes which are due to the topography. The range of temperature is unusually great; the hourly progress of the winds show curious changes in speed, in direction, and in temperature. The diurnal change in the barometer is the most characteristic of the form found in continental valleys. It is of the purest single-maximum type and has the largest amplitude known. With these features go those sharp thunderstorms, limited to certain hours of the day, and daily gales and hot blasts.

It is also noteworthy that the absolute humidity here is fairly constant and is that belonging to that part of the world. The air in the valley is part of the general aërial ocean, and this shows no sharp contrasts in its moisture contents, except where wind prevails across a mountain ridge. Here the prevailing winds are up and down the valley, and its relative aridity is due to its higher temperature.

A few words may be given to the winter climate, concerning which there are no recorded observations. The physical conditions of the valley, however, supported by the statements of those who have prospected there in the winter, and of those who have resided there in connection with borax works, enables us to reach a fair idea of this season. For five years, beginning in 1883, about 40 men were employed there. The season began with September and ended in June. By them the climate was considered healthy. Ducks and other migrating birds, jack rabbits, and cottontails were reported as abundant, and the neighboring Pi-Utes extended their migrations into the valley. Snowfalls occurred on the mountains, sometimes to the depth of several feet. Ice forms in, and extreme cold has been reported from, the neighboring but higher valleys. In fact, the relatively clear sky and bare soil make this region a favorable spot for the fall of winter temperatures. At Yuma the lowest temperature often reaches 27°, and once descended to 22°.5.

In short, following the year through, and accepting the guidance of the observations, of the physical conditions, and of the reports of those who have lived there, it is safe to conclude that the winter must be cool and salubrious, with an inch or two of rain. The early spring and late autumn must be of moderate temperature, with clear, delightful air and little rain; the autumn very dry; the summer, with May and September, as we know, hot and arid. While the diurnal changes are great, the annual must be very much greater. The winter mean temperature may be between 35° and 40°, and that of the year 58° or 60°.

Bulletin No. 2: "Notes on a New Method for the Discussion of Magnetic Observations," by Prof. Frank H. Bigelow. In this bulletin a general account of the relations thought to exist between terrestrial and cosmical magnetism and certain meteorological phenomena is given. The plan pursued is to subdivide the resultant deflecting force disturbing the normal terrestrial magnetic system at any instant into its several components and then trying to unravel these. The residuals derived from the observations, showing variations about a mean, are changed to a system of rectangular coördinates, which are transformed to equivalent polar coördinates, which, in turn, are transferred to a model in an attempt to classify the very complex systems that give rise to them. The result has been to give the following components: (1) The annual solar, due to the orbital motion of the earth; (2) the diurnal solar, due to the rotation of the earth on its axis; (3) the coronal, due to the rotation of the sun on its axis; (4) the disturbance, probably due to spasmodic actions in the body of the sun; and (5) the meteorological, probably due to variations in the terrestrial atmosphere as a conductor to magnetic-ether waves. The research has been conducted along three principal lines, and enough has already been accomplished to make sure the main lines of the development, giving at the same time the promise of very interesting conclusions, which it is hoped can be definitely announced before the end of another year. In order to clear the ground for the final object to be attained by the investigation, namely, the development of the meteorological term, the other components had to be studied with some care; and a full treatment of the magnetic needle in the annual and diurnal periods was undertaken. The records of thirty stations, where hourly observations have been conducted for at least a year, have been fully reduced and transferred to a 10-inch model. These stations are distributed in latitude (magnetic) from Kingua-Fjord to Hobarton; and in time from 1840 to 1890, including the British colonial stations, the international polar stations and the modern permanent observatories. The result is that the radiant field of sunlight is to be regarded as a magnetic field in which a spherical conducting magnet is rotating in the known astronomical conditions; that the earth is thus acted upon by a couple, tending to pull the north magnetic hemisphere toward and to push the south magnetic hemisphere away from the sun; that the plane of symmetry passing through the center of the earth, and thus not affecting its axial rotation, is itself turned westward by about 23° in the northern hemisphere and by about 8° in the southern from the meridian of the sun; that the lines of force are absorbed by the earth, as a better conductor of magnetic waves than the surrounding medium, and indicate by their peculiar curvature that magnetic refraction is the simple law of the complex resultant formula; that the polar fields pass into the mid-latitude fields through a belt which is to a certain extent discontinuous, and which is the region occupied generally by auroral manifestations, which must therefore be the result of a combination of magnetic wave vibrations increased sufficiently in frequency to become just visible as light; that among the many important conclusions in physics to be drawn from these premises is the confirmation of Maxwell's electro-magnetic theory of light.

The second step was the discussion of the magnetic and meteorological data. For this purpose the Washington observations of 1889, 1890, 1891 were reduced, and some persistent relations that can not be considered coincidences were found. Owing to the lack of material for the United States the records of European observatories were taken. The year 1887 was selected, because this is the only complete year of International Weather Maps. These were supplemented by the "Wetterkarte u. Wetterbericht d. Kgl. Bayer. Meteor. Centralstation Munchen, 1887." The computations were made for Los Angeles, Toronto, Greenwich, Paris, Pola, Prague, Vienna, Pawlowsk, Tiflis, Zi-ka-wei, and Batavia. What was at first supposed to be a simple meteorological term has been divided into two parts—(1) a term that can be properly ascribed to the motion of the sun on its axis, and which gives the individual dates on which the southern and the northern poles of the solar coronal system pass synodically in front of the earth, confirming remarkably the results hitherto obtained by Prof. Bigelow regarding the location of these coronal poles; (2) a proper meteorological term showing absorption of magnetic waves during periods of rain.

It may be said, in a preliminary way, that the weather conditions show a type of fluctuations related to these two terms that gives ground for hope that some interesting conclusions may be obtained. It has been decided to extend the computations into the years adjacent to 1887 to verify the results. Quite a large amount of material for the discussion of the "disturbances" has been collected and is already partially reduced, but not enough yet to show that additional knowledge is to be gained. All the large disturbances registered at Washington for 1889, 1890, 1891 are being discussed for the recurrence of the phenomena at a single station, and the disturbances of January 3, January 28, and February 13, 1892, as recorded at widely distributed stations, are also to be treated.

Two cosmical fields in the neighborhood of the earth seem to be clearly made out—(1) the radiant or electro-magnetic field parallel to the plane of the ecliptic; (2) the coronal field perpendicular to the same plane at the earth, consisting of longer and therefore invisible magnetic waves. When these other waves penetrate the atmosphere and come in contact with its oxygen and aqueous vapor, they pass through a series of transformations, by which some of the wave lengths are increased so as to give the heat vibrations; some are absorbed and broken up in the air, and others at the earth itself.

Bulletin No. 3 is a "Report on the Relations of Soil to Climate," by Prof. E. W. Hilgard, of the University of California. This treats of the processes of soil formation—(1) through mechanical agencies, changes of temperature, freezing water, moving or flowing ice, flowing water; (2) chemical agencies, solution by water alone, carbonic acid, the oxygen of the atmosphere, water in combination; and (3) weathering or fallowing.

Following a classification of the soils, Prof. Hilgard gives a synopsis of the climatic factors that modify soils, such as the influence of rainfall, temperature, and sunshine. Conjointly with the study of soils, that of climatic conditions is of the utmost practical and theoretical importance. Meteorological stations must be more numerous, and located largely with reference to the agricultural problems to be determined in connection with them. "Actual field surveys to define the agricultural subdivisions," says Prof. Hilgard, "should be made by parties covering not only the agricultural, but also the meteorological, geological, and botanical aspects of the several problems. This will be but simple and tardy justice to the fundamental industry upon which the very existence of nations depends.

Bulletin No. 4 is "Some Physical Properties of Soils in their Relation to Moisture and Crop Distribution," by Prof. Milton Whitney, of the Maryland Agricultural College. This report is based partly on the author's original work and partly on a generalization of the work of others in this line, as reported in the literature of the day. The limits of the report do not permit of the presentation of even the main facts from which these generalizations have been drawn, which are well known, however, through the admirable writings of Johnson and Storer, or of the views generally held by agricultural chemists as to the cause of the local distribution of plants.

Bulletins in course of preparation are: "Variation of Barometer," by Dr. F. N. Cole, of Ann Arbor, Mich.; "Fluctuations of Ground Water," by Prof. Franklin H. King, of Madison, Wis.; and probably papers on "Average Wind Velocities in the United States," by Prof. Frank Waldo; and on "Rainfall Laws," by Prof. Gustavus Hinrichs.

For exhibition at the World's Fair, at Chicago, a set of normal charts has been prepared, as follows:

Normal pressure and wind for January, April, July, October, and the year (5).
Normal temperature for January and July (2).
Difference between the maximum and minimum (6).
Normal precipitation for the seasons and the year (5).
Snowfall chart (1).
Grains of moisture per cubic foot, January and July (2).
Clouds for January and July (2).
Rain and wind, January and July (2).
Number of days on which .01 inch precipitation fell, January, July, and the year (3).
Number of days on which maximum temperature was above 90, June, July, and August (3).
Number of days on which minimum temperature was below 32, December, January, February, and March (4).
Mean hourly temperature departures, Chicago and Yuma (2).
Diurnal range of wind velocity at Chicago (1).
Diurnal range of wind direction at Chicago (1).
Typical weather map.

SEVERE LOCAL STORMS.

Some study has been made of the most destructive storms and a list of casualities has been prepared by Prof. Hazen. These storms have been grouped as follows: (1) Where the loss did not exceed $3,000; (2) where the loss was in the neighborhood of $20,000; and (3) where the amount was $100,000 or more. Of 1,207 storms considered, 71 per cent are storms that were not especially dangerous to either life or property. Only 70 storms, or about 5 per cent of the total number reported, were destructive to the amount of $10,000 or more.

DEATHS BY VIOLENT WINDS AND LIGHTNING.

Whenever deaths were reported a circular was sent to the nearest voluntary observer, or to the postmaster, asking for names, etc.

Months.	Wind.			Lightning.		
	1890.	1891.	1892.	1890.	1891.	1892.
January	......	2	......	......	......	......
February	......	1	......	......	......	......
March	160	10	20	2	......	......
April	6	9	38	6	13	5
May	26	9	60	8	23	26
June	27	35	34	37	77	102
July	29	30	31	55	62	95
August	25	11	7	12	53	62
September	......	1	......	......	8	2
October	......	......	......	......	......	......
November	......	......	......	......	......	......
December	......	......	......	......	......	......
Total	273	108	190	120	236	292
	571			648		

RECORDS OF THE WEATHER BUREAU.

I can only repeat the statement of last year relative to utilizing the records now in the possession of this office. The policy of the Bureau is to afford an opportunity to everyone interested in climatology to have the benefit of the enormous accumulation of meteorological records.

We have now the observations for the twenty years during which the meteorological work was in charge of the Signal Service, and also those for many years before, when in charge of the Smithsonian Institution. I propose to utilize these data by special studies by the proper officers of the Bureau. Several studies of this sort are now under way and others are being organized. But I believe that we should pursue no exclusive policy in the treatment of our records. They should be thrown open to all students of meteorology who are competent to use them, subject only to such restrictions as will preserve them from injury. I recommend that meteorologists be invited to make use of them in the Bureau. Space can be found for a limited number of such students and the necessary guidance and oversight given them.

A brief statement of the records embraced in the files of the Weather Bureau follows:

(1) The records of Weather Bureau stations which have been in operation since November, 1870. Of such stations, 373 have been in operation at one time or another. Main dependence is of course placed upon these observations.

(2) The records of the Medical Department of the Army from 1860 to date, and the reports of voluntary coöperating observers from December, 1873, to date.

(3) As a special deposit, the records collected by the Smithsonian Institution from 1847 to 1873. This collection embraces original registers or monthly values of temperature and precipitation secured through the coöperation of the United States Lake Survey, under the Engineer Corps, U. S. Army; the U. S. Coast Survey, under the Treasury Department; the compilations of Dr. F. B. Hough from observations made under the direction of the regents of the University of the State of New York; the records made in Pennsylvania under the direction of the Franklin Institute of Philadelphia, the transactions of various societies, and periodical publications.

(4) Abstracts of monthly registers forwarded by directors of State weather services and meteorological societies.

(5) Abstracts of reports made by the Central and Southern Pacific Railway agents.

(6) Records of observations at stations of the Canadian meteorological service, furnished through the courtesy of the director.

(7) Copies of many private series of observations, the originals remaining in the custody of the owners.

The duties of the Records Division of the Bureau have been so fully described in previous reports that no extended comment is needed here. Meteorological forms and reports as shown in the following table have been received from all classes of observers in the United States. The gain over 1891 is 6,978.

No. of form.	Description.	Received.
1001	Original monthly record of observations	1,752
1002	Annual meteorological summary	150
1003	Annual meteorological summary abridged	300
1004	Monthly meteorological record of third-order stations	194
1004	Monthly meteorological record of special rainfall stations	780
1005	Monthly meteorological record of cotton region stations	856
1005	Monthly meteorological record of sugar and rice stations	21
1006	Monthly meteorological record of river stations	2,076
1008	Monthly meteorological record of voluntary observers	12,401
1009	Monthly meteorological record of voluntary observers abridged	
1011	Monthly meteorological summary (State weather services)	103
1012	Monthly meteorological summary of voluntary observers' records (temperature and precipitation)	375
1014	Abstract of daily journal	1,776
1015	Anemometer record sheet	33,660
1015	Self-recording rain-gauge record	144
1016	Anemometer and anemoscope record sheets	1,020
1017	Anemometer, anemoscope, and rainfall record sheets	19,260
1021	Prevailing hourly wind direction	349
1022	Hourly wind movement	1,798
1026	Hourly barograph record	648
1026	Hourly thermograph record	900
1026	Hourly hygrometer record	10
1029	Annual report of stations (observers)	151
1031	Monthly record of wind signals	600
1032	Monthly record of cold-wave signals	1,115
1033	Monthly record of wind signals, special display	642
1055	Records of observations of Piche evaporometer	18
1061	Cipher report (telegraphic) of observations	106,580
1064	Record of radiation	24
1065	Record of sunshine	242
1066	Monthly verification of weather and temperature forecasts	334
	Trace sheets, barograph	2,808
	Trace sheets, hygrometer	43
	Trace sheets, thermograph	4,108
	Total	195,238

In addition to the foregoing numerous special reports of severe local storms, thunderstorms, tornadoes, etc., have been received and acknowledged.

The promptness and efficiency of regular and special observers in forwarding the reports required of them is especially commendable. It is almost incredible that out of nearly 200,000 reports there should be but 113 delinquent cases, and yet such is the fact. The loss in transit through the mails was limited to but one record of value (original thermograph trace).

FOREIGN METEOROLOGICAL REPORTS.

On July 1, 1891, reports of simultaneous meteorological observations were received from Canada, Denmark, France, Germany, Italy, Netherlands, Spain, and Turkey, through the courtesy of meteorological services and individual observers in those countries. The following circular letter was sent to each of the meteorological services and coöperating observers on November 1, 1891:

U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU,
Washington, D. C., November 1, 1891.

Owing to the inability of this Bureau to bear the labor and expense incidental to a proper continuation of the International Meteorological publications issued by the United States Weather Service since 1875, the Chief of the Bureau deems it advisable to formally discontinue this work, on the part of the United States, after December 31, 1891.

The series of simultaneous meteorological observations, upon which these publications were based, was inaugurated as a result of the Vienna Meteorological Conference of September, 1873. In accordance with the promises of the Chief Signal Officer these observations were arranged, reduced, and published at the expense of the United States, and the publications were distributed to coöperating observers throughout the world.

Continued reductions in the funds available for carrying on the work, however, led the Chief Signal Officer to issue a circular letter, dated August 1, 1887, in which he announced that after December, 1887, this work would be discontinued by the United States. This letter resulted in a discontinuance of the simultaneous observations by many of the more important foreign services. In a subsequent circular the Chief Signal Officer stated that he would publish a monthly summary of observations furnished by coöperating observers who desired to continue the work. This monthly summary, which contains less than 200 foreign reports from observers irregularly distributed over the Northern Hemisphere, was published from January, 1888, to June, 1889.

In finally discontinuing the international work on the part of the United States, the Chief of the Weather Bureau desires to thank the chiefs of weather services and the voluntary observers for the cordial coöperation which has so largely contributed to the success of this work in the past. He also desires to state that it is the intention of this Bureau to publish a summary, with charts, of the general meteorological conditions over the Northern Hemisphere, based upon international simultaneous observations for ten years, copies of which publication will be furnished to each observer who has coöperated in the work of international observation.

I have the honor to be, very respectfully, your obedient servant,

MARK W. HARRINGTON,
Chief of Weather Bureau.

There still remain, however, a few countries and individual observers who continue to forward reports of observations to this Bureau.

The number of reports received from points outside of the United States during the year was 3,014.

Acknowledgment is due and is hereby made to all foreign meteorological services and individual observers for the care and attention given to the preparation of their respective reports, and for their generous coöperation without which the prosecution of the international work of the Bureau would have been impossible.

EXAMINATION OF RECORDS.

The following table shows the number of forms and record sheets examined during the year:

Serial number of form.	Designation.	Number examined.	Error letters prepared.
1001	Original monthly record of observations	1,752	
1015	Anemometer record sheet (daily)	33,660	
1016	Anemometer and anemoscope record sheet (daily)	1,020	1,798
1017	Anemometer, anemoscope, and rainfall record sheet (daily)	19,260	
1022	Hourly wind movement (monthly)	1,798	
1002	Annual meteorological summary	150	150
1003	Annual meteorological summary	150	
1004	Monthly meteorological record of third-order and rainfall stations	194	194
1026	Hourly readings (monthly)	1,558	968
1061	Cipher report (telegraphic) of observations	106,580	1,252
1065	Sunshine record (monthly)	242	206
	Total	166,364	4,568

The examination to which the more important forms are subjected consists of an inspection of the report to see that there is agreement among the various entries, that no improbable entries have been made, that the reductions have been correctly made, and, finally, as to the numerical correctness of the monthly sums, averages, etc. Such an examination of the various statistical reports of observers operates not only as a check upon those who may be carelessly inclined, but also as a means of determining the relative accuracy and fitness for advancement of the better class of observers.

Nearly 20,000 more forms and record sheets were examined during the past year than in the preceding year. To accomplish this result it became necessary to shorten the time spent on the less important forms and to adopt shorter methods in others. The greater portion of the time devoted to the examination of meteorological reports is spent upon the original record of observations and other forms containing meteorological and climatological data used in the preparation of the Monthly Weather Review and other statistical reports.

The increase of the number of stations of the first order has been felt in the work of this division, both in the matter of instructing observers as to the preparation of reports from self-registering instruments, and in the greater number of forms to be examined. Purely instrumental records are sent to the official in charge of the instrument room for the correction of any noticeable mechanical defects in the working of the instruments. This plan keeps the official in charge of the instrument room fully informed as to the working of each of the self-registering instruments in the service.

REQUESTS FOR METEOROLOGICAL DATA.

Applications for climatological statistics have been as numerous as in former years and as varied in character. The liberal policy of the Bureau in regard to furnishing climatological information as outlined in previous reports has been followed during the year. All reasonable applications have been met and satisfied without expense to the applicants or detriment to the current work of the division. As illustrating the general use of climatological statistics, the following table showing the number of applications received from each State or Territory has been prepared. The District of Columbia includes, of course, the Executive Departments and both Houses of Congress.

Number of applications for climatological statistics received from each State and Territory.

State.	No.	State.	No.	State.	No.
Alabama	4	Louisiana	15	Ohio	4
Arizona	6	Maine	2	Oklahoma	4
Arkansas	2	Maryland	14	Oregon	3
California	13	Massachusetts	12	Pennsylvania	30
Colorado	3	Michigan	22	Rhode Island	3
Connecticut	5	Minnesota	10	South Carolina	1
Delaware	0	Mississippi	3	South Dakota	1
District of Columbia	87	Missouri	14	Tennessee	4
Florida	4	Montana	0	Texas	5
Georgia	3	Nebraska	4	Virginia	12
Idaho	0	Nevada	0	Vermont	1
Indian Territory	0	New Hampshire	2	Utah	0
Indiana	4	New Jersey	10	Wisconsin	2
Illinois	28	New Mexico	1	West Virginia	5
Iowa	3	New York	113	Foreign	15
Kansas	5	North Carolina	8		
Kentucky	13	North Dakota	2	Total	502

Special reports for the use of the various scientific divisions of the Department were made as follows: For the Division of Ornithology and Mammalogy, a report on the temperature of a number of places in the United States as illustrating the effect of climate on vital phenomena; for the Pomological Division, a series of frost charts showing the average date of last killing frost in the United States, and also the dates of last killing frost in 1889, 1890, and 1891; and for the Division of Vegetable Pathology, a report of the temperature and rainfall of certain years in the peach-growing districts of Delaware and Maryland. Computations, the extent of which can not be stated numerically, have also been made for the officials of the Bureau and for special agents and other investigators.

Copies of the compilations of precipitation and temperature data for Arkansas and New Jersey have been made for use of the Weather Bureau officials of those States. Much of the accumulated data of temperature and precipitation in the files of the division is of great value to the Weather Bureau officials in the several States and Territories and it is recommended that, as soon as other duties will permit, copies be made and sent to the States and Territories having most need of them. Some attention has been given to the preparation of the manuscript for an annual volume of meteorological observations to be printed in accordance with a plan approved by the Chief of the Bureau.

Work has also been done on normal values for use in preparation of charts for exhibition at the World's Columbian Exposition.

THE RECORDS VAULT.

The fireproof vault, in which are stored the original records of observation and other valuable reports, was fitted up with inside shelving during the year. No provisions for properly lighting or ventilating the vault have been made. The lack of ventilation is sorely felt, and has retarded a final classification and arrangement of the contents of the vault, but it is hoped that some action may be taken during the coming year to better the present conditions.

No records were bound during the year by reason of a lack of funds.

WORK OF THE REVIEW ROOM.

In the preparation of the Monthly Weather Review from June, 1891, to May, 1892, reports from 2,631 regular and voluntary observers have been used. Of these, 160 were regular stations of the Weather

Bureau; 1,719 were voluntary and State weather service stations; 98 U. S. Army post surgeons; 422 marine reports, through the Hydrographic Office; 32 Canadian reports; and 200 from the Central Pacific Railway Company. Marine reports, averaging about 75 per month, have also been received from the New York Herald. In addition to the regular contents of the Review, the following articles have appeared: Mean temperature at Nashville for thirty years; Excessive precipitation at Taunton, Mass., 1843 to 1890; Fluctuations of temperature and pressure at base and summit of Mount Washington; Some experiments in atmospheric electricity; Chinook winds; Mineral matter deposited with snow; Cloud work at Blue Hill Observatory; Observations of wind direction in West India cyclones; Precipitation at Washington and New York; Thunderstorms of May 3 in New York.

THE LIBRARY.

The work of the librarian has been of two kinds—(1) the collection and arrangement of the books and magazines proper in a meteorological library; (2) the preparation of a general catalogue. Some 13,000 books and 1,500 pamphlets are now in the library. Special efforts have been made to enrich the library in climatological literature. In conjunction with the Records Division, the Library began the preparation of an index of the foreign meteorological observations on file at this office. In January it had to be discontinued owing to lack of clerical force. Thus far the index is complete for Australia, China, Japan, India, and the East Indies.

The Library is open to all persons interested in meteorology, and it is gratifying to state that of many books loaned not a single volume has been lost or damaged.

About 1,000 titles have been added to the general catalogue of meteorology. It is of great importance to working meteorologists that this bibliography be put in print.

THE STUDY OF METEOROLOGY.

Prof. Abbe has been engaged in condensing and codifying the results of the International Meteorological Congress at Munich. Although a special committee was appointed by the conference to do this, it is thought that Prof. Abbe's paper may be of interest. In October, 1891, the manuscript of his extensive report on "Climate and Crops" was returned to him for condensation and certain changes before submittal for publication. This work has occupied much of his time, and it has been necessary for him to test experimentally certain conclusions which he had drawn from his study. He has also had to review the literature of the subject. Much of his time has also been occupied in answering correspondence on topics more or less intimately related to the work of the Bureau.

It will not be out of place, perhaps, to refer here to the loss which the science of meteorology sustained in the death of Prof. William Ferrel on September 18, 1891. He began his official connection with the Signal Service on August 1, 1882, and remained a faithful, able officer until September, 1886, when, having reached the age of 70, he carried out a resolution formed earlier in life of retiring from active life and resigned his professorship. His various papers contributed while thus connected with the Weather Service of the United States are:

"Recent Mathematical Papers Concerning the Motions of the Atmosphere." Part I—"The Motions of Fluids and Solids on the Earth's

Surface," with notes by Dr. F. Waldo. "Popular Essays on the Movement of the Atmosphere." "Temperature of the Atmosphere and Earth's Surface." "Recent Advances in Meteorology." "Vapor Tension, Dew-Point, and Relative Humidity Tables." "Reduction of Barometric Pressure to Sea Level and to Standard Gravity."

A full list of Prof. Ferrel's papers is published in the American Meteorological Journal, October, 1891. Some valuable papers commemorative of Prof. Ferrel were read at a meeting of the New England Meteorological Society in October, 1891.

TELEGRAPH ROOM.

During the year 1,277,500 words of cipher reports and 100,000 messages have been handled by the operators of the Bureau at Washington. The bills of the various telegraph companies for service are audited here, and during the year 492 bills have been certified to the Accounts Division for settlement. Six hundred and twenty-six miles of seacoast telegraph lines were operated by the Bureau. There are 8 sections in all, 3 on the Pacific coast, with 163 miles of line, and 5 on the Atlantic coast, with 463 miles. Sixty-five miles of submarine cables are included in these figures. The receipts from commercial messages on these lines were $5,166.07, which amount has been covered into the Treasury as required by law.

The Tatoosh Island line and cable were put in good working order in August, but during December were seriously damaged by a storm of unusual severity. Permanent repairs were not completed until January 20. The line is of great value, both for reporting vessels entering the Strait of Juan de Fuca and for weather reports, but owing to the rough and heavily timbered country it is subject to frequent interruptions. A wagon road is now under construction from Port Angeles to Cape Flattery, and steps have been taken to follow this road. The Fort Canby section also suffered in the storms of December, and particularly on December 7, when the wind averaged 75 miles per hour for fifteen hours and reached a maximum velocity of 98 miles. Temporary repairs were made without delay, followed by further repairs in the spring. The section is now reported to be in good condition. The line between San Francisco and Point Reyes Light, California, was damaged in December, in the heavy timber, near Tocaloma, and arrangements had to be made at once to have the weather and vessel reports from Point Reyes relayed by the Western Union office at Tocaloma, with a view to the ultimate abandonment of the Government line. This move, however, was strenuously opposed by the commercial bodies of San Francisco and others interested, and it was finally decided to improve the line. This was accomplished by July, 1892, and direct telegraphic service with Point Reyes Light resumed, to the great satisfaction of many interested therein. Several instances have occurred where the line has been of great value in reporting vessels and in summoning assistance.

The Nantucket section has been improved by the erection of 100 additional wooden poles on Naushon Island. This line has been instrumental in saving several vessels, notably the bark *Western Belle*, in March, 1892, which with cargo was valued at $286,000. The Block Island section is in excellent condition and has suffered only a few ordinary interruptions. The cable between Block Island and the mainland (11 miles) has remained unbroken.

The Hatteras section was greatly improved and strengthened by 840 new poles and 70 miles of new wire between Currituck Inlet and Life Saving Station No. 11. Further improvement will be necessary in another year near the southern terminus of the line, where some 1,300 new poles and 4 miles of new wire are needed. Communication was interrupted, in all, 44 days, a shorter period than during any preceding year; and, considering the exposed position of the line, fairly satisfactory. The cable between Cape Henry and Cape Charles, broken during the previous year, has been repaired. There has been no other cable trouble on this section. The reports of vessels from Cape Henry have been of great value to shipping interests, and have been promptly and accurately made. Several instances occurred during the year where the line was of great help in summoning assistance. The Wilmington section has required no general repairs and has been efficiently maintained at but slight expense. The Jupiter section received a thorough overhauling. Since the extension of the International Telegraph Company's lines to Jupiter, connecting the cable to Nassau, the Government line, so far as the transmission of vessel and weather reports is concerned, can be abandoned, but in view of the very great benefits conferred to the plantations along the Indian River, and which are not reached by the commercial lines as yet, the line has been maintained.

THUNDERSTORMS.

Some special observations were made in New England, New York, Pennsylvania, New Jersey, Ohio, Michigan, Indiana, Illinois, Wisconsin, and Missouri.

The intention was to make a practical study of thunderstorms, to see if it is possible to successfully forecast them. Each observer authorized to make forecasts of these storms received warnings from stations to the west by telegraph whenever storms occurred. The result was not all that might have been anticipated. The telegraphic service did not sufficiently cover the ground, and thunderstorms frequently arrived at stations before warnings were received from the west. These storms appear to be of two types: *a*, those traveling with a low area, with about the same velocity, and occurring in a narrow, elongated belt along the southeast quadrant; and, *b*, those accompanying heated terms, in which case these storms occur over a wide stretch of country. To make a fair test of the methods of telephoning and telegraphing warnings, the lines of the Michigan Bell Telephone Company were leased during the months of June, July, and August. The State was divided into nine sections, and the stations reported directly to the section center. These in turn reported to Detroit the direction of movement and the intensity of the storm. This plan worked very well. Telegraphic warnings from the west, however, were generally so retarded in transmission (it sometimes requiring from one to three hours to get a warning from one station to another) that the warnings were not of much practical use. Of 22 thunderstorms occurring in June in Michigan, 18 were forecasted from 8 to 24 hours in advance, two partially forecasted, and two complete failures.

Briefly, it appears from all this work that thunderstorms can be forecasted with some degree of success from the 8 a. m. and 8 p. m. weather maps; that these storms have a general progressive easterly motion; that they occur in the southeast quadrant of "lows," and have approximately the same velocity; that during heated terms attention is to be directed to the isothermal lines rather than to the position of the low; and that by the agency of the telephone, warnings can be successfully given.

STATE WEATHER SERVICE.

State weather service work, the general features of which have been fully outlined in previous reports, has been carried on to a much greater extent than heretofore, and the results accomplished prove the usefulness and importance of this branch of the Bureau. The entire territory of the United States, with the exception of Alaska, is now covered by local weather services, the last organized being that for Idaho. During the year Iowa, Maryland, New Jersey, and Ohio have, by legislative enactments, provided for the maintenance of their respective State services, and it is probable that their action will be followed in the present year by the legislatures of other States. The work in New England was until March 22, 1892, conducted under the direction of the New England Meteorological Society, with a central station at Cambridge, but on the date named the station was transferred to Boston and the name changed to the New England Weather Service. In Kansas, the director, owing to press of other duties, felt compelled to withdraw in April, 1892, much to the regret of the Chief of the Bureau. The Kentucky service, until August, 1891, was operated under the auspices of the Polytechnic Society of Louisville, when it was placed under the direction of the observer at Louisville. Until August, 1891, the Dakota Weather Service covered both North and South Dakota, when separate services were formed. In California, in addition to the usual work of the service, weekly weather crop bulletins have been issued from Red Bluff, Fresno, and Los Angeles. The regular monthly reports now contain important tables, rendering it possible to obtain the special features of the climate of every section of the country. Thus farmers, immigrants, physicians, invalids, and all others have a means of securing detailed information.

THE WEATHER CROP BULLETIN.

This forms a most important feature of State weather service work. Besides the National Bulletin, all the States and Territories, except Nevada and Idaho, issue local bulletins during the season of planting, cultivation, and harvesting of crops. Such has been the demand for the National Bulletin that the edition has been more than doubled, and yet the demand increases. The text of the bulletin is telegraphed by the press associations, and is reproduced either in whole or in part in many papers.

THE DISTRIBUTION OF FORECASTS, FROST, AND COLD-WAVE WARNINGS.

This branch of the work of the division has greatly increased during the past year, but has been hampered by inadequate appropriations for telegraphic purposes. The increase in the number of stations supplied by telegraph at Government expense with the daily forecasts, as compared with the number supplied on June 30, 1891, is over 200 per cent, and on the 1st of July, 1892, our lists show a total number of 1,888 receiving a daily telegram at the expense of the Weather Bureau.

A large number of applications could not be favorably considered, as the allotment of the telegraph appropriation would not admit of any increase over the number already supplied. One hundred and thirty-six stations have been established under the auspices of the National Grange of the Patrons of Husbandry, many of which were supplied with flags by the Weather Bureau, while others disseminated the forecasts and warnings by means of steam whistles.

There appears to be no abatement in the interest manifested by all classes and conditions in the forecasts and warnings, and hearty coöperation is met with by this office in its endeavors to place the information in the hands of all who would be benefited.

The railroad telegraph and train service, as gratuitous means of distribution, are largely utilized, and nearly 3,000 places receive the forecasts daily in this manner, and over one thousand points are supplied by mail or a free telegraph or telephone service.

The following tabulated statement shows the number of places supplied with forecasts and warnings by paid service and without expense, and is arranged with a view to comparison of the work of distribution in each State and Territory:

Distribution of forecasts, cold-wave, and frost warnings.

States and Territories.	By telegraph or telephone at Government expense.			Without expense to the United States, by—			
	Forecasts and warnings.	Cold-wave warnings only.	Frost warnings only.	Mail.	Telegraph or telephone.	Railroad telegraph.	Railroad train service.
Alabama	16		3	1	1	2	56
Arizona							
Arkansas	24	1			18	2	3
California	64	1	*4	16	7		
Colorado	26	2		2			7
Connecticut	17	3	9		46		156
Delaware	6					5	
District of Columbia	1				2		
Florida	18		18	129	9		
Georgia	49		34				83
Idaho	1						
Illinois	94	11	1	1	10	199	36
Indiana	81	4		2		52	80
Indian Territory	4	1					
Iowa	89	2		60			22
Kansas	39	4		3	23	91	3
Kentucky	44	1	101	1	3	4	
Louisiana	35	5	4	17	14	10	59
Maine	32	2			4	10	77
Maryland	20	1	4	4	1	61	
Massachusetts	27	1	27	13			274
Michigan	98	7		8	19	67	5
Minnesota	91	2			2		
Mississippi	40	4	1	15	26	33	14
Missouri	51	1	100	3	53		137
Montana	3	1			1		
Nebraska	54	3	1	65			
Nevada	5						
New Hampshire	17	1		2	8	3	15
New Jersey	32	5	29	51	13	138	
New Mexico		1					
New York	138	8	26	62	80	23	143
North Carolina	59		16	173	8		
North Dakota	27		11				
Ohio	101	1	32		57	53	
Oklahoma	6	1					
Oregon	32			4			
Pennsylvania	50	11		7	85	356	7
Rhode Island	2			3			28
South Carolina	25	6	2	4	11	19	
South Dakota	61		1	5			
Tennessee	27		43	15	19	15	98
Texas	41	2		15		3	5
Utah	1				6		1
Vermont	12	1				1	
Virginia	26	3		8		18	153
Washington	18		3				
West Virginia	21		2			39	
Wisconsin	163		20		7		
Wyoming		3					
Total	1,888	100	492	639	533	1,204	1,462

Grand total, 6,368.

*Rain warnings.

INSTRUMENT ROOM.

The maintenance of a high standard in the instrumental outfit of the various stations of this Bureau is confided to this division. The character of instrument best adapted to the particular necessities of the service demanded, the accuracy of the instruments themselves, and the questions of exposure and proper care are all matters that call for a high degree of training and ability. Active efforts have been made to improve the former types of apparatus, to devise and develop new ones, and to adopt improvements when convinced of their value. The personnel of the division is well adapted for such work. Among other innovations may be noticed the adoption of ink in recording instruments. .

On the 30th of June, 1892, 63 first-order stations were in operation, and at each of these, in addition to eye observations, records for each 24-hour period were obtained of pressure, temperature, wind direction and velocity. At 21 stations a photographic record of sunshine and an automatic record of rainfall were obtained. In addition to these continuous records there were in operation, at other selected stations, 22 thermographs, 6 barographs, 1 hygrometer, 1 recording rain-gauge, and 1 sunshine recorder. The demand for automatic instruments becomes greater and greater as they become better known, and it is the intention of this Bureau to supply each large city therewith, even when near other large cities, in order to meet the frequent and important calls by courts for official records at particular hours. It has not been found practicable as yet in part because of the considerable cost of apparatus to equip all the stations with desirable instruments. The distinction made by this Bureau of first-order and second-order stations is, it will readily be understood, one that has not reference to the size or importance of the city in which the station is located, so much as to the meteorological importance of records.

It is hardly necessary to allude to the system of checking by eye-readings the records of all self-recording instruments. The necessary corrections are, of course, made in all tabular data based thereupon.

SOIL THERMOMETER.

Students of soil physics have long felt the need of improved instruments for the measurement of soil temperatures. The ordinary thermometers, with stems long enough to bring the top of the column of mercury above the ground while the bulb is buried at depths of from a few inches to several feet, are subject to very large and uncertain errors, due to the fact that the stem may be at a different temperature from that of the bulb. The error increases as the stem is lengthened, while the actual changes of soil temperature becomes less and less as we descend. Furthermore, since the long portion of the stem between the bulb and the graduations may have a different sized bore, often larger than the graduated portion, it is difficult to determine the correction to be applied to reduce the reading to a true temperature on the assumption that the entire instrument is at the same temperature.

In a mercurial thermometer of the ordinary construction, suitable for getting temperatures 12 inches below the surface, the error referred to may be 0.13° F when the stem is only 10° different from the bulb. If the internal diameter of the ungraduated portion of the stem is only a small amount larger than that of the graduated portions the error is much greater, being in proportion to the squares of the diameters.

Still greater errors arise if the maker is not careful to avoid the formation of accidental enlargements of the bore of the tubes at points of union, which enlargements act as small secondary bulbs, with temperature that may be widely different from that of the true bulb. For the best results the ungraduated portion of the stem above the bulb should be made of much finer bore than the graduated portion. This construction is not feasible in the ordinary mercurial thermometer, as the graduated portion must be very fine unless very large bulbs are used. A soil thermometer which will register the maximum and minimum temperatures also possesses several advantages, and an effort was made during the past year to construct a desirable form of thermometer for the use of Prof. Whitney in his studies of soil physics. A special form of the old Six maximum and minimum thermometer, with the stem prolonged to carry the bulb to the desired depth, had already been tried by Prof. Whitney, but in his instrument the exposed column was exceptionally long and led to a very large error, which was still greater owing to the high coefficient of expansion of the alcohol with which the bulb and stem were filled. It is apparent from these remarks that ordinary instruments are subject to large error. In the instrument constructed, in addition to the small constriction and spherical portion at the bottom, the bulb is fused to the stem in such a manner that a slender prolongation of the latter extends quite through and well into the spherical bottom portion. The top portion of the thermometer stem differs in no essential respect from the stem of the ordinary thermometer. The bulb is almost wholly filled with alcohol, which acts as the principal thermometric fluid, and presents the advantage of its high coefficient of expansion. The remainder of the bulb and the stem of the thermometer, up to a point convenient for graduation, is filled with mercury. The mercury is retained about the point just above the small sphere, and prevents the entrance of alcohol into the stem when the thermometer is horizontal. In order to register the maximum and minimum temperatures, a short column of alcohol is placed in the upper portion of the stem above the mercury, and within this are arranged two small steel indices, so constructed that they will not slide in the tube of their own weight, but are easily pushed upward by the mercury column, or pulled downward by the top meniscus of the alcohol column. The indices are set by the aid of a small magnet, the one being drawn down upon the top of the mercurial column and the other raised up against the meniscus of the alcohol. The rise of the mercury carries its index upward, leaving it to register the highest point reached, while the alcohol meniscus withdraws the other index and leaves it at a point representing the minimum temperature. It only remains to add that the graduations are fixed in the usual way, having reference only to the positions of the summit of the *mercurial* column. Beyond the highest point supposed to be reached by the mercury, say about 120 degrees, the graduations are extended in an arbitrary manner. The scale numbers represent temperatures by mercurial column, and are continued in regular sequence beyond the 120° point. On this plan the readings for minimum temperatures are on a purely arbitrary scale, and are converted into true degrees of temperature by use of a table prepared for each thermometer, which table embodies as well all the corrections for instrumental error. The use of mercury in the stem of the thermometer not only admits of the use of the index for registering the maximum temperature, but possesses the additional advantage of reducing the error due to uncertain temperature of the stem to about one-sixth what it would be if alcohol were used. Moreover, if necessary, as in the case with thermometers for greater depths than that figured, the ungraduated portions of the stem can be made of very much finer bore than the graduated portion, the effect of which is to diminish the objectionable error to a comparatively unimportant quantity.

SUBURBAN FIRST-ORDER STATIONS.

A matter of considerable popular interest investigated during the year was the proposed establishment of a number of suburban meteorological stations around large cities with a view to getting at truer records. It appears, however, that, with the shelters now in use and considering the various corrections applied, the readings are substantially the same. The question was submitted to observers at a number of selected stations, and lengthy and valuable reports made thereon. It has long been established in meteorology that the average temperatures observed in large cities are higher than those observed in the country near by. The diurnal and annual maximum and minimum temperatures show a larger range in the country than in the city. If data especially applicable to agriculture and forestry are desired, naturally the observing stations should be located in woods and fields. But, on the other hand, if we are to study rainfall and temperature in their relation to the welfare of cities, the reverse holds. Furthermore, the most important service performed at present by this Bureau is the prediction of coming changes of weather. While, therefore, we are extremely desirous of obtaining data bearing directly upon agricultural matters, it has not been practicable as yet to curtail, in anyway, the work of the present stations. As for the work to be accomplished at agricultural institutions and experiment stations, Bulletin No. 10, issued by the Office of Experiment Stations in March, 1892, treats at some length. The paper is of service in indicating the scope and methods best adapted for successfully investigating the relations of climate to agriculture. Such problems, for example, are the distribution of temperatures within such heights in the air and depths in the soil as are occupied by animal and plant life; the changes of temperature with the hour of the day, with the season, with the weather, and with the topography; the problems of air drainage; the occurrence of frosts and protection from them; the distribution of moisture; the problems of condensation and evaporation of water in the air; the solar and terrestial radiations and the disposition of them; the action of the meteorological elements on organic life and the reactions of life on them; the actions and reactions of weather, climate, and soil; the precipitation of the moisture of the air and the final disposition of it. Special observations very much desired are the amount of sunshine, the temperature of the soil, the evaporating power of the atmosphere, the chemical effects of sunshine, and other matters of particular value in studying the relation of climate to crops.

GENERAL REMARKS.

The successful prosecution of the work of this Bureau requires not only the systematic arrangement of its climatological data, but the thorough discussion of this material. The discussion is being performed under the supervision of Lieut. B. M. Purssell, and is provided for by a special appropriation. The particular topic at present under investigation is the rainfall of the entire country. We hope that some of the more prominent results will soon be in such condition that practical use may be made of them.

Another matter of great importance in the work of this Bureau is the determination of the best methods for distributing widely and intelligently the forecasts. This matter has received special attention during the past year, and we feel that the facts in the case warrant the statement that our success has been limited only by the appropriation. This is an expenditure where the money is directly used to benefit the people. None of this goes in any way for the support of the Bureau or its employés, but is returned directly in giving warning of impending changes.

A third subject is that of improvement in the character of the forecasts themselves. This, of course, necessitates the most careful study of general meteorology itself and the application of our knowledge to the special problems of forecasting. This is largely a matter calling for special scientific research, and of the scientific force of the Bureau one member is now devoting his entire time to the fundamental physical laws underlying meteorology and another to the relations between meteorology and general terrestrial phenomena. We must also have now in meteorology observations of the conditions prevailing in the upper air strata. The policy of the Bureau has looked, therefore, to the reëstablishment of the high-level stations, and the station at Pikes Peak has been reopened. And yet all the requirements of modern meteorology can not be fully met by mountain stations. We require a certain number of observations made in free air, and for this purpose balloons seem to be the only means at present available. Advantage has been taken of one or two balloon ascensions to make observations of the humidity and temperature, but nothing calling for marked comment has yet been obtained from these observations. With a proper outfit, which need not necessarily be very expensive, doubtless much could be ascertained.

In conclusion, therefore I feel called upon, to recommend that for the coming year the climatological work be continued under a special appropriation, and that the attention of Congress be called to the pressing need of our being enabled to distribute in adequate and speedy manner our forecasts to agricultural communities not now easily reached; and, finally, that an effort be made to extend our knowledge of atmospheric conditions by observations made at high elevations in the air, either by balloons or otherwise.

WEATHER CONDITIONS OF THE CROP OF 1892.

(Prepared by H. H. C. DUNWOODY, *Major, Signal Corps.*)

As has been stated in previous reports, the Weather Crop Bulletin forms a most important feature of State weather service work. Besides the National Weather Crop Bulletin all States and Territories, except Idaho and Nevada, issue local bulletins during the season of planting, cultivation, and harvesting of crops. The character of these bulletins has been much improved, more attention having been given summarizing and discussing the reports and treating the general crop and weather conditions in editorial form. The circulation of these bulletins, both State and national, has vastly increased during the year, and while the actual number of copies has been largely in excess of the issues of former years this increase represents in a comparatively small degree the enormous extent which the circulation of the weather crop bulletins has attained through the press of the country. In order that the bulletins might be given the widest circulation possible, after a careful consideration of the matter, it was decided to change the day of issue of the bulletin from Saturday to Tuesday. The change in the day of issue of the bulletin, which went into effect June 8 of the current year, has resulted in its publication in a much larger number of newspapers than formerly, as a large majority of the weekly papers of the country are published during the latter part of the week, and these did not heretofore extensively publish the bulletin for the reason that it did not reach them until the information contained in the bulletin was too old to be of sufficient interest to justify publication. Expressions from the directors of the various State weather services who were requested to inquire into and report upon the advantages or disadvantages of the change in the day of issue show that the object had in view, *i. e.*, increased circulation, has been fully realized. Such has been the demand for the National Bulletin that the edition has been more than doubled, and there is a constantly increasing demand. The text of the National Bulletin is telegraphed by the press associations and is reproduced either in its entirety or in part in a very large number of newspapers throughout the country. Special maps showing the temperature and rainfall conditions covering biweekly periods have been prepared and reproduced by photolithographic process in reduced size in the columns of several agricultural journals. As illustrating the extent of the circulation of these special charts, through reproduction in the columns of the various papers, it may be stated that through the regular Eastern and Western editions of the Farm and Home (published at Springfield, Mass., and Chicago, Ill.) are printed more than a quarter of a million copies of the special chart similar to that issued with the National Weather Crop Bulletin. These special biweekly charts are accompanied by brief notes on the temperature and rainfall conditions during each period covered by the charts.

The plan inaugurated last year of publishing a summary of the Weather Crop Bulletins, giving the more important meteorological elements, presented in such form as to enable those interested in agriculture to compare the weather conditions which prevailed during the growth of the crop with the actual yield of the several crops, is continued and is here re-presented in graphic form.

Plate I exhibits the seasonal conditions of rainfall from March 1 to October 3, 1892, throughout the United States. From this chart it will be seen that excessive rains occurred in the central portion of the cotton region, including the central portions of Alabama and Mississippi and the greater portions of Arkansas and Tennessee, thus giving the central portion of the cotton region a large excess of seasonal rainfall, while the east and west portions of the cotton region received much less rain than the usual amount.

A second area of excessive rainfall extends from New England westward over the lake region to the Dakotas, the greatest excess being in Upper Mississippi Valley, including the greater portions of Iowa, Minnesota, Wisconsin, and Illinois. From the chart it will be seen that the entire spring wheat region and the northern portion of the winter wheat belt received more than the usual amount of rain, while the greater portion of the winter wheat belt received slightly less than the normal rainfall.

The rainfall was below the normal in the Rocky Mountain region, while in the agricultural districts of the Pacific coast there were but slight variations from the normal rainfall.

Examination of the tabular statement accompanying this report will enable one to determine the exact period of the occurrence of the excessive precipitation shown within the shaded areas, and indicated by the light lines on the chart, and also the period of drought, or deficiency in precipitation, indicated by the light lines on the unshaded portions of the chart.

Comparing this chart with that for the previous year, it will be seen that there has been a deficiency in rainfall over the east and west portions of the cotton region during the two years, while in the central portion of this region the deficiency of last year has been replaced by a large excess. In the Ohio Valley both years show a slight deficiency, while in the lake region and Upper Mississippi Valley the deficiency of the last year has been replaced by well-marked excesses. During the year 1891 Kansas and Nebraska received more than the usual amount of rain, while in 1892 the rainfall was slightly below the average in these States, except in northern Nebraska, where the rainfall was heavy.

Plate II defines the regions where the temperature was in excess or deficient as compared with the average of previous years. From this chart it will be seen that over the greater portion of all agricultural districts the season was cooler than usual, the greatest deficiency of temperature being over the central portion of the cotton region and in southern California, where the temperature for the season averaged 2 degrees per day below the normal from March 1 to October 3. Over the wheat and corn States the temperature averaged about 1 degree below the normal, while the only portion of the country where an excess of temperature prevailed is that extending from northern New England westward to northern Minnesota.

Comparing this chart with a similar chart for 1891, it will be seen that both years are almost identical, except on the Pacific coast, where the excess of last year has been replaced by a deficiency.

Plates III and IV show the conditions of temperature and rainfall, by weeks, at selected stations, so distributed as to give the approximate conditions of the Missouri Valley, the east and west portions of the cotton region, the central Mississippi Valley, and South Dakota. These diagrams will serve as a type to indicate the general weather conditions from week to week for the localities represented, and from the tabular statement similar diagrams may be constructed for each station named in the table. For example, take the diagram for Springfield, Ill., the same station selected for illustration in the previous report. The heavy horizontal line, marked 0, indicating the normal conditions of rainfall and temperature, and the figures to the left indicating degrees when referring to temperature, and tenths of an inch when referring to rainfall. The full black line refers to temperature and the dotted line to rainfall. It will be seen that, by comparing with the diagram of the previous year, the early spring months of last year were moist and cool, while May and the latter part of April of that year were warmer and received less than the usual amount of rain. During the current year, however, the entire spring was relatively cool and moist. In both years the month of June was warm and dry, and the month of July was moist and cool, the curves showing excess of rain and deficiency of temperature. In August, during the current season, the normal conditions prevailed, and there was an excess of rainfall in the first half of September, while during the season of 1891 there was an excess of rainfall in August, and September was dry and warm.

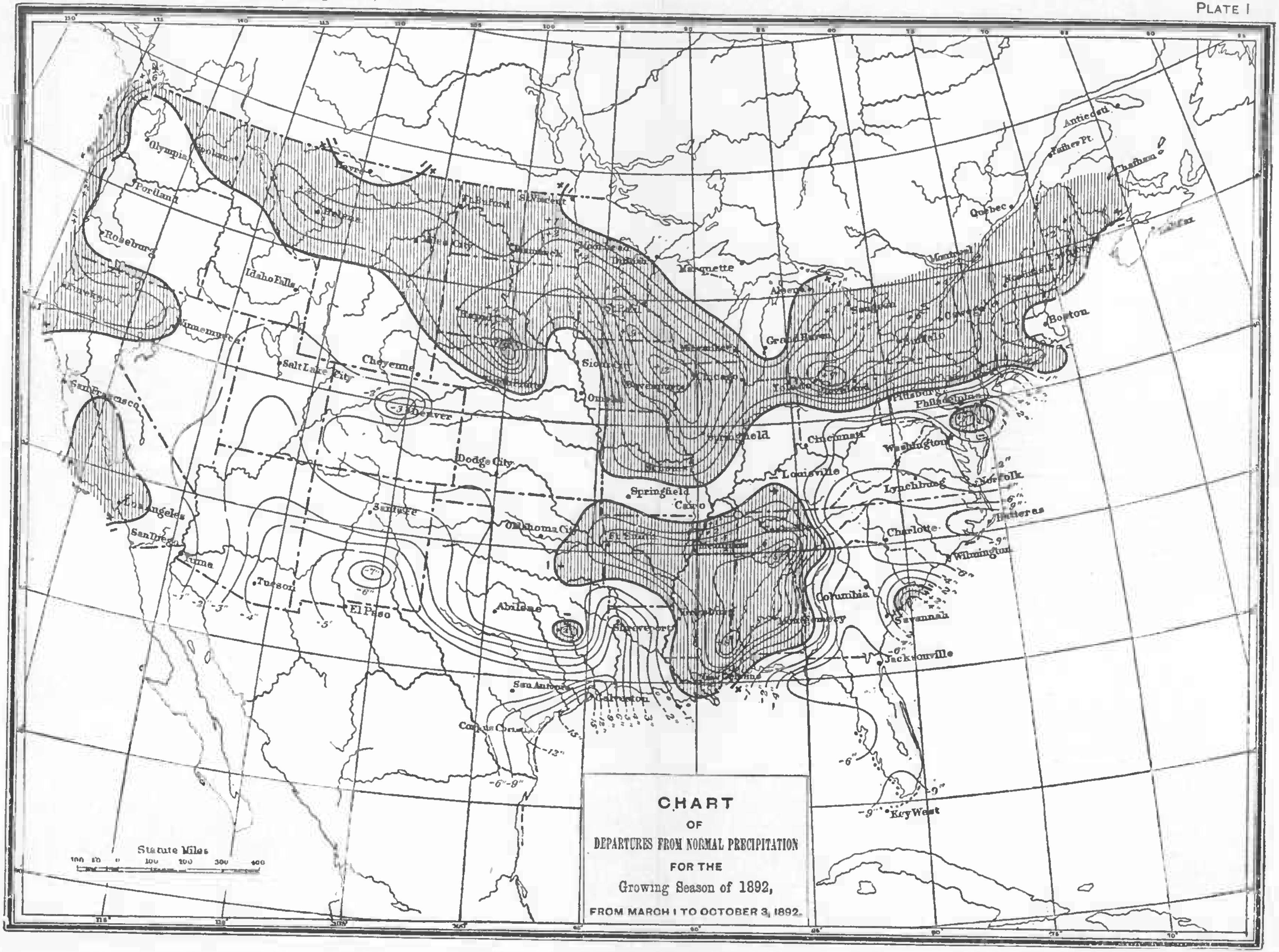


CHART
OF
DEPARTURES FROM NORMAL PRECIPITATION
FOR THE
Growing Season of 1892,
FROM MARCH 1 TO OCTOBER 3, 1892.
Statute Miles
100 50 0 100 200 300 400
Olympia
Portland
Roseburg
Havre
Helena
Ft. Buford
St. Vincent
Idaho Falls
Winnemucca
Salt Lake City
Cheyenne
Denver
San Francisco
Los Angeles
San Diego
Yuma
Tucson
El Paso
Santa Fe
Dodge City
Oklahoma City
Abilene
San Antonio
Galveston
Corpus Christi
Shreveport
Vicksburg
Springfield
Cairo
Louisville
Cincinnati
Washington
Philadelphia
Pittsburg
Cleveland
Grand Haven
Marquette
Duluth
Sioux City
Omaha
Chicago
Springfield
Lynchburg
Norfolk
Hatteras
Charlotte
Wilmington
Columbia
Savannah
Montgomery
Jacksonville
Key West
Boston
Oswego
Buffalo
Montreal
Quebec
Father Pt.
Anticosti
Chatham
Marquette
Memphis

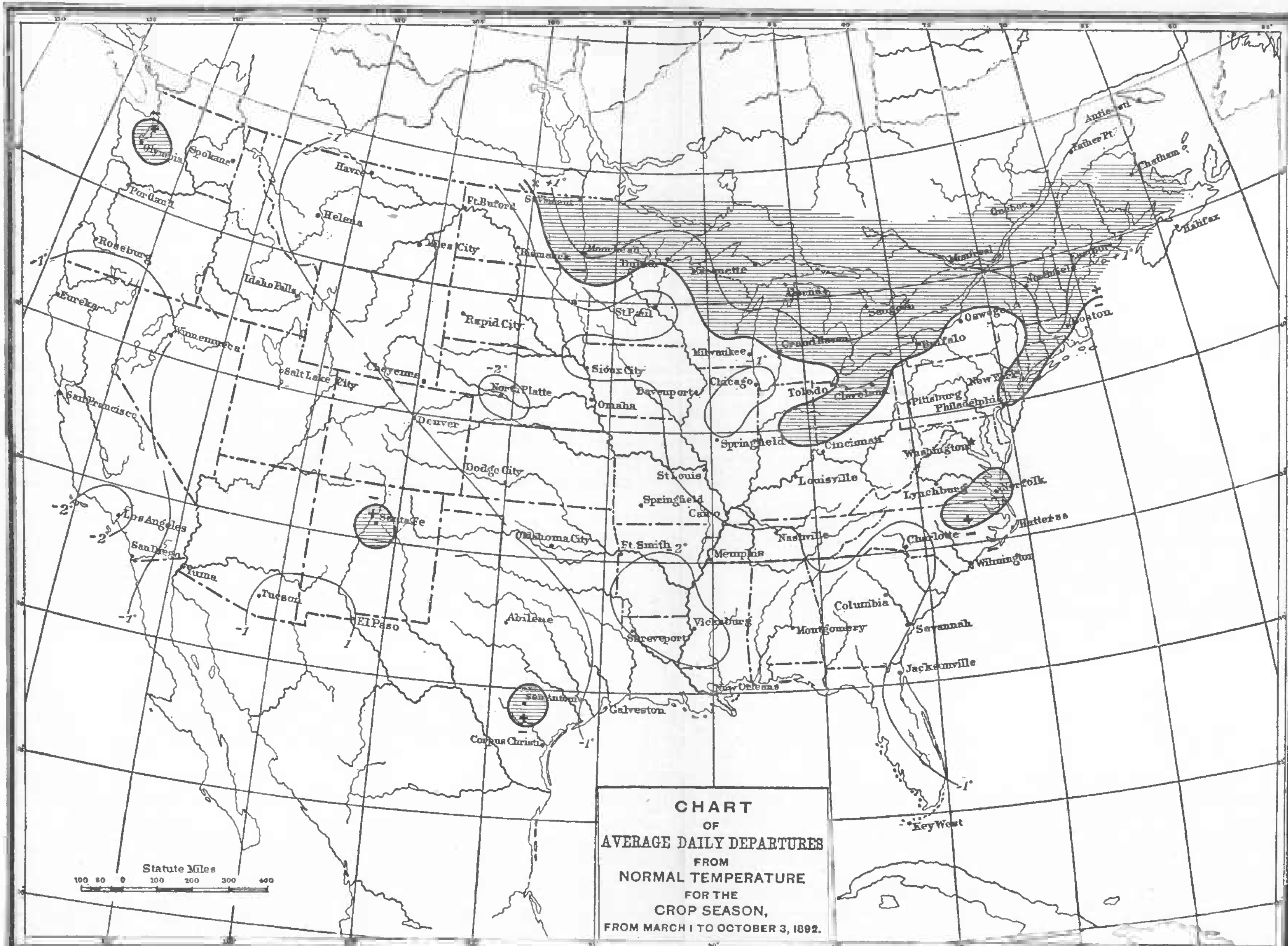
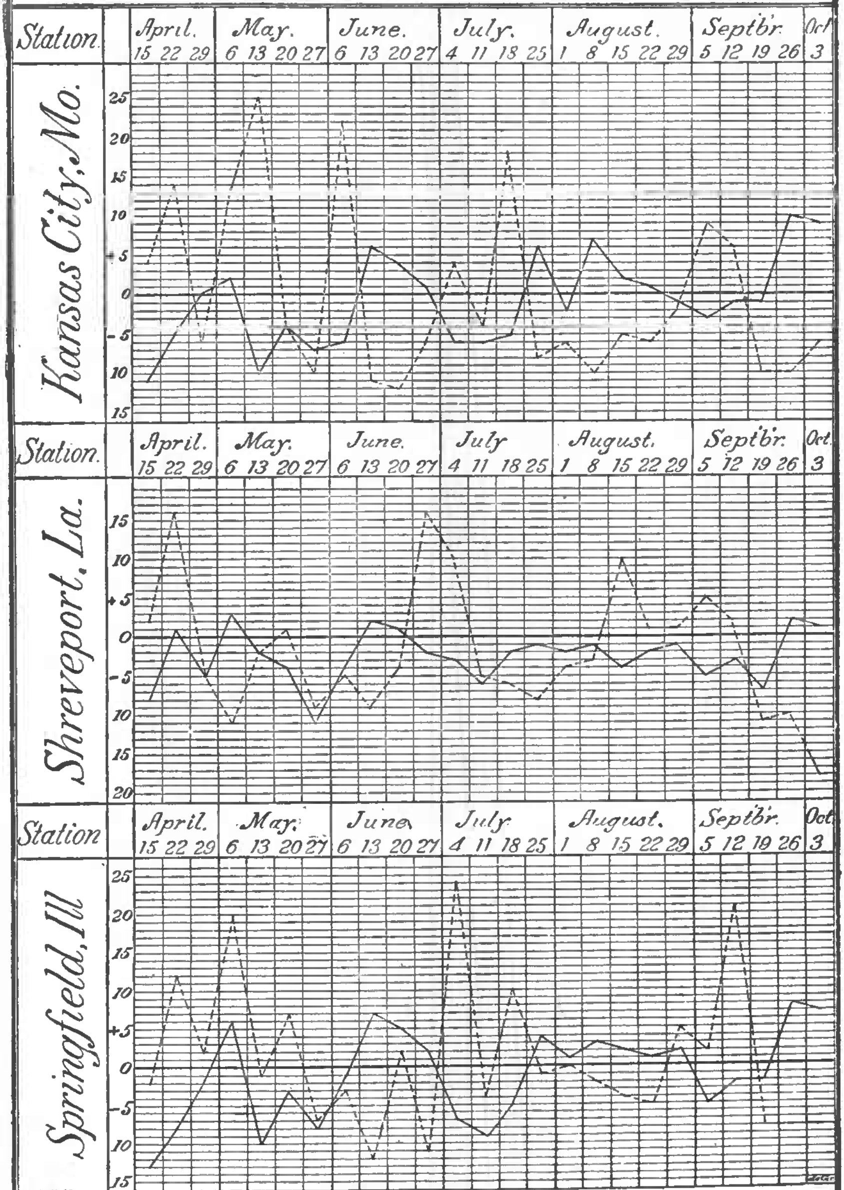
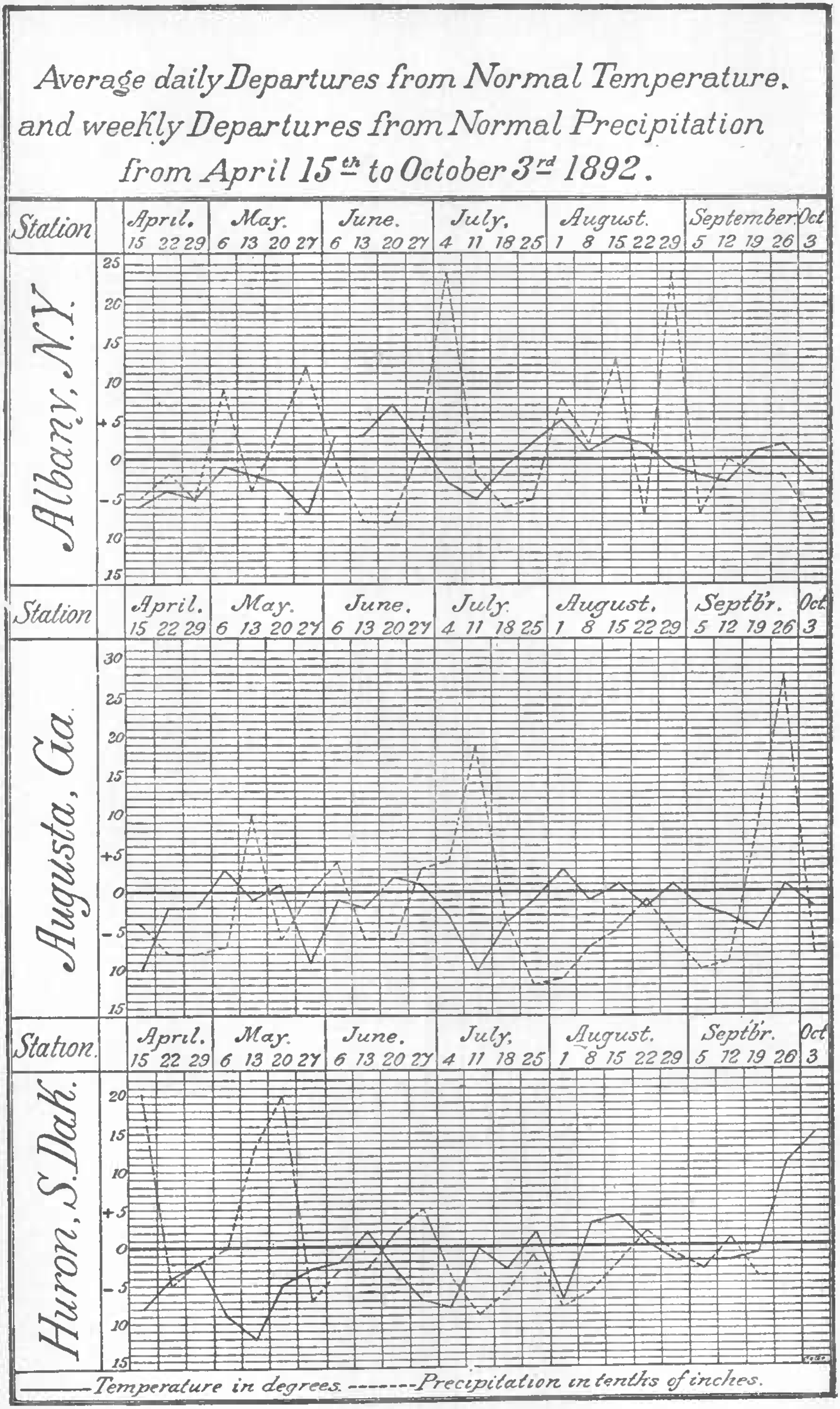


CHART
OF
AVERAGE DAILY DEPARTURES
FROM
NORMAL TEMPERATURE
FOR THE
CROP SEASON,
FROM MARCH 1 TO OCTOBER 3, 1892.

Average daily Departures from Normal Temperature, and weekly Departures from Normal Precipitation, from April 15th to October 3rd 1892.



——— Temperature in degrees. - - - - - Precipitation in tenths of inches.


Average daily Departures from Normal Temperature,
and weekly Departures from Normal Precipitation
from April 15th to October 3rd 1892.
Station
April. May. June. July. August. September. Oct
15 22 29 6 13 20 27 6 13 20 27 4 11 18 25 1 8 15 22 29 5 12 19 26 3
Albany, N.Y.
25 20 15 10 +5 0 -5 10 15
Station
April. May. June. July. August. Septb'r. Oct
15 22 29 6 13 20 27 6 13 20 27 4 11 18 25 1 8 15 22 29 5 12 19 26 3
Augusta, Ga.
30 25 20 15 10 +5 0 -5 10 15
Station.
April. May. June. July. August. Septb'r. Oct
15 22 29 6 13 20 27 6 13 20 27 4 11 18 25 1 8 15 22 29 5 12 19 26 3
Huron, S. Dak.
20 15 10 +5 0 -5 10 15
——— Temperature in degrees. - - - - - - - Precipitation in tenths of inches.

The presentation of meteorological data in this form, when compared with the actual yield of crops in the locality, can not fail to give indications of the effect of weather upon the staple crops, and with additional years the comparison will become more accurate and therefore more valuable. In the tabular statement will be found the departures from the normal of both temperature and rainfall for each week for the season of 1892. The first column in each table contains the conditions as compared with the normals from January 1 to April 8, the date of the issue of the first weekly bulletin; the remaining columns give the departures for each successive week for the remainder of the season. The tables thus present the seasonal conditions for all agricultural districts of the country, and diagrams similar to those given may be readily constructed for any locality.

TABLE I.—*Temperature departures for the season of 1892 from the normal of many years.*

Stations.	From Jan. 1 to Apr. 8, inclusive.	For the weeks ending— April 15.	April 22.	April 29.	May 6.	May 13.	May 20.	May 27.	June *6.	June 13.	June 20.	June 27.
New England:												
Eastport, Me	+2.8	0	+1	+1	0	0	+1	−1	+2	+4	+2	−5
Portland, Me	+1.8	−2	+1	−2	−2	−1	−1	−5	+4	+3	+3	−5
Boston, Mass	+1.6	−2	+1	−1	+1	−3	−1	−2	+7	+3	+6	0
Middle Atlantic States:												
Albany, N. Y	−0.2	−6	−4	−5	−1	−2	−3	−7	+3	+3	+7	+2
New York City, N. Y	+0.4	−6	−3	−1	+3	0	−1	−4	+4	+2	+4	+4
Philadelphia, Pa	−0.2	−7	−4	−2	+5	−2	0	−6	+3	0	+5	+3
Washington, D. C	−0.1	−10	−8	−3	+9	−3	+2	−7	+4	+1	+7	+6
Lynchburg, Va	+0.7	−10	−8	−3	+9	−3	+4	−8	+1	0	+5	+4
Norfolk, Va	−0.5	−8	−2	−4	+7	−1	+5	−5	+3	0	+4	+6
South Atlantic States:												
Charlotte, N. C	−1.5	−10	−8	−3	+6	−1	+3	−9	0	−2	+3	+2
Wilmington, N. C	−2.0	−8	−2	−3	+3	−2	+3	−4	−1	−2	0	+2
Charleston, S. C	−1.0	−6	−1	−1	+1	−1	+2	−5	−2	−2	−1	+1
Augusta, Ga	−2.3	−10	−2	−2	+3	−1	+1	−9	−1	−2	+2	+1
Savannah, Ga	−1.9	−8	0	−2	+1	−1	+1	−5	−1	−2	0	0
Jacksonville, Fla	−1.3	−6	+3	−1	+2	+2	+2	−5	−2	−2	−1	−1
Gulf States:												
Atlanta, Ga	−2.4	−12	−3	−3	+6	0	+2	−9	+1	0	+3	+2
Mobile, Ala	−1.7	−8	−1	−3	+1	0	+1	−10	0	+1	−1	−1
Montgomery, Ala	−1.3	−8	+3	−1	+4	+2	+2	−10	0	0	+2	0
Vicksburg, Miss	−1.7	−8	+3	−3	+4	0	0	−11	−2	+2	−1	−2
New Orleans, La	−1.8	−5	0	−3	+2	0	0	−8	−1	0	−2	0
Shreveport, La	−1.4	−8	+1	−5	+3	−2	−4	−11	−4	+2	+1	−2
Fort Smith, Ark	−0.5	−10	+3	−2	+7	−5	−4	−9	−5	+3	+3	+2
Little Rock, Ark	−1.3	−10	+2	−1	+6	−4	−5	−9	−5	+3	+2	0
Galveston, Tex	−1.7	−2	0	−1	+2	0	+2	−7	−2	−1	−2	−2
San Antonio, Tex	−0.6	+3	+5	+4	+10	+3	+3	−3	0	+2	+3	+2
Ohio Valley and Tennessee:												
Memphis, Tenn	+0.1	−12	+3	0	+8	−3	−1	−9	−4	+3	+2	+1
Nashville, Tenn	−1.0	−12	+1	0	+8	−1	−1	−10	0	+3	+4	+3
Chattanooga, Tenn	−1.2	−11	0	−1	+6	0	+1	−8	0	+2	+3	+3
Louisville, Ky	−0.4	−13	−4	−2	+8	−6	−2	−8	+2	+4	+6	+3
Indianapolis, Ind	+0.3	−12	−5	−2	+8	−9	−3	−10	+3	+5	+6	+2
Cincinnati, Ohio	−1.8	−12	−4	−2	+9	−7	−2	−10	+2	+3	+6	+3
Columbus, Ohio	−0.1	−12	−5	−3	+9	−4	0	−9	+4	+6	+8	+2
Pittsburg, Pa	−0.2	−12	−4	−1	+8	−6	+1	−10	+4	+3	+8	+2
Lake Region:												
Oswego, N. Y	0.0	−6	−3	−5	−1	−5	0	−8	+4	+4	+4	−1
Buffalo, N. Y	+1.3	−7	−1	−5	0	−4	+2	−8	+4	+4	+5	+1
Cleveland, Ohio	+0.9	−8	−2	−3	+5	−5	+2	−7	+4	+6	+7	+2
Detroit, Mich	−0.8	−11	−4	−5	+1	−8	−1	−5	+3	+5	+6	+1
Alpena, Mich	+3.0	−3	−1	−2	−1	−2	+3	−1	+2	+6	+1	0
Grand Haven, Mich	+1.2	−10	−3	−4	+1	−6	+1	−6	0	+6	+5	−1
Milwaukee, Wis	+1.0	−8	−3	−3	+1	−7	−3	−3	−5	+5	+1	−2
Chicago, Ill	−1.5	−10	−4	−2	+4	−9	−3	−7	−6	+5	+2	−3
Duluth, Minn	+1.2	−7	−1	−6	−6	−7	−3	−1	−2	−2	−2	+1
Upper Mississippi Valley:												
St. Paul, Minn	+1.5	−8	−4	−7	−7	−10	−5	−3	−4	+5	−5	−4
Lacrosse, Wis	+2.6	−8	−5	−5	−5	−8	−4	−3	−3	+6	0	−4
Davenport, Iowa	+1.2	−10	−5	−3	+2	−9	−5	−6	−4	+5	+3	0
Des Moines, Iowa	+1.8	−10	−7	−3	−1	−12	−6	−6	−6	+4	+2	−3

* The departures in the column for June 6 are for ten days, due to change of day of issue of Bulletin from Saturday to Tuesday.

TABLE I.—*Temperature departures for the season of 1892 from the normal of many years*—Continued.

Stations.	From Jan. 1 to Apr. 8, inclusive.	For the weeks ending— April 15.	April 22.	April 29.	May 6.	May 13.	May 20.	May 27.	June *6.	June 13.	June 20.	June 27.
Upper Mississippi Valley—Continued.												
Springfield, Ill	−0.9	−13	− 8	− 2	+ 6	−10	−3	− 8	−1	+ 7	+5	+ 2
Cairo, Ill	+0.1	−12	− 1	0	+ 8	− 4	−2	− 8	−1	+ 5	+5	+ 3
St. Louis, Mo	0.0	−13	− 6	− 1	+ 6	− 9	−3	− 8	−2	+ 7	+5	+ 4
Missouri Valley:												
Springfield, Mo	−0.6	−12	− 1	− 2	+ 6	− 8	−7	−10	−5	+ 5	+5	+ 1
Kansas City, Mo	+0.1	−11	− 5	0	+ 2	−10	−4	− 7	−6	+ 6	+4	+ 1
Concordia, Kans	+2.0	− 8	− 5	− 1	− 1	−11	−5	− 6	−6	+ 6	+1	+ 1
Omaha, Nebr	+1.4	− 9	− 7	− 1	− 5	−12	−6	− 7	−5	+ 7	+2	− 2
Valentine, Nebr	+1.1	− 6	− 9	+ 1	−10	−16	−6	− 2	−5	+ 3	−2	− 7
Huron, S. Dak	+2.6	− 8	− 4	− 2	− 9	−12	−5	− 3	−2	+ 2	−3	− 7
Extreme Northwest:												
Moorhead, Minn	+5.4	− 3	+ 1	− 4	− 8	− 7	−4	− 3	−2	+ 6	−2	− 7
Bismarck, N. Dak	+2.5	− 6	− 1	− 7	−14	−11	−5	− 2	−7	− 1	−3	−10
Fort Buford, N. Dak	+4.1	− 4	0	− 9	−15	−10	−2	+ 1	−7	− 2	−2	−11
Rocky Mountain Slope:												
Havre, Mont	+6.9	− 2	− 5	−11	−16	− 9	0	+ 4	−5	− 5	0	− 5
Cheyenne, Wyo	−0.1	− 2	− 9	0	− 5	−12	−4	+ 2	−6	− 1	−1	− 2
North Platte, Nebr	−1.7	− 6	− 8	0	− 5	−13	−3	− 1	−7	+ 2	−2	− 5
Denver, Colo	−1.5	0	−10	+ 1	− 1	−12	−5	+ 1	−6	− 2	−2	+ 1
Dodge City, Kans	0.0	− 4	− 5	0	0	−11	−5	− 4	−6	+ 5	−1	0
Pacific Coast:												
Olympia, Wash	+2.0	− 2	− 1	− 3	− 1	− 1	+2	+ 5	−4	− 2	+1	+ 5
Portland, Oregon	+1.3	− 3	− 3	− 6	− 3	− 3	+2	+ 4	−5	− 5	0	+ 5
Roseburg, Oregon	+1.2	− 4	− 3	− 5	− 5	− 4	+5	+ 5	−4	− 6	+1	+ 3
Red Bluff, Cal	+1.5	− 4	− 6	− 9	−14	−10	0	+ 6	+1	−11	+1	+ 1
Sacramento, Cal	+1.1	− 3	− 4	− 6	− 9	− 7	+2	+ 2	+4	− 8	+1	0
San Francisco, Cal	+0.5	− 3	− 2	− 5	− 4	− 3	+7	− 1	−1	− 5	−4	− 1
Los Angeles, Cal	+0.4	+ 2	− 3	− 3	− 7	− 5	+6	− 1	0	− 7	−7	− 6
San Diego, Cal	0.0	+ 1	− 3	− 2	− 3	− 3	+3	0	0	− 4	−4	− 4

* The departures in the column for June 6 are for ten days, due to change of day of issue of Bulletin from Saturday to Tuesday.

Stations.	For the weeks ending— July 4.	July 11.	July 18.	July 25.	August 1.	August 8.	August 15.	August 22.	August 29.	September 5.	September 12.	September 19.	September 26.	October 3.
New England:														
Eastport, Me	−1	+ 2	+1	+ 2	+3	0	0	+5	0	+1	0	+4	+ 3	− 2
Portland, Me	−2	+ 3	+2	+ 1	+4	+2	+4	+4	−3	−2	−2	+4	+ 5	− 1
Boston, Mass	−2	− 4	+2	+ 5	+4	+1	+6	+4	−2	−3	−5	+4	+ 4	− 1
Middle Atlantic States:														
Albany, N. Y	−3	− 5	−1	+ 2	+5	+1	+3	+2	−1	−2	−3	+1	+ 2	− 2
New York, N. Y	−1	− 3	0	+ 2	+6	+1	+4	+5	−2	−2	−3	+2	+ 2	0
Philadelphia, Pa	−3	− 4	−1	+ 2	+6	+1	+4	+3	+1	−3	−3	0	+ 4	− 2
Washington, D. C	−2	− 7	−6	0	+7	+1	+4	+3	+3	−2	−4	−1	+ 3	− 2
Lynchburg, Va	−6	−11	−2	+ 3	+7	+2	+3	+3	+3	−1	−2	−3	+ 1	− 2
Norfolk, Va	−3	−10	−6	0	+7	+3	+4	+3	+3	0	−2	0	+ 3	− 2
South Atlantic States:														
Charlotte, N. C	−5	−14	−3	+ 2	+4	0	0	+1	+3	0	−2	−2	+ 3	− 2
Wilmington, N. C	−3	− 9	−3	0	+4	+2	+3	0	+2	−1	−3	0	+ 4	− 2
Charleston, S. C	−4	− 8	−3	0	+3	+1	+2	0	+1	+1	−2	−1	+ 1	− 1
Augusta, Ga	−3	−10	−4	− 1	+3	−1	+1	−2	+1	−2	−3	−5	+ 1	− 2
Savannah, Ga	−4	− 7	−3	− 2	+2	−1	+1	0	+4	0	−2	0	+ 2	− 1
Jacksonville, Fla	−4	− 3	−1	− 1	+2	−2	0	−1	+1	0	−2	−1	+ 1	− 1
Gulf States:														
Atlanta, Ga	−4	−12	−4	0	+4	+1	+1	−3	+1	−1	−1	−5	+ 4	+ 1
Mobile, Ala	−1	− 6	−3	− 2	−1	−2	−1	−2	+2	−1	−1	−5	+ 1	+ 1
Montgomery, Ala	−1	− 9	−4	0	0	−1	0	−2	+2	0	−2	−5	+ 2	− 1
Vicksburg, Miss	−3	− 7	−5	− 1	−3	−1	−2	−1	−1	−4	−3	−6	+ 3	+ 1
New Orleans, La	0	− 8	−2	0	−1	−1	0	0	+2	0	−3	−4	+ 2	− 1
Shreveport, La	−3	− 6	−2	− 1	−2	−1	−4	−2	−1	−5	−3	−7	+ 2	+ 1
Fort Smith, Ark	−3	− 6	0	− 3	0	+3	0	+1	−1	−5	−4	−3	+ 5	+ 3
Little Rock, Ark	−3	− 8	−2	+ 2	−1	+1	−2	0	−2	−5	−4	−4	+ 4	+ 1
Galveston, Tex	−2	− 6	−3	− 1	−1	−2	−1	0	+3	+1	−1	−3	+ 3	+ 1
San Antonio, Tex	+3	− 2	+1	+ 1	+1	−4	−2	−2	+2	+1	−2	−2	+ 4	+ 5
Ohio Valley and Tennessee:														
Memphis, Tenn	−4	− 9	−3	+ 3	0	+2	−2	+1	+1	−3	−2	−3	+ 6	+ 1
Nashville, Tenn	−4	− 8	−3	+ 2	+2	−1	0	0	+1	−2	−1	−4	+ 5	+ 1
Chattanooga, Tenn	−2	− 9	+1	+ 2	+4	−1	+1	−3	+1	−2	−1	−4	+ 3	− 1

TABLE I.—*Temperature departures for the season of 1892 from the normal of many years*—Continued.

Stations.	For the weeks ending— July 4.	11.	18.	25.	August 1.	8.	15.	22.	29.	September 5.	12.	19.	26.	October 3.
Ohio Valley and Tennessee—Cont'd.														
Louisville, Ky	−8	−8	−4	+5	+2	+1	+1	+2	+2	−3	+1	−4	+4	+2
Indianapolis, Ind	−7	−5	−4	+6	+4	+1	+2	+4	+3	−2	+2	−2	+9	+6
Cincinnati, Ohio	−7	−5	−5	+4	+4	+1	0	+2	+1	−3	−1	−4	+5	+2
Columbus, Ohio	−7	−6	−6	+3	+5	0	+1	+3	+3	−2	+1	−2	+6	+3
Pittsburg, Pa	−7	−6	−5	+2	+5	0	+2	+3	+2	−3	−1	−1	+5	+1
Lake Region:														
Oswego, N. Y	−5	−4	−3	+2	+5	+1	+3	+3	0	−1	−2	−1	+6	−1
Buffalo, N. Y	−5	0	−2	+3	+6	+2	+3	+3	+2	0	0	−2	+6	0
Cleveland, Ohio	−6	−3	−5	+4	+6	+1	+5	+3	+2	−1	+1	−2	+6	+2
Detroit, Mich	−7	−2	−3	+6	+4	+1	+4	+2	+2	−1	0	−3	+6	+2
Alpena, Mich	−3	0	0	+6	+2	+2	+5	+3	+2	0	0	0	+6	+5
Grand Haven, Mich	−8	−1	−4	+4	+4	+1	+3	+4	+4	−4	0	−1	+7	+6
Milwaukee, Wis	−4	−3	−1	+9	+2	+3	+3	−1	+1	−7	−2	0	+7	+6
Chicago, Ill	−8	−4	−3	+8	0	+1	+2	0	0	−7	−3	−2	+6	+6
Duluth, Minn	−1	+3	−1	+6	+3	+5	+4	+3	+7	−2	−2	+3	+7	+13
Upper Mississippi Valley:														
St. Paul, Minn	−9	0	−2	+6	−2	+3	+2	0	+2	−4	−2	+1	+10	+12
Lacrosse, Wis	−8	−2	−3	+5	0	+3	+4	+3	+2	−3	−2	−2	+9	+10
Davenport, Iowa	−7	−4	−5	+5	+2	+4	+4	+2	+1	−5	−2	−3	+9	+10
Des Moines, Iowa	−7	−4	−2	+6	−1	+3	+2	−2	−1	−3	−2	−3	+11	+12
Springfield, Ill	−7	−9	−5	+4	+1	+3	+2	+1	+2	−5	−2	−2	+8	+7
Cairo, Ill	−4	−8	−4	+3	+1	+1	−1	0	0	−4	−1	−3	+7	+4
St. Louis, Mo	−8	−7	−5	+4	0	−4	+1	+2	+1	−4	−2	−3	+9	+11
Missouri Valley:														
Springfield, Mo	−6	−7	−4	+4	−2	+4	0	+1	−1	−5	−3	−1	+9	+6
Kansas City, Mo	−6	−6	−5	+6	−2	+7	+2	+1	−1	−3	−1	−1	+10	+9
Concordia, Kans	−3	−7	0	+10	−2	+9	+3	−1	−2	−2	−2	−1	+11	+12
Omaha, Nebr	−5	−4	−1	+8	−3	+7	+2	−1	−2	−2	−2	0	+12	+13
Valentine, Nebr	−4	0	−2	+6	−1	+8	+8	0	−2	−1	−1	+3	+8	+14
Huron, S. Dak	−8	0	−3	+2	−7	+3	+4	0	−2	−2	−2	−1	+11	+15
Extreme Northwest:														
Moorhead, Minn	−5	+5	+1	+4	−2	+5	+5	+2	+3	−1	0	−1	+12	+15
Bismarck, N. Dak	−6	+2	−1	+1	−8	+1	+6	−1	−2	−1	−5	+3	+9	+14
Fort Buford, N. Dak	−4	+4	+1	+1	−7	+1	+4	−4	−2	−1	−1	+6	+8	+13
Rocky Mountain Slope:														
Havre, Mont	+2	+1	−1	0	−8	−1	+1	−5	−1	−2	+1	+7	+5	+14
Cheyenne, Wyo	−2	−2	−2	+5	−4	+5	+4	−2	−3	+1	−2	+7	+8	+10
North Platte, Nebr	−5	−4	−2	+6	−3	+4	+4	−1	−2	−2	−3	+2	+7	+11
Denver, Colo	0	−1	−1	+4	−6	+5	+5	0	−2	+1	−2	+5	+7	+12
Dodge City, Kans	−3	−7	0	+6	−3	+7	+2	−1	−3	−4	−2	+1	+9	+9
Pacific Coast:														
Olympia, Wash	+3	−3	−2	−3	+3	+2	+1	+3	+1	−1	+5	....	+1	+7
Portland, Oregon	+3	−4	−4	−7	+1	0	0	+4	+1	−3	+8	−1	−2	+6
Roseburg, Oregon	+2	−2	−4	−4	0	−3	0	+1	0	−3	+6	0	0	+8
Red Bluff, Cal	+4	−2	−4	−1	−4	−3	−7	+5	+2	−4	+4	−5	−1	+3
Sacramento, Cal	+4	−3	−3	−1	−2	+1	−3	+4	−2	−4	0	−5	0	+2
San Francisco, Cal	+1	−3	−3	−2	−4	−2	+1	+2	−4	−2	+3	−2	0	+1
Los Angeles, Cal	0	−2	−5	−4	−3	−4	−4	+2	−3	−5	−3	−2	+2	+3
San Diego, Cal	−3	−1	−4	−3	−3	−2	−4	0	−1	−3	−2	−4	0	0

TABLE II.—*Precipitation departures for the season of 1892 from the normal of many years.*

Stations.	From Jan. 1 to Apr. 8.	For the weeks ending— April 15.	22.	29.	May 6.	13.	20.	27.	June 6.*	13.	20.	27.
New England:												
Eastport, Me	−2.93	−.33	−.54	−.02	−.73	−.80	−.83	+.24	−.50	−.45	+.87	−.26
Portland, Me	−2.81	−.41	−.37	−.28	−.40	+.15	+.20	+1.34	−.68	−.65	+.34	+1.72
Boston, Mass	−2.63	−.83	−.33	−.43	+.05	−.22	+.94	+1.18	−.82	−.46	+.08	+.49
Middle Atlantic States:												
Albany, N. Y	−1.27	−.50	−.23	−.53	+.94	−.35	+.44	+1.19	−.09	−.84	−.76	+.13
New York, N. Y	−1.35	+.33	+.18	−.48	−.31	+.14	+.54	+1.03	−.60	+.12	−.16	−.01
Philadelphia, Pa	−.84	−.16	+.34	−.16	+.27	00	+1.22	+.93	−.70	−.56	−.77	−.09
Washington, D. C	+3.49	+.27	+1.93	−.05	−.72	−.27	+.17	+1.44	−1.34	−.73	−.73	+.31
Lynchburg, Va	+.70	−.17	+1.38	−.47	−.40	+.24	−.76	−.37	+.39	+.15	−.42	−.38
Norfolk, Va	+2.28	−.60	+1.34	+1.37	−.91	+.06	−.67	+1.45	−1.10	+.95	−.36	−.25

* The departures in the column for June 6 are for ten days, due to change of day of issue of Bulletin from Saturday to Tuesday.

TABLE II.—*Precipitation departures for the season of 1892 from the normal of many years*—Continued.

Stations.	From Jan. 1 to Apr. 8.	For the weeks ending—										
		April			May				June			
		15.	22.	29.	6.	13.	20.	27.	6.*	13.	20.	27.
South Atlantic States:												
Charlotte, N. C	+ .95	— .69	+ .58	— .53	— .80	— .16	— .52	— .74	+ .66	— .74	+1.05	+ .16
Wilmington, N. C	— .88	— .38	— .42	— .55	— .78	— .52	— .93	— .76	— .84	— .70	— .83	— .45
Charleston, S. C	— 4.38	— .72	— .94	— .83	— .68	+ .34	— .55	— .34	+1.65	+ .48	+ .61	+ .41
Augusta, Ga	+ 1.35	— .41	— .83	— .80	— .72	+1.04	— .64	— .04	+ .41	— .63	— .58	+ .29
Savannah, Ga	— 3.51	— .84	— .88	— .77	— .57	+1.11	— .40	— .29	— .23	+ .01	—1.75	— .90
Jacksonville, Fla	— 5.22	— .68	— .74	— .77	— .83	— .34	—1.00	— .96	+ .59	— .71	— .56	+1.17
Gulf States:												
Atlanta, Ga	+ 3.61	— .73	— .72	— .70	— .84	— .43	— .23	— .70	+1.32	— .20	— .67	— .21
Mobile, Ala	+ 2.26	—1.13	+ .24	00	— .96	— .58	— .38	—1.10	—1.19	—1.11	— .47	—1.13
Montgomery, Ala	+14.87	—1.05	—1.21	— .56	— .97	+ .18	— .39	— .60	+ .16	— .77	— .94	+ .70
Vicksburg, Miss	— 1.41	— .17	— .77	+1.38	—1.25	— .95	— .87	—1.08	+ .04	— .70	+ .74	— .83
New Orleans, La	— 8.11	—1.26	+6.51	+1.28	— .90	+ .41	— .33	—1.26	—1.44	— .07	+ .89	—1.35
Shreveport, La	— 3.14	+ .23	+1.65	— .51	—1.11	— .22	+ .11	— .89	— .52	— .87	— .40	+1.63
Fort Smith, Ark	— 1.32	—1.25	— .72	+1.31	— .98	+1.34	+5.20	+ .02	+1.21	—1.04	+1.58	— .94
Little Rock, Ark	— 4.32	— .95	+2.74	— .96	— .99	+ .94	+3.36	—1.05	+1.98	— .64	— .81	— .48
Galveston, Tex	— 5.81	— .70	— .69	+ .11	— .84	— .78	— .81	—1.03	—1.22	—1.19	+ .70	+ .78
San Antonio, Tex	— 2.91	— .81	— .81	— .61	— .77	— .71	— .03	— .71	— .07	— .63	— .60	+2.39
Ohio Valley and Tennessee:												
Memphis, Tenn	— 5.49	+ .01	+2.23	— .88	— .93	+2.93	+ .76	+ .02	+2.64	— .94	— .54	—1.01
Nashville, Tenn	— 4.54	— .93	+1.95	— .10	— .77	+ .39	+1.13	— .67	+2.37	— .75	— .02	— .37
Chattanooga, Tenn	— .76	— .18	+ .25	— .35	— .98	— .38	+ .76	— .28	+1.25	— .93	+ .91	+2.61
Louisville, Ky	— 4.52	— .79	+4.01	— .18	— .14	+ .15	+1.05	— .31	+ .59	— .82	— .23	.60
Indianapolis, Ind	— 1.81	— .38	+ .76	+ .65	+ .32	+ .60	+1.40	— .30	+2.92	— .42	+ .01	— .81
Cincinnati, Ohio	— 3.71	— .38	+2.54	— .27	— .13	+ .42	+1.06	— .64	— .81	— .15	+ .17	— .06
Columbus, Ohio	— 1.71	— .21	— .17	— .78	— .55	— .83	+1.28	— .66	— .55	— .44	+1.79	+ .04
Pittsburg, Pa	— .56	+ .09	— .25	— .50	+ .71	— .34	+ .29	— .02	+ .17	+ .11	+ .07	— .28
Lake Region:												
Oswego, N. Y	— 2.53	— .25	— .19	— .45	+ .95	— .26	+ .20	+ .77	+1.02	- .37	— .71	+2.29
Buffalo, N. Y	+ 1.55	— .40	— .30	— .62	+1.99	— .13	+ .28	+2.20	+ .53	+1.87	— .32	+2.27
Cleveland, Ohio	+ .76	— .25	— .19	— .23	+2.98	+ .26	+ .20	+ .36	+ .50	+ .04	+ .14	+ .42
Detroit, Mich	— .10	— .40	— .22	— .39	+3.13	+ .38	+ .98	— .21	+3.46	— .08	+ .82	+ .14
Alpena, Mich	— 1.96	— .55	— .16	— .49	+ .55	+ .10	— .60	— .28	+ .56	— .80	+1.87	+1.54
Grand Haven, Mich	+ 1.85	— .55	— .31	+ .14	+1.35	+ .40	— .46	— .70	+1.33	— .24	+1.27	— .04
Milwaukee, Wis	— .53	— .19	— .25	— .16	+3.43	+ .78	+ .52	— .77	+ .81	+ .94	+ .84	+ .95
Chicago, Ill	— 1.08	— .21	— .53	— .71	+2.76	— .15	— .08	— .28	+ .10	+ .37	+3.02	+4.35
Duluth, Minn	+ 1.53	— .49	— .55	+1.06	+ .96	— .11	+2.33	— .58	+ 45	+1.13	+ .46	— .81
Upper Mississippi Valley:												
St. Paul, Minn	— .89	— .51	— .57	— .46	+ .24	+ .06	+2.07	— .69	+ .17	+1.26	+1.86	+ .09
Lacrosse, Wis	+ .61	— .17	+ .93	— .26	+1.54	+ .96	+3.00	— .67	— .37	+ .14	+1.11	+2.77
Davenport, Iowa	+ 2.92	— .17	— .18	— .09	+4.31	— .05	+ .16	— .76	+1.21	+1.60	+ .36	+4.75
Des Moines, Iowa	+ 2.42	+ .63	— .06	— .79	+1.90	+ .67	+1.00	—1.16	+ .56	— .56	— .58	— .59
Springfield, Ill	+ 1.56	— .20	+1.20	+ .15	+2.03	— .12	+ .72	— .74	— .33	—1.15	+ .25	—1.08
Cario, Ill	— 4.70	— .11	+1.09	+ .57	— .83	+1.01	+1.84	— .81	+ .43	—1.00	+ .58	— .20
St. Louis, Mo	+ 2.24	+ .04	+1.79	+ .05	— .23	+1.26	+1.50	— .91	+1.02	— .82	+ .30	— .77
Missouri Valley:												
Springfield, Mo	+1.48	+ .51	— .06	— .23	+ .50	+ .83	+ .75	—1.40	+3.23	— .60	—1.14	+ .80
Kansas City, Mo	+6.04	+ .45	+1.42	— .63	+1.34	+2.46	— .37	— .97	+2.25	—1.14	—1.18	— .58
Concordia, Kans	+2.41	— .35	— .24	— .59	+ .20	+1.96	+1.65	— .77	+1.46	— .96	— .03	— .80
Omaha, Nebr	+2.11	+ .86	+ .10	— .45	+ .51	+1.55	+2.61	— .80	—1.16	— .48	—1.38	— .88
Valentine, Nebr	+2.95	+ .94	+ .69	+1.14	+ .04	+1.87	— .25	— .77	— .29	— .42	+2.00	— .26
Huron, S. Dak	+2.61	+2.05	— .46	— .18	+ .04	+1.26	+2.02	— .71	— .32	— .34	+ .16	+ .50
Extreme Northwest:												
Moorhead, Minn	+1.51	— .06	— .49	+ .97	+ .14	— .20	+2.48	— .24	— .53	— .84	— .53	— .21
Bismarck, N. Dak	+ .10	— .31	— .56	+1.30	+ .42	+ .17	— .54	— .53	— .16	+ .71	— .70	— .16
Port Buford, N. Dak	— .68	— .19	— .21	+2.04	— .10	— .14	— .37	— .48	+ .69	+1.06	— .84	— .45
Rocky Mountain Slope:												
Havre, Mont	—1.59	+ .08	— .08	+ .04	+ .30	+ .16	— .28	— .25	— .54	+2.55	— .69	— .41
Cheyenne, Wyo	+1.40	— .26	+ .67	— .36	— .02	+1.66	— .07	— .42	+1.16	— .39	— .02	— .03
North Platte, Nebr	+1.41	+ .55	+1.59	— .19	— .20	+1.17	— .32	— .59	— .03	— .77	— .31	— .65
Denver, Colo	— .01	— .39	+1.10	— .56	— .57	+ .37	— .38	— .51	+ .97	— .31	— .06	— .12
Dodge City, Kans	+1.97	— .26	— .34	— .51	— .52	+ .49	+ .05	— .66	—1.08	— .77	+2.21	— .75
Pacific Coast:												
Olympia, Wash	—11.70	+ .84	— .54	— .87	— .12	+ .39	— .04	— .43	+ .59	— .29	— .10	— .31
Portland, Oregon	—10.11	+ .27	— .21	+1.31	— .45	+ .38	— .08	— .50	— .31	+ .26	— .29	— .24
Roseburg, Oregon	— 5.41	— .42	+ .09	+ .18	+ .51	+ .58	— .19	— .35	— .41	+ .26	— .28	— .28
Red Bluff, Cal	— 1.06	— .20	+ .19	+ .06	+ .96	— .14	+1.34	— .21	— .22	+ .12	— .14	— .09
Sacramento, Cal	— 3.09	— .51	— .09	— .42	+ .59	+ .04	+1.02	— .11	— .10	— .07	— .07	.00
San Francisco, Cal	— 4.34	— .30	— .05	— .05	+ .44	— .06	+1.01	— .12	— .10	— .07	— .07	— .07
Los Angeles, Cal	— 2.19	— .43	— .41	— .28	+1.89	— .08	— .07	— .07	— .08	— .06	.00	+ .06
San Diego, Cal	— .19	— .21	— .21	— .19	+ .93	— .07	— .07	.00	— .08	+ .13	.00	.00

* The departures in the column for June 6 are for ten days, due to change of day of issue of Bulletin from Saturday to Tuesday.

TABLE II.—*Precipitation departures for the season of 1892 from the normal of many years*—Continued.

Stations.	For the weeks ending—								
	July				August				
	4.	11.	18.	25.	1.	8.	15.	22.	29.
New England:									
Eastport, Me	+.43	+.98	−.94	−.83	−.82	+.05	+1.31	−.69	+.88
Portland, Me	+1.07	−.77	−.58	−.80	+.09	+.26	+1.94	−.81	+3.37
Boston, Mass	+.36	−.72	−.52	−.51	+.26	−.50	+1.24	−1.05	+.87
Middle Atlantic States:									
Albany, N. Y	+2.44	−.16	−.65	−.47	+.81	+.22	+1.26	−.70	+2.38
New York, N. Y	+.66	−.47	−1.05	−.54	−.95	−.38	+1.01	−1.05	−.12
Philadelphia, Pa	+1.93	−.96	−.72	−.97	−.56	−.65	−.66	−1.00	+.65
Washington, D. C	+.07	−.86	+.47	+.26	+.52	−.26	−1.00	−.98	−.92
Lynchburg, Va	+1.10	−.08	−.84	+.53	+1.60	−.86	−.57	−.88	−.55
Norfork, Va	+3.39	+.32	+1.15	−1.04	−.40	−.91	−1.47	−1.12	−.94
South Atlantic States:									
Charlotte, N. C	−.30	+2.22	−.30	−1.40	−.05	−.55	−1.26	−1.22	−.49
Wilmington, N. C	+4.60	−.12	+2.14	+.81	−1.58	−1.24	−1.66	−1.72	−.04
Charleston, S. C	+2.87	+3.21	+1.62	−1.16	−1.75	−1.24	−1.22	−1.66	+2.23
Augusta, Ga	+.38	+1.93	−.32	−1.18	−1.12	−.69	−.49	−.07	−.60
Savannah, Ga	+1.11	−.29	+1.78	+.90	−1.28	−.51	+.09	−1.71	−1.30
Jacksonville, Fla	−.46	−.21	−1.45	+.07	−1.35	−.56	−.80	−.88	−.26
Gulf States:									
Atlanta, Ga	−.71	+1.08	+.01	−.77	−.26	−.22	−.99	+.58	+2.39
Mobile, Ala	−1.16	+4.98	−.34	+1.90	+1.91	+.41	+1.39	+2.79	+1.94
Montgomery, Ala	−.60	+6.19	−.12	+.29	−.76	−.27	+.46	+3.83	+.26
Vicksburg, Miss	−.89	+1.70	+3.83	−.13	+.18	+.75	+.26	+.80	+.27
New Orleans, La	−.84	+3.61	−1.20	−.05	−.81	−.27	+.93	+1.94	−1.24
Shreveport, La	+.99	−.46	−.64	−.79	−.39	−.31	+.96	+.07	+.11
Fort Smith, Ark	+1.06	−.69	−.30	−.84	+.47	−.91	+.39	−.84	+1.07
Little Rock, Ark	−.80	+1.20	+.02	−.73	−.50	−.89	−.28	−.26	+4.42
Galveston, Tex	−.60	+.21	−.35	−.58	−.57	−.44	+3.28	−1.17	−1.45
San Antonio, Tex	−.63	−.58	−.63	−.63	+.84	+1.30	+1.23	−.78	−.66
Ohio Valley and Tennessee:									
Memphis, Tenn	+.91	+4.82	−.31	−.62	−.31	−.91	+.83	−.55	+.19
Nashville, Tenn	−.04	+1.14	+.77	−.53	+.22	−.86	−.04	−.65	+.40
Chattanooga, Tenn	−.36	+2.26	−.62	+1.17	−.56	−.70	+.09	+1.09	+.99
Louisville, Ky	+1.54	−.88	+.05	−.69	−.39	−.59	−.56	+.34	+.74
Indianapolis, Ind	−.18	−1.06	−.82	−.67	+.30	−.35	−.71	−.39	−.40
Cincinnati, Ohio	+.07	−.70	−.20	−.52	−.66	−.92	+.07	−.06	+.22
Columbus, Ohio	+1.25	−.81	−.58	+.12	+1.39	+.85	+.64	−.68	−.62
Pittsburg, Pa	+1.77	−1.16	−.74	−.70	+1.85	−.16	−.42	−.75	−.15
Lake Region:									
Oswego, N. Y	+2.14	−.07	−.20	−.47	+.25	+.80	+1.18	−.54	+.40
Buffalo, N. Y	+2.54	−.76	+.10	−.36	−.70	+.23	−.15	+.24	+1.20
Cleveland, Ohio	+.47	−.91	−.66	+.41	+.16	−.18	−.58	+.71	+.06
Detroit, Mich	+.87	−.82	−.62	−.77	+.33	−.37	−.70	+.75	−.16
Alpena, Mich	−.56	−.69	+.92	+.10	+.60	−.50	+1.31	−.77	+.13
Grand Haven, Mich	+.03	−.72	−.56	−.59	+.32	−.59	−.48	−.67	+.17
Milwaukee, Wis	−.02	−.77	−.77	−.73	−.05	−.64	−.44	−.23	+1.93
Chicago, Ill	+.73	−.89	−.76	−.82	+.62	−.39	−.51	−.50	−.02
Duluth, Minn	−.92	−.91	+.11	+.17	−.77	.00	−.77	+.34	−.45
Upper Mississippi Valley:									
St. Paul, Minn	+.57	−.77	+1.13	−.64	+5.07	+.81	−.32	−.77	+.38
Lacrosse, Wis	−.28	−1.01	−.41	−.77	+1.68	−.44	−.26	−.63	+.17
Davenport, Iowa	+1.09	−.85	+.10	−.16	−.22	−.91	−.49	−.83	+.38
Des Moines, Iowa	+1.15	+.82	+.60	+.72	+1.66	−.77	−.04	−.74	+.87
Springfield, Ill	+2.40	−.37	+1.04	−.14	+.03	−.22	−.38	−.50	+.47
Cairo, Ill	−.53	+.23	−.78	−.69	+.16	−.27	+2.78	−.58	−.13
St. Louis, Mo	+.68	+.35	+.95	−.38	−.53	+.39	.00	−.56	−.35
Missouri Valley:									
Springfield, Mo	+.53	+.07	+1.37	−.99	+.25	−1.05	+.05	−.50	−.37
Kansas City, Mo	+.37	−.44	+1.84	−.83	−.58	−.98	−.54	−.65	−.24
Concordia, Kans	+.46	−.70	+.82	−.80	−.29	−.91	−.27	−.15	+.69
Omaha, Nebr	−.19	−1.34	−1.01	−.45	+.61	−.77	−.38	+.01	+.56
Valentine, Nebr	−.33	+.38	−.70	−.68	−.31	−.38	+2.83	+.42	+.68
Huron, S. Dak	−.45	−.91	−.63	−.08	−.76	−.65	−.23	+.23	−.09
Extreme Northwest:									
Moorhead, Minn	−.01	−1.07	+3.19	−.31	−.66	−.44	+.98	−.14	+1.07
Bismarck, N. Dak	−.44	+.63	+1.22	−.53	−.42	−.54	−.20	−.11	+1.21
Fort Buford, N. Dak	−.04	−.45	−.32	+3.21	−.27	−.35	−.09	−.26	+.13
Rocky Mountain Slope:									
Havre, Mont	−.05	+.04	+.02	−.45	−.24	−.41	−.35	+.55	−.16
Cheyenne, Wyo	−.28	−.36	−.26	−.35	+.19	−.22	−.23	−.15	−.22
North Platte, Nebr	−.70	−.57	−.53	−.35	+2.51	−.27	−.26	−.18	+1.48
Denver, Colo	−.26	+.02	−.27	−.31	+.14	−.18	−.35	−.31	+.02
Dodge City, Kans	−.52	−.59	−.25	−.72	−.73	−.80	+.37	+.27	+1.98

TABLE II.—*Precipitation departures for the season of 1892 from the normal of many years*—Continued.

Stations.	For the weeks ending—								
	July				August				
	4.	11.	18.	25.	1.	8.	15.	22.	29.
Pacific Coast:									
Olympia, Wash	— .28	+ .05	+ .35	— .06	— .14	— .14	+ .54	— .14	— .20
Portland, Oregon	— .23	— .02	+ .43	— .13	— .14	— .14	+ .03	— .14	— .14
Roseburg, Oregon	— .24	— .17	+ .34	— .07	— .07	— .07	— .05	— .05	— .07
Red Bluff, Cal	— .05	.00	.00	.00	.00	.00	.00	.00	.00
Sacramento, Cal	.00	.00	.00	.00	.00	.00	.00	.00	.00
San Francisco, Cal	.00	.00	.00	.00	— .03	.00	.00	.00	.00
Los Angeles, Cal	.00	.00	.00	.00	— .04	— .04	.00	.00	.00
San Dieogo, Cal	.00	.00	.00	.00	— .01	— .03	— .06	.00	.00

Stations.	For the weeks ending—				
	September				October
	5.	12.	19.	26.	3.
New England:					
Eastport, Me	— .27	— .77	— .48	— .49	— .94
Portland, Me	— .75	— .17	+ .98	— .13	— .72
Boston, Mass	— .58	— .69	+ .59	— .22	— .83
Middle Atlantic States:					
Albany, N. Y	— .71	— .04	— .23	— .21	— .83
New York, N. Y	— .86	— .84	— .28	— .77	— .81
Philadelphia, Pa	— .93	— .58	+ .29	— .06	— .64
Washington, D. C	— .98	— .83	+ .33	+1.25	— .81
Lynchburg, Va	— .93	— .87	— .04	+ .49	— .88
Norfolk, Va	+1.03	—1.21	— .73	— .26	— .95
South Atlantic States:					
Charlotte, N. C	— .83	— .74	— .07	+ .79	— .87
Wilmington, N. C	+ .62	—1.33	— .76	+2.91	—1.24
Charleston, S. C	— .63	+2.43	+1.82	+2.35	—1.24
Augusta, Ga	— .98	— .92	+ .79	+2.82	— .75
Savannah, Ga	— .95	+2.76	+ .54	+2.39	— .72
Jacksonville, Fla	— .15	+3.78	+1.55	— .05	+1.43
Gulf States:					
Atlanta, Ga	—1.10	—1.08	+1.50	— .92	— .76
Mobile, Ala	— .16	+ .61	+ .89	— .96	— .46
Montgomery, Ala	— .72	— .63	+1.76	— .69	— .67
Vicksburg, Miss	— .59	— .32	— .78	— .60	— .68
New Orleans, La	+ .83	+1.23	—1.07	— .27	— .03
Shreveport, La	— .54	+ .17	—1.12	—1.00	— .76
Fort Smith, Ark	— .14	+ .46	— .77	— .70	— .62
Little Rock, Ark	— .87	+2.59	— .84	— .70	+ .54
Galveston, Tex	—1.45	—1.66	—1.80	—1.35	— .86
San Antonio, Tex	+2.98	— .83	—1.01	— .89	— .09
Ohio Valley and Tennessee:					
Memphis, Tenn	— .36	— .78	— .49	— .62	— .74
Nashville, Tenn	+ .05	+ .04	+1.19	— .27	— .74
Chattanooga, Tenn	— .43	— .28	+1.42	+ .53	— .82
Louisville, Ky	— .74	— .73	+1.61	— .53	— .63
Indianapolis, Ind	— .66	— .26	+1.17	— .51	— .70
Cincinnati, Ohio	+ .05	— .60	+1.55	+ .49	— .52
Columbus, Ohio	— .20	— .62	+ .03	— .16	— .63
Pittsburg, Pa	+ .57	— .19	— .27	+ .04	— .52
Lake Region:					
Oswego, N. Y	— .17	— .50	— .24	+ .07	— .45
Buffalo, N. Y	— .38	— .48	+ .40	— .34	— .83
Cleveland, Ohio	.00	— .26	— .27	— .45	— .65
Detroit, Mich	— .20	— .37	+2.19	— .41	— .56
Alpena, Mich	— .36	— .72	+1.03	— .65	— .88
Grand Haven, Mich	— .73	+ .34	— .50	— .74	— .63
Milwaukee, Wis	— .49	+1.51	— .70	— .70	+ .25
Chicago, Ill	— .26	+ .52	— .68	— .60	— .69
Duluth, Minn	+1.10	— .83	—1.00	— .94	— .88
Upper Mississippi Valley:					
St. Paul, Minn	— .37	+ .95	— .77	— .72	+ .49
Lacrosse, Wis	—1.08	+1.85	—1.13	— .98	— .72
Davenport, Iowa	— .77	+1.31	— .77	— .76	— .70
Des Moines, Iowa	— .68	+ .08	— .84	— .77	— .77
Springfield, Ill	+ .25	+2.07	— .82	— .84	— .84
Cairo, Ill	— .57	— .63	+ .22	— .50	— .56
St. Louis, Mo	— .10	+ .07	— .80	— .73	— .66

TABLE II.—*Precipitation departures for the season of 1892 from the normal of many years*—Continued.

Stations.	For the weeks ending— September 5.	12.	19.	26.	October 3.
Missouri Valley:					
Springfield, Mo	—.42	—.34	—.83	—.77	—.64
Kansas City, Mo	+.94	+.59	—1.05	—.98	—.62
Concordia, Kans	—.33	—.40	—.56	—.56	—.51
Omaha, Nebr	—.01	—.20	—.77	—.71	—.41
Valentine, Nebr	—.24	—.04	—.35	—.25	—.35
Huron, S. Dak	—.32	+.10	—.35	—.35	—.35
Extreme Northwest:					
Moorhead, Minn	—.49	—.34	—.56	—.56	—.56
Bismarck, N. Dak	—.31	+.33	—.21	—.24	—.28
Fort Buford, N. Dak	—.16	—.17	—.21	—.21	—.08
Rocky Mountain Slope:					
Havre, Mont	—.03	—.27	—.28	—.16	—.88
Cheyenne, Wyo	—.06	—.25	—.21	—.14	—.14
North Platte, Nebr	—.37	—.03	—.35	—.20	—.28
Denver, Colo	—.30	—.23	—.16	—.14	—.14
Dodge City, Kans	+.69	—.27	—.21	—.28	—.34
Pacific Coast:					
Olympia, Wash	—.35	—.41	....	+2.55	—.94
Portland, Oregon	—.21	—.34	—.37	+1.12	—.66
Roseburg, Oregon	—.08	—.14	—.32	+.32	—.37
Red Bluff, Cal	—.11	—.14	+.15	—.14	—.17
Sacramento, Cal	—.05	—.07	—.07	—.07	+.08
San Francisco, Cal	.00	—.02	—.07	—.07	—.08
Los Angeles, Cal	.00	.00	00	—.02	—.10
San Diego, Cal	.00	.00	00	—.03	—.07

STATE WEATHER SERVICE DIVISION.

By H. H. C. DUNWOODY, *Major, Signal Corps.*

INTRODUCTION.

State weather service work, the general features of which have been fully outlined in previous similar reports, has been carried on to a much greater extent than heretofore, and the results accomplished during the year fully sustain the high standard of usefulness claimed for State weather service organizations. The entire territory of the United States, with the exception of Alaska, is now covered by local weather services, the last organized being that for Idaho, where energetic work is now being done toward perfecting the service in that State.

During the year Iowa, Maryland, New Jersey, and Ohio have by legislative enactments provided for the maintenance of their respective State weather services, and it is expected that the action of these States will be imitated by numerous others during the coming year. The work in New England was until March 22, 1892, conducted under the direction of the New England Meteorological Society, with central station at Cambridge, Mass., but on the date named a change was effected whereby the central station was transferred to Boston, and the title of the organization under which the work is now carried on is "The New England Weather Service." In Kansas, the director, owing to press of duties in connection with the Washburn College, in April, 1892, felt compelled to withdraw from the local service, much to the regret of the Chief of the Weather Bureau. The Kentucky service, until August, 1891, was operated under the auspices of the Polytechnic Society, Louisville, but in that month was placed under the direction of the Weather Bureau observer at Louisville. Until August, 1891, the Dakota weather service covered the territory of both North and South Dakota. In the month named action was taken to form separate services, Bismarck being selected as the central station of the North Dakota service and Huron for South Dakota. In addition to the usual work of the California service there have been issued from Red Bluff, Fresno, and Los Angeles weekly weather crop bulletins devoted to their respective localities, and these local bulletins have met with much favor.

PUBLICATIONS.

The character of the publications issued by the local services has been so greatly improved that among the weekly and monthly reports now published may be found many possessing a high standard of excellence from both literary and typographical standpoints. Too much can not be said in praise of the valuable work of the directors of the several local organizations in the line of improving their publications. The regular monthly reports now contain tables of meteorological data and the several elements are generalized and discussed, and in many reports the graphic illustrations are of a highly creditable character. With access to these State reports it will be possible to determine the special features of the climate of every section of the United States, and it would be difficult to estimate the value of this one feature of State weather service work, affording as it does a means of supplying to immigrants, invalids, and meteorological students detailed information which it would not be possible to secure were it not for the existence of the extensive system of meteorological observations conducted by State weather services.

The Weather Crop Bulletin has been prepared as usual in the State Weather Service Division, and full description of the value of this important feature of Weather Bureau work will be found under the special heading "Weather Conditions of the Crop of 1892."

THUNDERSTORMS.

During the year special attention has been given to the collection of data relating to thunderstorms over the Northern and Central States from the Mississippi Valley eastward to the Atlantic coast, and at a number of designated centers special forecasts of the occurrence of thunderstorms have been issued, the object of this special thunderstorm work being to give information as to the prevalence of severe storms of this class at points from which reported, with forecasts of their occurrence in other localities in the direction of the storm's course. The work in this line during the summer of 1892 was of an experimental nature, but the results accomplished have been very satisfactory, and has demonstrated that in this direction there is opportunity for doing valuable and effective work.

VOLUNTARY STATIONS.

In April, 1892, the work pertaining to the selection and equipment of voluntary meteorological stations was transferred from the Records Division to the State Weather Service Division. During the year there have been nearly seven hundred new voluntary stations established.

MAP DISPLAYS AT U. S. CAPITOL.

The State Weather Service Division has also had charge of the display of weather maps, etc., at the United States Capitol, where large weather symbol maps have been shown in the Senate and House lobbies. The interest in this work is constantly increasing.

IMPROVEMENT OF THE WEATHER SERVICE.

At the session of the National Grange, Patrons of Husbandry, held at Springfield, Ohio, November 11 to 19, 1891, the following resolution was introduced by Leonard Rhone, master of the Pennsylvania State Grange, and referred to the committee on agriculture:

Resolved, That the National Grange confer with the Secretary of Agriculture as to a more complete weather service by arranging with manufacturers for a system of signals by use of the steam whistles connected with their establishments, on the same principles as that of the Bell telephone of long and short rings.

And upon which resolution the committee reported as follows:

WORTHY MASTER:

Your committee on agriculture have duly considered the resolution asking for more complete weather signals for the benefit of agriculture, introduced by the master of Pennsylvania State Grange. We fully concur in its suggestions, believing that great benefit would be derived from the adoption of such a code of signals.

We report favorably and recommend the adoption of the foregoing resolution by this body.

W. C. GIFFORD,
S. H. ELLIS,
MRS. PATIENCE HUNT,
MRS. A. F. CLARDY,
Committee.

Acting upon the above resolution the Chief of the Weather Bureau on February 12, 1892, addressed the following letter to the masters of the various State granges:

DEAR SIR: After conference with Mr. Trimble, secretary, and Messrs. Rhone and Chartters, of the executive committee, National Grange, Patrons of Husbandry, in regard to the resolution adopted by your order relative to the better dissemination of weather forecasts by whistles, I am pleased to inform you that the Weather Bureau will cordially coöperate with your order in placing the daily forecasts within reach of as many of your members as the limited appropriations of the Bureau will permit.

In order to place this information directly before the members of the grange, I would request your assistance by furnishing me with a list of the names and addresses of the secretaries of the live subordinate granges within your jurisdiction. Inclosed please find franked addressed envelope for forwarding the list so that it will safely reach me.

As part of the duties enjoined by the law transferring to the U. S. Department of Agriculture, the extending of the benefits of the service in the agricultural districts is one of the most important, and to this end the inclosed circular explaining the code adopted for the use of whistles was issued to cover the exact ground indicated by your resolution. It is the intention to forward a copy of this circular to each of your subordinate granges with a letter explaining the assistance required in selecting stations that will be most useful to their interests.

I would suggest that you address a letter to each of the granges informing them of the action taken by the Weather Bureau to comply with their requests as indicated by the resolution quoted.

As rapidly as the lists of addresses of the secretaries of the local granges, requested in the preceding letter, were received, the following letter was mailed to each:

DEAR SIR: I am instructed by the Chief of the Weather Bureau to communicate with you in reference to the display and use of weather forecasts and cold-wave signals within the limits of your grange jurisdiction, for the benefit of farmers of your section. This is done in order to carry out the expressed wishes of the National Grange, as will be seen noted upon the inclosed printed slip.

Your grange with your name is found upon the list furnished by your State officials as one recommended for carrying out the details of this work.

Will you kindly, at the earliest moment, bring the subject before a meeting of your grange, discuss it thoroughly, and then forward the name of the member chosen to coöperate with us in carrying out the details of the work. Such person will be regularly appointed and full instructions furnished as to the duties required, which must be performed without compensation, except the benefits to be received by himself (or herself), in connection with the farmers of your locality, in being promptly warned of coming storms, cold waves, frosts, etc. A set of signal flags will be furnished as far as the limited appropriations will permit. If the whistles are used, there will be no expense, and in this connection some large mill or factory in your vicinity could be utilized.

The law transferring this Bureau from the War Department to the Department of Agriculture was urged and supported by your organization, and it is the earnest desire of the Secretary of Agriculture and the Chief of the Weather Bureau to make it of the greatest possible practical value to the agricultural interests of the whole country. The Chief of the Weather Bureau will, to the full extent of the limited appropriations for this service, coöperate with the farmers in this direction.

Permit me to urge early and prompt action in this matter, sending your reply in the inclosed franked envelope, which requires no postage.

Very respectfully,

N. B. CONGER,
Acting Chief of Division.

This letter was sent to the secretaries of more than 3,100 local granges throughout the country, and as a result there were established a large number of weather forecast signal stations.

ROUTINE WORK.

During the year in the routine work of the State Weather Service Division, there have been sent nearly 16,000 letters and more than 6,000 letters have been received, recorded, and acted on. The work of conducting this enormous correspondence, together with the preparation of the text and charts of the Weekly Weather Crop Bulletins, has been performed with the small force of seven clerks.

The following is a list of the several State weather services, with the names and addresses of the officials in charge:

State Weather Services.

[Persons marked thus * are employees of the Weather Bureau.]

State and central station.	Director.	Assistant director.
Alabama, Auburn	Prof. P. H. Mell*	
Arizona, Tucson	J. C. Hayden*	
Arkansas, Little Rock	M. F. Locke	F. H. Clarke.*
California, Sacramento	James A. Barwick*	
Colorado, Denver	W. S. Miller*	
Florida, Jacksonville	E. R. Demain*	
Georgia, Atlanta	Park Morrill	
Idaho, Idaho Falls	J. H. Smith*	
Illinois, Springfield	John Craig*	
Indiana, Indianapolis	Prof. H. A. Huston†	C. F. R. Wappenhans.*
Iowa, Des Moines	J. R. Sage	Dr. G. M. Chappel.*
Kansas, Topeka	T. B. Jennings*	
Kentucky, Louisville	Frank Burke*	
Louisiana, New Orleans	Geo. E. Hunt*	
Maryland, Baltimore	Dr. Wm. B. Clark	Dr. C. P. Cronk.*
Michigan, Detroit	E. A. Evans*	
Minnesota, Minneapolis	J. H. Harmon*	
Mississippi, University	Prof. R. B. Fulton*	
Missouri, Columbia	Levi Chubbuck	H. A. McNally.*
Montana, Helena	E. J. Glass*	
Nebraska, Crete	Prof. G. D. Swezey	G. A. Loveland.*
Nevada, Carson City	Chas. W. Friend	Ford A. Carpenter.*
New England, Boston	J. Warren Smith*	
New Jersey, New Brunswick	E. W. McGann*	
New Mexico, Santa Fe	H. B. Hersey*	
New York, Ithaca	Prof. E. A. Fuertes	R. M. Hardinge.*
North Carolina, Raleigh	Dr. H. B. Battle	C. F. von Herrmann.*

† Address, Lafayette, Ind.

State Weather Services—Continued.

[Persons marked thus * are employees of the Weather Bureau.]

State and central station.	Director.	Assistant director.
North Dakota, Bismarck	W. H. Fallon *	
Ohio, Columbus	L. N. Bonham	C. M. Strong. *
Oklahoma, Oklahoma City	J. I. Widmeyer *	
Oregon, Portland	H. E. Hayes †	B. S. Pague. *
Pennsylvania, Philadelphia	W. P. Tatham	H. L. Ball. *
South Carolina, Columbia	A. P. Butler *	
South Dakota, Huron	S. W. Glenn *	
Tennessee, Nashville	J. B. Marbury *	
Texas, Galveston	D. D. Bryan	Dr. I. M. Cline. *
Utah, Salt Lake City	G. N. Salisbury *	
Virginia, Lynchburg	Dr. E. A. Craighill	J. N. Ryker. *
Washington, Olympia	E. B. Olney *	
West Virginia, Parkersburg	W. W. Dent *	
Wisconsin, Milwaukee	Willis L. Moore *	
Wyoming, Cheyenne	E. M. Ravenscraft *	

† Address, Oswego, Oregon.]

OPERATIONS OF STATE WEATHER SERVICES.

The following reports of the operations of the several State weather services have been prepared and submitted by the directors:

ALABAMA.

(P. H. Mell, Weather Bureau, director.)

The work of the service may be divided into four distinct departments:

(1) Telegraphic system. Under this head is disseminated the weather forecasts and special warnings. This service is under the charge of the observer at Montgomery.

(2) Collecting meteorological data through the agency of regular and voluntary observers throughout the State.

(3) Publishing bulletins.

(4) Compiling and studying the records of the service for the purpose of preparing special bulletins on climatology.

The benefits resulting to the people of the State from the dissemination of weather forecasts are greatly appreciated in most sections. In a few localities, however, the warnings did not seem to be as highly valued as their merit warrants, and the result has been that the displaymen have lost interest and the services have been discontinued. These localities, however, are but few, and they are more than balanced by those places where the flags are closely watched each day and the fulfillment of the warnings highly valued. The frost predictions have been of great benefit to the market gardeners and truck farmers; to the farming communities, however, the valuable results have not been so manifest. The means of telegraphic communication outside of the cities, towns, and villages are so meager that the farmers, as a class, are not reaping the benefits from this system that is desirable.

The work of the observers in collecting meteorological data is of a high order of efficiency. Fifty per cent of these observers have been connected with the service for over five years, and they have taken much interest in the progress of the weather system in Alabama. The observers reporting to the central station at the close of the year number forty-three, and with one or two exceptions they are all provided with maximum and minimum thermometers of the authorized standard. As in other States, so in Alabama, the chief work of the observers is the reading of thermometers and reading the amount of precipitation. Some investigations have been conducted during the year toward the study of thunderstorms and electrical disturbances, and observers have been requested to give full reports concerning all such phenomena.

In the publication of meteorological data, the work has been of two natures: (1) the regular monthly bulletins that are issued on the 15th of each month throughout the year, and (2) the weekly crop bulletins that were printed on Saturday of each week during the crop season from April 1 to November 1. Copies of these two bulletins are sent to all newspapers in Alabama, all observers, the directors of the State weather services in the United States Weather Bureau, and all parties who make application for them. The newspapers of Alabama have shown much interest in the service by republishing the weekly bulletins and extracts from the monthly bulletins.

The study of the data that have been accumulating at the central office during the past ten years has been steadily pushed ahead, and material for future bulletins relating to climate is nearly in shape for the printer. The policy of the director of the Alabama weather service has been to open the files of the office to the examination of students of meteorology, and, where the value of the work would warrant, to publish their investigations under the head of "Special Bulletins of the Alabama Weather Service." Several such works have been issued in the past, and, as already stated, others are in progress of preparation.

During the past five months the director has been engaged in the preparation of a monograph, at the request of the Chief of the Weather Bureau, on the climatology of the cotton plant. This work is intended for publication by the Bureau in its annual report for the year ending June 30, 1892. In the preparation of this monograph it has been necessary to examine the records of all stations located in what is technically known as the cotton belt, extending from Virginia to western Texas.

ARIZONA.

(J. C. Hayden, Weather Bureau, director.)

The local service was organized in September, 1891, and the first monthly bulletin was issued in October. No forecasts have been issued to the public during the year, and as the people are engaged more in mining and cattle-raising than in agricultural work, forecasts would probably have been of very little benefit. People are, however, beginning to direct their attention to agriculture, and during the coming season of frosts several display stations will probably be established, from which it is expected much good will result.

Weekly weather crop bulletins were commenced on April 8, 1892. The average issue to the public is about 75 a week, and many receiving them state that they are very interesting and valuable. The number of crop correspondents at present reporting to this office is twenty-two.

The monthly meteorological reports issued from this office appear to be of great interest to the public, and will prove valuable to the Territory, as they are carefully scrutinized by persons outside the Territory who entertain views of engaging in the raising of semitropical fruits. Many persons have addressed the local bureau for meteorological statistics relating to the climatology of certain sections of the Territory, which information has always been furnished as far as possible. The average issue of the monthly bulletin is about 100. Fifty-seven voluntary meteorological stations are now in operation in Arizona. A majority of these are using their own instruments. Seventeen stations have been established during the year. Five have been discontinued.

ARKANSAS.

(M. F. Locke, director; F. H. Clarke, Weather Bureau, assistant director.)

During the past year the service has received its entire support from the National Weather Bureau. It has continued its work on substantially the same plan as outlined in my report made a year ago. It has been the aim of the director to secure only such voluntary observers who manifested an interest in the work and how would consent to make a continuous record. Owing to this requirement, the increase in the number of stations has not been as rapid as could be desired; but it has been a healthy growth, and the regularity with which reports are rendered and the care taken in their preparation prove that the selections made were good ones.

The number of display stations has been increased from 13 to 19, besides 5 places to which forecasts are sent by telephone, free of expense to the Government, but which do not display flags. There are also on hand 6 applications for the daily forcasts and 6 for frost warnings. Increased interest is shown in this branch of the service by several applications from points along the railroads where there are no telegraph offices at present, to have this office use its influence in having offices opened in order that they may receive the weather forecasts.

The lack of telegraphic facilities makes it impossible to reach a large portion of the State where the forecasts would be of great value. This is especially true of the plateau region in the northern and western parts of the State, where the fruit crop predominates.

Reports from displaymen state that the forecasts are watched closely, and that farmers in the vicinity and shippers of perishable articles are governed thereby.

The interest taken in the Weekly Weather Crop Bulletin continues to increase, as is shown by the increased demand for same both at home and abroad. At date of last report the weekly edition was 250, whereas at present it is 362, making total number of bulletins issued during the thirty-six weeks it is published 13,032. They are also published in full in the city papers, and Memphis Commercial, and the editorial part in many weekly papers throughout the State. The crop report is also included in a "patent inside" which is furnished by the Arkansas Democrat Company to about forty weekly papers in the State.

A marked increase in the number of crop correspondents is also noted. Every county in the State, except three, is represented by from 2 to 5 correspondents, the total number reporting being 193. A much larger number could be procured were mail facilities better over a large portion of the State. The crop bulletins of the various State services are displayed in a place set apart for the purpose in the Board of Trade and are carefully perused by those interested.

The monthly report of voluntary observers is included in that of the State Commissioner of Mines, Manufactures, and Agriculture, who has kindly allotted three pages of it to the State service. The monthly edition consists of 1,500 copies, which are mailed free to all applicants. Reports are received regularly from 39 voluntary observers and 3 regular Weather Bureau stations. Two cotton region stations were closed during the past year by direction of the Chief of the Weather Bureau, and 9 voluntary stations have been established and applications are on file for 4 more stations in desirable localities. The monthly reports from observers continue to improve in accuracy, amount of data furnished, and promptness with which rendered.

Some simple form of instrument shelter should also be furnished to observers. I am confident that a much less number of thermometers would be broken, and thus in a short time the saving from this source would more than pay for the shelter.

I would again suggest the advisability of an inspection of voluntary stations. I am confident that much good would be accomplished, which would be ample compensation for the time and money expended.

CALIFORNIA.

(James A. Barwick, Weather Bureau, director.)

The State weather service of California was established in September, 1891, in compliance with instructions from the Chief of the Weather Bureau, and is being conducted in coöperation with the State Agricultural Society, which bears the expense of printing the weekly and monthly bulletins. The monthly meteorological bulletin for June, 1892, will contain about 300 reports from observing stations, showing an increase of about 30 reports in ten months. Over 200 monthly reports are received from stations established by the Southern Pacific Railroad Company, in its Pacific division. The regular edition of the monthly meteorological bulletin is 600 copies, which are judiciously distributed.

The Weekly Weather Crop Bulletin is also printed at the expense of the State Agricultural Society, 600 copies being issued weekly. When haying and harvesting are completed and the marketing of fruit commences, the number of crop reports begins to drop off, as during the heated term of July and August many of the observers and crop correspondents leave for an outing without arranging for a continuance of the reports. The interest in the State weather service work is generally confined to the months from September to July. Haying and harvesting are usually completed in July, and these crops lie out in the field for several months—often until the first rains of September or October. Fruit-dealers buy the fruit crop while still on the trees, and the work of picking and marketing is done by them, the grower having no concern in the crop after the sale is consummated. It will therefore be understood why so many correspondents discontinue their reports and pay no attention to requests to forward them after they have disposed of their own crops.

COLORADO.

(W. S. Miller, Weather Bureau, director.)

The most popular branch of State service work continues to be the weekly weather crop bulletins. The number of crop correspondents this season is 85. The weekly edition of the bulletin averages 325.

The total number of voluntary observing stations is 101; during the year 34 stations were discontinued and 28 established. The stations are all equipped with standard instruments. The observers are very faithful in performing the labor involved, and they are more than deserving of all the commendation and appreciation their work calls forth.

From the data received from voluntary observers and crop reporters is compiled a "Monthly Review." The number of copies issued monthly is about 450. The interest in this and other publications of the service is best evidenced by the complimentary notices received.

At the close of the year there were 26 weather-signal display stations in operation within the State. The forecasting of frosts and cold waves is especially appreciated during critical periods of crop-growth and harvesting.

The greater part of the time which could be spared from current work was devoted to the preparation of normal monthly, seasonal, and annual temperature and precipitation data. The tables are now completed, and base maps have just been received on which these data will be graphically charted and distributed among those specially interested.

During the year a great deal of miscellaneous data has been prepared for publications, for the use of State officials, and in compliance with individual requests, etc.

FLORIDA.

(E. R. Demain, Weather Bureau, director.)

The organization of a weather service for Florida was undertaken last summer in accordance with directions contained in letter from the Chief of the Weather Bureau in July, 1891. There were at the time 19 voluntary and 7 Weather Bureau stations in the State. The voluntary observers were transferred to the State weather service, and the first monthly summary, that for September, was issued about the middle of October.

Meanwhile a call for voluntary observers in sections of the State not represented was issued through the press and by correspondence, and the promise was made that instruments would be furnished. In a short time about 20 additional observers had offered their services, but on account of the stock of thermometers and rain gauges for issue to volunteers having become nearly exhausted, only those located in counties from which no reports were received were supplied. Since the first monthly report was issued, 14 new stations have been added, 13 of which were equipped with Weather Bureau instruments. This made a total of 40 stations. Three stations have been discontinued and the instruments called in. Three more have rendered no reports for several months and the observers have probably ceased making observations. There were at the close of the year 34 meteorological stations, voluntary and regular, in operation in the State.

Weather forecasts were wired to 18 different points until June, when 14 were discontinued until October, as they were considered of little benefit during the heated term.

Frost warnings were wired to 26 places at Government expense, and to 1 at the expense of the individual, and were mailed to 2 persons. In a number of instances when frost seemed probable, telegrams were received from different sections of the State, requesting that the forecasts be wired. Frost warnings were displayed during the season on the steamer *Manatee*, between Jacksonville and Mandarin, for the benefit of the truckers and fruit growers living near the St. James River. This steamer also carries the weather signals daily.

The distribution of the a. m. forecasts by mail was begun March 22, 1892. On that date they were bulletined and mailed to 135 selected post-offices in parts of the State that it was believed could be reached in time to make the information valuable to the people. Changes have since been made, as it was found that some of the points could not be reached in time. At the close of the year the a. m. forecasts were mailed to 121 offices and the p. m. forecasts to 3 offices. The postmasters at several points, in addition to posting the bulletins in their offices, procured flags and made displays for the benefit of their localities.

As to the benefits resulting from the liberal distribution of the forecasts and warnings, it is conceded by all with whom I have communicated that the frost warnings during the past season were the most satisfactory ever issued, but there is still room for improvement. One or two frosts occurred late in the spring, for which no warnings were received, and did considerable damage to trucking interests. The forecasts and warnings are received with much eagerness during the season when damage is liable to occur from frosts, and the interest in the work of the service generally is increasing.

The crop-bulletin feature has been very favorably commented upon by the two leading agricultural papers of the State, as well as by many individuals. The editor of the "Dispatch, Farmer, and Fruit-Grower" wrote upon the receipt of the first bulletin that, in his opinion, it was the best thing yet undertaken by the Weather Bureau, and that he would gladly give the bulletins space in his paper. He publishes them in full. The average issue of the bulletin is 95 copies, and we have at present 50 crop correspondents. Efforts are constantly being made to increase the number. Poor mail facilities in many sections of the State greatly interfere with the success of this work, but so far we have succeeded in getting enough reports from which to prepare bulletins that have been favorably received by the public.

The average number of monthly summaries issued has been about 125.

GEORGIA.

(Park Morrill, Weather Bureau, director.)

The work of organizing this service began on October 10, 1891. It has been established entirely through the agency of the Weather Bureau without State support. The only thing lacking under the present system, and one which might justify the seeking of State aid, is an adequate printing fund. Were an allowance of $500 per year made for printing, the service in its present form would be perfectly efficient. There being no State service in Georgia up to October, 1891, the growth of the service and its present magnitude are one and the same.

The daily a. m. forecasts are telegraphed to 121, and the p. m. to 2 points. At 44 of these stations weather-signal flags are displayed, and at the remaining 79 the forecasts are bulletined. Frost and cold-wave warnings are telegraphed to 77 points, including the 44 regular forecast display stations, and 33 special frost-warning stations. The latter are supplied with cold-wave flags.

Many commendations have been received both of the general forecast, and the special frost-warning services. Both of these might well be increased to an indefinite extent. The opportunity for the use of frost warnings is especially great in the fruit and truck industries, as they are coming to rank among the most important in the State.

The data for the weekly weather crop bulletins are collected through the agency of 320 crop reporters. Reporters delinquent for more than one month are dropped from the lists.

The bulletin is published entire in the "Constitution" each Wednesday morning, and the same type is used for printing 500 copies of the bulletin under proper heading. These copies are mailed to all crop reporters and voluntary observers in the State, to 85 weekly newspapers, to directors of other State services, and to other interested parties.

The appreciation of these reports is most clearly shown by the recent action of the "Constitution" in adding to its weekly publication of the Georgia Bulletin the publication of a telegraphic summary from each of the ten other State services of the South.

The system of weather crop reports, I think, is probably the most popular feature of the State service. Information in regard to crop prospects is always eagerly sought, and is attainable at regular intervals only from this source.

Two hundred copies of the monthly report are mailed to the reporting stations, to other State services, and to 88 papers in Georgia. This report is now prepared by milliograph, and embraces 7 large bulletin sheets. In this form it is unattractive in appearance. Means should be provided for properly printing it. The milliograph process, while useful in many ways, is not fitted for the production of any large issue of matter of permanent value. These monthly reports certainly ought to be printed in a neat and uniform manner.

In October, 1891, there were 12 voluntary meteorological stations from which reports were received. To these 27 others have been added. These, together with 28 cotton region and river stations, give 67 stations provided with standard instruments and rendering monthly reports. In addition to these there were, in October, 1891, 4 stations from which reports were not being received. These were delinquent for a considerable time previous. From two of them the instruments have been reclaimed, while in case of the other two they have been abandoned. With these exceptions no stations have been discontinued.

The 67 points from which the reports are now received cover the State quite well. A few more stations are needed in the southern section. It is very difficult in that portion of the State to secure satisfactory observers. I think that 15 additional stations in the proper locations would be all that are required for complete and satisfactory climatic data.

The most pressing need of this branch of the work is a careful inspection of all the stations now in operation and provision for an initial inspection of each new station established. New observers as a rule have no technical knowledge of the use of their instruments or the theory of proper exposures. Great improvement would result from an inspection of stations by a competent observer.

I would also suggest the issuance of flood warnings either from this point or from Washington to certain exposed points on rivers which have their source in the mountains of north Georgia, notably Columbus, Rome, and West Point. Nearly every year serious damage is occasioned by flood in these places, and at present no provision is made to warn them. Such warnings could be readily issued, as stations are already established on these watersheds and considerable data exist as to past rainfalls and floods.

The matter of increasing the number of regular frost-warning stations has already received your attention. I think that a large increase should be made in the number of these stations in Georgia, but that it can be best accomplished a little later in the season. With this increase, and with the moderate increase suggested in the number of voluntary observation stations, I think that the Georgia weather service might well be considered efficient and complete.

ILLINOIS.

(John Craig, Weather Bureau, director.)

Since the transfer of the Bureau from the War Department to the Department of Agriculture, considerable progress has been made in the work pertaining to this branch of the service. Reports are now received on an average from about 55 stations; this includes 6 reports from regular Weather Bureau stations. The increase is owing to the liberal policy pursued by this Department in furnishing instruments to the observers. At the present time about 70 per cent of the stations from which reports are received have been equipped with Weather Bureau instruments. Forms 1011 and 1012, compiled from the reports received, have been forwarded to Washington on the 15th of each month. A monthly report, cyclostyle, has been issued to the principal newspapers throughout the State.

During the present season, weekly crop reports have been received from about 42 counties, and the information contained therein is used in compiling the crop bulletins issued from this station on Tuesday of each week. Four hundred and seventy copies are issued weekly, 209 of which are issued to the secretaries of local granges in the State, this being done at the request of the grand secretary of Illinois, and the balance are distributed among the correspondents reporting to the various State weather centers, and to the principal newspapers of Illinois and St. Louis, Mo. This part of the work is highly appreciated by those interested, and it is considered one of the best features of the service. As a general thing, the reports are published in full by the principal newspapers of the State.

Weather forecasts and warnings are telegraphed to the principal points in the State. Eighty-seven stations are receiving reports daily, except Sunday, at government expense.

The Ohio and Mississippi and the St. Louis, Alton and Springfield Railways furnish without expense to the Government, the forecasts and warnings to the stations (46) along their respective lines. These forecasts and warnings are greatly appreciated by the citizens.

INDIANA.

(Prof. H. A. Huston, director; C. F. R. Wappenhans, Weather Bureau assistant director.)

During the fiscal year ending June 30, 1892, 81 display stations received the forecasts by telegraph—49 in the morning and 29 at night; and the night message was mailed to 3 stations. One station received the cold-wave message only; and frost, thunderstorm, storm warnings, and the cold-wave messages were sent to all display stations by telegraph.

In January, 1892, the sending of forecasts to railroad agents was resumed; it had been done for a great number of years, but after the novelty had worn off, station agents became careless in posting the bulletins every day, leaving old ones for display, which misled the public, and this mode of dissemination of the forecasts was gradually discontinued. At present the forecasts are sent by telegraph to 12 depots of the Pittsburg, Chicago, Cincinnati and St. Louis Railway, and to 4 depots on the Indianapolis, Decatur and Western Railway. By baggage-masters of the night trains of the various divisions of the "Big Four System," the forecasts on form 1036 are sent to 58 depots, on the Cincinnati, Hamilton and Indianapolis Railway to 4 depots, on the Louisville, New Albany and Chicago Railway to 9 depots, and on the Lake Erie and Western Railway to 8 depots. The displaymen and everyone else with whom I spoke about it assured me that the people appreciate the display and the forecasts very much, especially where the forecasts are heralded by steam whistle (which is being done at 7 stations), as the sound reaches farther than the flags can be distinguished, and therefore many more people living in the country have the benefit of the signals, and watch for the time when they usually are sounded.

Starting with the issue of 150 weekly crop bulletins at the beginning of the season, I have been compelled to increase the number issued to 400, which is the number issued at the end of the fiscal year. The Indiana Farmer, with a circulation of about 15,000 copies, publishes the full bulletin regularly; the city papers, and a few of the weekly papers in the State, publish the synopsis, and this is also sent by the operator of the Associated Press. There are about 30 correspondents who send reports regularly, and a few who do so occasionally. Merchants on 'change and others who read or receive the bulletin, expressed themselves quite favorably in regard to the publication, and it seems the bulletins are of general benefit.

Five hundred monthly bulletins of the Indiana State weather service are published every month. There are at present 34 volunteer observers who send reports; none were discontinued, and 6 were established during the year.

In order to make the observations of the service more uniform and of more value, I would respectfully suggest that all those observers who have exposed thermometers only may be furnished with a maximum and minimum thermometer. When I have more time at my disposal I will furnish a list of those observers to whom self-registering instruments ought to be sent. If there should be volunteer observers in Indiana who, having instruments provided by the Weather Bureau, and who send their reports only to the central office at Washington, I would respectfully suggest that they may be instructed to send the reports to my address and, if desired, after making copy of the report, I could forward the original to the central office.

IOWA.

(J. R. Sage, director; Dr. G. M. Chappel, Weather Bureau, assistant director.)

That this service has steadily grown in public favor, since its establishment by law in 1890, is attested by the fact that the bill appropriating an increased amount for its support the coming biennial term passed both branches of the late general assembly without a negative vote. A very earnest effort has been made by those charged with its management to increase its efficiency and to make it worthy of public support and confidence.

Monthly meteorological reports are now received from 94 stations, including the 5 Weather Bureau stations within this State, and 2 (Omaha and Lacrosse) in contiguous States. Weekly weather crop reports are received during the crop season from the observers at the most of these stations, and from 86 weather crop observers who are not supplied with standard instruments. In addition to these, there is connected with this Bureau a well-trained and intelligent corps of crop correspondents, numbering about 1,050, from whose reports monthly tabulations, showing the condition and acreage of staple crops, are made during the season. These are published in the Monthly Review, and widely distributed by advance sheets to the press of the country. Of the Monthly Review, there were issued during the year 24,500 copies. The total number of weather-crop bulletins issued during the year (twenty-six weeks) was 36,500, and the issue during the current season has been increased to 1,700 per week. These are distributed to the press of the State, and to all who are sufficiently interested to make application for copies. Summaries of the weekly bulletins are given to the Associated Press, and are published in all the papers receiving the same in time for their weekly issues. The general appreciation of these publications has been attested by numerous letters and flattering press notices.

There are within the State 85 display stations at which daily forecasts are received and displayed by flags or given to the public by whistle signals. There is an evident increase of public interest in this work of the National Bureau, and the State service has done all in its power to give the widest possible dissemination to the weather forecasts.

This service was established as an auxiliary organization, and it has been the aim of those charged with its administration to take up the work of extension at the points where, by necessary limitation, the National Weather Bureau left it incomplete. With this in view, upon ascertaining that the National Bureau had no available funds for the purchase of instruments, the State appropriation has been drawn upon for the equipment of 9 stations, at which thoroughly competent observers have been secured.

The director has also agreed to pay for the paper and printing of 100,000 penalty wrappers, to be used in mailing the bulletins, weather maps, and other issues at the central station, to be used during the current season.

Frequent requests have been made for the donation of flags for the equipment of display stations at various places within the State; but this service has not approved such applications, believing it would be better for the general public to expend the money appropriated for that purpose in sending the forecasts to stations where the people will contribute the small amount necessary to purchase the required outfit of flags, etc.

The establishment of a local forecast station at Des Moines, for the State of Iowa' has greatly increased public interest in the service, and the issue of weather maps, which now reach over 330 points at an hour sufficiently early to give value to the forecasts thereon, has also contributed to the same end.

This service has undertaken the work of preparing data in form of charts, tables, maps, and pamphlets illustrating the climatic features of the State, as related to crop production and the public health, to be used as a part of the Iowa exhibit at the World's Columbian Exposition. This work will necessarily entail a considerable draft upon the clerical force of the office.

KANSAS.

(T. B. Jennings, Weather Bureau, director.)

This service consists of 1 central station, 72 voluntary stations, 5 regular stations of the National Service, 1 station of the U. S. Army Medical Service, 20 stations of the Union Pacific Railroad, 85 weather crop reporters, and 16 forecast and cold-wave warning display stations.

Owing to the large increase of duties devolving upon him, requiring his whole time in the class room and laboratory of the college, Prof. Lovewell withdrew from the directorship of this service in April last, and the present director assumed charge.

On April 9 the office of the central station was moved from Washburn College into the city, thus permitting it to be in close touch with the press and public and giving it the benefit of immediate telegraph and mail facilities.

The weekly weather crop bulletins were continued until September 19 and resumed April 15. They are furnished to each United States Weather Bureau station in the State, each voluntary station, and each weather crop reporter of this service, to 423 daily and weekly newspapers in the State, 4 of the largest agricultural papers outside of the State, 103 post-offices in the State, each State weather service, and to the following railroads, viz, the Atchison, Topeka and Santa Fe; the Chicago, Rock Island and Pacific; the Kansas City, Fort Scott and Memphis; the Missouri, Kansas and Texas; the Missouri Pacific, and the Union Pacific.

In connection with the weekly bulletin, a weekly rain chart is issued showing the distribution of rain over the State during the preceding week, and is based on the same reports that are used in compiling the bulletin. Three hundred copies of this chart are milliographed and sent to the State educational institutions, a large number of post-offices, three high schools, the public libraries, the State societies—agricultural, historical, horticultural, etc., county agricultural associations, and the observers.

The monthly bulletins are printed by the State Board of Agriculture, 5,000 copies being printed each month for general distribution. Owing to a law passed by the last legislature requiring all State printing to be submitted to a board on printing for approval before incurring the expense, this feature of the work has been seriously, though unintentionally, hampered by much delay in getting the monthly data into the hands of the public and thereby tending to discourage a few of the voluntary observers.

A monthly rain chart is issued with the bulletin, by aid of the milliograph, and 300 copies distributed on a plan similar to that of the weekly edition.

In connection with the monthly rain charts are issued 50 charts showing the departure from the normal temperature and 50 showing departure from the normal rainfall for the month, based on records extending from six to forty years. These, being prepared for study, are issued in a limited quantity and sent to meteorological investigators, and a few scientific institutions interested in this line of study.

Meteorological and climatic data have been compiled by this office, at various times, for the State Board of Agriculture, the State Horticultural Society, some of the railroads, and occasionally for newspapers, while each autumn requests come from many of our largest cattle-owners for information covering the preceding season, to enable them to decide where to winter the cattle, at home or in some other part of the State.

The present director has begun the study of two important subjects—hot winds and the relation of rainfall in Kansas to areas of low pressure. The daily details of the State service, together with those necessarily devolving upon him in its connection with the National Service, permit of but slow progress, yet much encouragement is had from the progress already made.

It is here desired to acklowledge the valuable assistance afforded this service during the year by the Chief of the Weather Bureau, without which its measure of success would have been reduced to a minimum.

KENTUCKY.

(Frank Burke, Weather Bureau, director.)

Until the early part of August last, the Kentucky weather service was operated under the auspices of the Polytechnic Society of Louisville. During the latter part of that month, owing to lack of proper support by that body, it was transferred to the charge of the observer at Louisville, and has remained under his direction to date.

The expansion of the service and the appreciation of its benefits by the public during the past year have shown a marked and most encouraging increase. It has now passed beyond the tentative period of its existence and is rapidly acquiring a substantial footing among the recognized public institutions of the State. Though the attempt made two years since to secure legislative support for it met with failure, there is every reason to believe that a second presentation of a bill providing for its maintenance would be successful. The wide dissemination of its publications throughout the State, the interest manifested in it by the press, and the display of weather forecast signals in most of the important towns, have accomplished much in the way of educating the people to its purposes and benefits. That there is a largely increased interest in it is evinced by the comparative ease with which observers and crop correspondents can now be obtained, which work was formerly attended with the greatest difficulty. The outlook for the service is brighter now than at any other period in its history, and, despite the many drawbacks incident to its progress in this State, it has advanced to a position of recognized usefulness, and, with proper support by the general assembly of the State, will compare favorably with any other similar organization in the country.

The number of forecast telegrams sent out daily at present is 40, a larger number than at any other time since the organization of the service. These figures, however, do not by any means represent the extent of the actual displays made in the State, as about a third of the places to which the telegrams are sent serve as subcenters of distribution, from which they are distributed in various ways throughout the contiguous country without expense to the Government. The telephone is utilized extensively for this purpose in the interior towns, and the whistle system is rapidly acquiring popularity in places where the facilities for its use exist. It is to be regretted that the telegraphic system of the State is so incomplete, as frequent cases have arisen of places where the warnings were greatly desired by the people, but which, owing to lack of proper communication, or to excessive "other lines" tolls, the possibility of sending them was precluded. The numerous applications for, or inquiries relative thereto, and the willingness of most displaymen to incur the expense of purchasing flags for the display of signals, give ample evidence of the increasing popularity of this branch of the work of the service. Efforts have been made, from time to time, to increase the distribution of warnings through the mails, but it has been impracticable to do so, except to a limited extent from this center. This is due mainly to the lack of departing trains at suitable hours and the infrequent stops made by those which might be available for the delivery of forecasts. There are, however, a number of displays made by persons who obtain the forecast from the morning papers, notably along the line of the Louisville Southern Railroad.

The frost-warning system of Kentucky is perhaps the most highly developed in the country. Although the weather conditions of the past autumn did not admit of the best utilization of these warnings, the knowledge of the coming of a dangerous frost would have been promptly received by at least 250 persons, and by them distributed throughout their respective districts. The manager of the Newport News and Mississippi Valley Railroad, and the manager of the Western Union office here have rendered valuable aid in the perfecting of this system. The Louisville Tobacco Board of Trade has assisted in the work by the subscription of funds for the purchase of frost-warning flags and in securing reliable displaymen in all parts of the tobacco districts of the State. A single frost warning sent out at a critical time may result in immeasurable benefit to tobacco-growers, but great care should be exercised in the phraseology of the telegrams, and a clear distinction made between the predictions of light and heavy frosts, as the cutting of the crop while partially green is more injurious to it than are the effects of a light frost.

There are issued weekly at the present time 500 copies of the crop bulletin. This includes many sent outside the State, and represents nearly double the number issued last season. The report is compiled from the weekly statements of about 200 correspondents distributed through all the agricultural counties of the State. Its publication in nearly all of the principal newspapers of the State secures for it a wide circulation, which is constantly increasing. The addition of the rainfall chart to the bulletin has greatly enhanced its value and has excited much interest and favorable comment. The reports are especially valuable during that portion of the season while tobacco is maturing, and they are eagerly read by speculators and others interested in that crop. It is intended to make the condition of this important staple a special feature of the reports, and to that end the number of correspondents in the tobacco-growing counties is now being largely increased. With the completion of the arrangements now in progress, very complete reports will be received from every tobacco district of the State. It is in contemplation to issue, at regular intervals during the remainder of the season, a special tobacco bulletin. It is thought that there is a need for such a publication and that it will meet with the approbation of everyone interested in the crop.

At the commencement of the year there were 18 stations in operation from which meteorological reports were received. None of these were discontinued wholly, but from several of them full reports were not received. At the present time there are 32 stations making full reports and 13 rainfall stations. The work of increasing the number of these stations is necessarily slow, as by past experience it has been found that scarcely more than half of those who signify their willingness to undertake the work fulfill their promises. Consequently great care has been exercised in the selection of observers, and as a result nearly all on the present list have proved to be competent and reliable. The strictures placed upon this work by the inadequate supply of instruments available for issue has prevented a larger increase than that exhibited. Thirteen stations were, however, supplied with rain gauges purchased by funds raised through subscription among the tobacco dealers of Louisville, and the observers thereat will make temperature and other observations as soon as the necessary instruments can be issued to them.

It is hoped that during the present year some method will be devised to accomplish the printing of the publications of the service, and thereby save the vast labor entailed by the present duplicating process, the results of which at the best are very unsatisfactory. This may be done through the coöperation of the State Board of Agriculture, but that organization has at present no funds available for such purpose.

A field for work for the service in this State which would doubtless be most prolific of good results and practical benefits is the study of the climatic influences affecting the growth of tobacco, which is by far the most important crop raised in the State. No plant is perhaps more keenly susceptible to soil and weather conditions, and a knowledge of the influences to which it is subject would more than repay the research required.

Another matter which might be embraced within the scope of the work of the State weather service is the investigation of local climatic peculiarities. There are many well-authenticated cases in the State of comparatively small areas which show markedly different climatic features from their environments. Excessive or deficient precipitation, the relative frequency and character of frosts, light or killing, are subjects which might be considered in this connection. It is within the power of a well-equipped weather service to throw much light upon these and kindred matters, and it is hoped that at an early day some attempt may be possible toward the accomplishment of these ends. It is a matter for congratulation that at last its efforts are meeting with the encouragement and appreciation of those who derive the greatest benefit from its work. Its further extension is now but a matter of means for the consummation of the ends in view, and there is scarcely room to question the willingness of the next general assembly of the State to provide them.

LOUISIANA.

(George E. Hunt, Weather Bureau, director.)

The year closes with 49 active stations, rendering regular weekly and monthly reports; of these 31 are strictly voluntary, the remainder being cotton region, river, and sugar and rice observers, who, in addition to their regular work, coöperate in the State work, and their reports form a part of the State publications.

The generous action of the Chief of the Weather Bureau in extending the scope covered by the Government forecasts, and furnishing prepaid weather and temperature messages to parties interested, meets with high appreciation in this State, as is testified by the fact that there are now 30 stations receiving the forecasts daily by telegraph. Many of these stations were furnished flags by the Government, by means of which they display the forecasts on flagstaffs which they have erected; others have provided themselves with flags at their own expense, while the remainder give the forecasts publicity by means of bulletins which are posted conspicuously at post-offices and other places of general resort. In addition to the above, there are 21 points accessible at an early hour by the morning trains from New Orleans, which receive the forecasts by mail.

The establishment of 7 stations in the sugar and rice region of this State was brought about mainly in my capacity as director, and several of the appointed observers were selected from the old voluntary corps. These stations are: Baton Rouge, Donaldsonville, Franklin, Lake Charles, Opelousas, Rayne, and Schriever. Additional stations were authorized at Covington and Point-a-la-Hache, but they have not yet been placed in working order, owing to a question of telegraphic communication at the one place and the inability to secure a competent person to assume the duties at the other. The reports from these stations are valued additions to the meteorological records of the State, as they come from districts devoted especially to the cultivation of sugar and rice.

The popularity of the weekly weather crop bulletin continues undiminished, while its circulation has increased to over 200 copies. In addition to its private distribution, which is large, it reaches every newspaper in the State, and is reproduced generally in their columns.

As in previous years, the publications of the State service have been prepared and distributed without cost to the Government. It has depended upon the advertising patronage of the Weather Journal and a monthly subscription of $12 given by the commercial bodies of this city for its support. The amounts received in this manner have sufficed to defray all expenses, giving a gratuitous distribution of meteorological data published in the Journal to representative citizens in all portions of the State, and to many persons in adjoining States whose requests for the paper have been granted. The director has all along had in contemplation the plan of placing the State service on a permanent basis by means of legislative enactment whereby sufficient funds would be appropriated to render it independent of both national and private aid, and at the same time admit of a more complete and satisfactory publication of the meterological data complied at the observing stations. In this matter he moved slowly and cautiously, not forgetting the fact that several previous efforts in that direction had started out with every promise of success, only to meet with complete failure. In sounding the sentiments of the people, he found unanimous approval of his plans; the representative men of the city and country gave their hearty indorsement, and the leading dailies of the State discussed the matter in their editorial columns, urging that the proposed bill be made a law.

Copies of these editorials were forwarded to the chief office from time to time as they appeared. Encouraged by this hearty support, the director framed a bill to establish a State weather service for the State of Louisiana, coöperating with the United States Weather Bureau, for the collection and dissemination of crop statistics and meteorological data, which was introduced in the legislature by the Hon. S. J. Kohlman.

The bill was considered favorably by the appointed committees in both houses, but the director now learns that action on it has been indefinitely postponed, leaving its fate an uncertainty. It is hardly probable that the bill will pass, the main obstacle which now, and has in the past, prevented its becoming a law being the lack of funds in the State treasury.

In the event of the failure of the bill to become a law, the service will, of course, continue as at present; and while the work can not be conducted on as high a plane as the modest ambition of the director might desire, it will, with the support of the voluntary observers, continue to be a power for good to the commercial and agricultural interests of Louisiana.

MARYLAND.

(Dr. William B. Clark, director; Dr. C. P. Cronk, Weather Bureau, assistant director.)

Forty places in Maryland and Delaware are supplied with weather forecasts and special warnings. Of these 20 receive them by telegraph at Government expense, 23 giving the forecasts to the public by means of flags, 2 giving them by means of whistle signals, and 3 stations displaying the frost and cold-wave flags only. Four of the remaining 12 stations or persons receive the forecasts by mail, the other 8 by telephone.

The benefits from the forecasts have been acknowledged in many cases, and there has been but one instance during the year of telegrams being discontinued for want of interest in the forecasts. The increasing interest in the forecasts is shown by the numerous applications for them received both from Maryland and Delaware.

Up to June 14 the issue of the Weekly Weather Crop Bulletin had averaged 1,500 copies, there having been a gradual increase from 900 to nearly 2,000. The expense of so large a weekly edition being greater than the size of the printing fund warranted, the post-offices of the State were stricken from the list, and consequently the weekly edition has been reduced to 800. Since the change in the day of issuing the bulletin from Saturday to Tuesday, it has been printed weekly, in part or in full, by several State papers, so that it is given a wide circulation.

The attention given the bulletin by the newspapers is perhaps the best evidence of its popularity and value, but letters received from many farmers give direct proof of its usefulness. Through the medium of the bulletin, farmers are enabled to institute a closer comparison of their own crops and soils with those in other sections, and to determine better the value of the product. It also creates an additional interest in farming, and opens the way to improvement in agriculture and the enlightenment of the farmer. The number of correspondents is now 54, and is increasing.

Monthy reports were issued until November, 1891, when, from the lack of funds, publication was temporarily suspended. However, a bill appropriating $2,000 annually for the maintenance of a State weather service was passed by the legislature of Maryland, and signed by the governor with the understanding that but $1,000 annually should be used.

Considerable trouble was encountered in the devising of plans for the publication of complete and presentable reports commensurable with the small balance available for printing. Finally it was decided to begin a new series of reports with the April number, and to include in this report a summary of the four months from December, 1891, to March, 1892, inclusive. This was done, and the edition numbered 2,000. The report for the month of May, current year, has also been issued, and that for June will soon follow. A neatly engraved map, in colors, exhibiting the monthly distribution of rainfall and monthly isotherms is included in the report. This publication has been well received.

There are now in operation 19 voluntary meteorological stations, and of these 9 have been established during the fiscal year ending June 30, 1892. Five stations have been discontinued during the year. With a transportation fund for use in establishing and inspecting stations, much better results could be accomplished in the securing of competent and reliable observers and in the giving of necessary and important instruction relative to the proper usage of instruments and the correct method of preparing meteorological forms.

MICHIGAN.

(E. A. Evans, Weather Bureau, director.)

Owing to the failure of the State legislature of 1890 and 1891 to appropriate means whereby the State service could be maintained, and in order to economize in the expense of keeping up the work of the service, the station at Lansing was discontinued July 31, 1891, and removed to Detroit August 15, where the work has since been carried on.

The work of the service has been the establishment of voluntary observers' stations throughout the State and to collect the reports of such voluntary observers for publication each month. There has also been published in connection with the summary of each report charts showing the rainfall and temperature for each month. These charts show graphically the temperature conditions and distribution of rain throughout the State.

There are 54 stations receiving forecasts and cold-wave warnings by telephone, and 32 by telegraph at Government expense. Of these 86 stations, 83 are displaying flags and 3 sound whistle signals.

There are 32 stations on the line of the Detroit, Grand Haven and Milwaukee Railway, which receive the p. m. forecasts through the superintendent of this railway by telegraph over its lines free of cost to the Government. These forecasts are used for bulletin purposes, frames having been supplied at Government expense in which the messages are posted upon receipt.

Railway train signals are carried upon seven of the railroads in the State, as follows: Detroit, Grand Haven and Milwaukee Railway, Chicago and Grand Trunk Railway; Port Huron Division, Grand Trunk Railway; Michigan Central Railway, Chicago and West Michigan Railway, Grand Rapids and Indiana Railway, and Pontiac, Oxford and Port Austin Railway. The forecasts in general have given excellent satisfaction throughout the State, and many favorable comments have been received at this office as to the correctness of same.

The average issue of the Weekly Weather Crop Bulletin from this office is 366.

This feature of the work in this State is fast becoming popular and of great interest, more particularly among the farming community, as is evinced by many in their willingness at all times to coöperate and extend the area of circulation of the bulletin. Together with the bulletin issued every Tuesday is a chart showing the distribution of rainfall during the week and departure of temperature from the normal. There are at present 91 crop correspondents reporting to this office weekly.

Relative to the change of date of issue of the bulletin from Saturday to Tuesday, I would state that under the old plan the Michigan Farmer, with large circulation among the agricultural districts of the State, published the bulletin in full, with the rainfall chart; but owing to the fact that their publication day was Friday, and most of the reports closed Saturday, the weekly bulletin and chart was discontinued on account of the information not being available for publication. This was a net loss of nearly 20,000 circulation in the State.

There are 4,000 monthly summary of reports of voluntary observers published in this State by the secretary of state at Lansing, of which 260 are sent out from this office, the balance being distributed by the secretary of state.

There are in operation in the State 102 voluntary observers' stations. During the past year 9 new stations have been estabiished and 11 discontinued. Considering the work of the observers being entirely voluntary, great credit is due them for their faithfulness and the care and accuracy with which their records are kept.

MINNESOTA.

(J. H. Harmon, Weather Bureau, director.)

When the present director took charge of the service, August 5, 1891, the crop correspondents numbered 40, voluntary observers 18, regular observers of the Weather Bureau 5, and display stations 15. The policy outlined by the previous directors has been continued, and the progressive policy of the Chief of the Weather Bureau has been pursued, and at the present time the crop correspondents number 142, voluntary observers 40, display stations 90, and the regular Weather Bureau stations 6.

The Weather Crop Bulletin continues to be the leading feature of the service, and every effort is made to give it the widest possible circulation both through the mail and publication by the press, it being printed on Tuesday and mailed that night to 300 addresses, mostly in this State. There is also published a bulletin containing the report in detail from each correspondent, a general summary of conditions and precipitation chart, graphically drawn. These are furnished whenever requested.

The interest in the service has generally increased during the past year, resulting in a large increase in the work of the station, necessitating additional assistance.

The demand for the daily forecasts has been so great that applications for them had to be discouraged. Of the display stations established during the year, in all but two instances the display flags were purchased by enterprising citizens or by the city councils.

It is much to be desired that rain gauges be furnished to certain crop reporters in order that the rain chart may be of greater value; also that the number of voluntary observers be increased until each county is represented.

The time required to manifold the crop bulletin with the rainfall map by means of the milliograph process is such as would warrant an effort being made to have the appropriation increased to such an extent as to allow the same to be done by some local printer, or by means of logotypes in this office. This would allow a circulation of from 5,000 to 10,000 copies in place of a few hundred. Reports could then be printed upon one sheet that now require three, and would be in much better form for display as exchanges, etc., as a concise report is generally desired, and a report of over 2 pages is seldom looked at. A sheet of a uniform size should be used for this purpose whenever possible, with a heading that will plainly show the State for which it is a report. This suggestion also applies to the monthly reports issued by the various State weather services. The monthly report of this State service consists of a general summary, a report by stations in detail, and a precipitation chart.

The Minnesota State service receives no financial aid from the city, State, or from any private institution.

MISSISSIPPI.

(Prof. R. B. Fulton, Weather Bureau, director.)

There has been a large increase in the number of stations in this State desiring and receiving the daily forecasts. This is due to a rapidly growing interest in the work of the United States Weather Bureau throughout the State, to an intelligent apprehension of its aims and methods, and to the coöperation of the Louisville, New Orleans and Texas and Illinois Central Railroads.

There are 48 stations (display) receiving forecasts at Government expense by wire, and 58 by telegraph through the coöperation of the railroads named above, 17 others receive the cold-wave warnings by mail from near telegraph stations. Most of these stations display flag signals.

There has been a decided improvement in the promptness with which messages are transmitted.

As the public is being educated to appreciate the purpose and value of the forecasts the demand for them increases.

An effort will be made next season to distribute cold-wave warnings largely to small post-offices away from telegraph lines by mail from regular display stations. A satisfactory beginning of such work was made last winter through the coöperation of Mr. B. T. Webster, of Louisville, addressed cards being furnished from this office.

The storm and wind signals displayed by volunteer displaymen on the Gulf coast at 3 stations have been much appreciated by the maritime interests, for whose use they were intended.

The work of this office has been largely directed toward educating the public by correspondence and other means to a fuller appreciation of the forecast work of the Bureau, and with more success than in any preceding year.

It is probable that the weather forecasts will soon become as important a factor in business, domestic, and social life as the accurate measurement of time for practical purposes has become.

The edition of the Weekly Crop Bulletin issued is continually enlarging, and now amounts to 220 copies per week. These are distributed to crop reporters, to newspapers, to business exchanges and firms, and to the weather services in other States.

They are sent regularly to 13 daily and 32 weekly newspapers, which publish them in whole or in part. Many dealers in staple agricultural products request special copies.

Reports are received from about 50 counties in the State, covering the most important agricultural districts.

In making up the weekly bulletin the brief synoptical form seems to be most popular, but some daily papers prefer the extracts from the original reports from the counties. These are given occasionally at critical times in the weekly bulletin.

For the monthly bulletin reports are used from 44 stations in the State, some of the observers being cotton region observers, who continue their records during the winter season as volunteers.

The number of new volunteer stations established during the year is 4, and the number of stations discontinued is 3. A number of other stations have been applied for within 50 miles of some established station.

From the very considerable damage wrought by freshets in the larger tributaries of several rivers in the State, notably in the case of the Tombigbee, Big Black, Tangipahoa, and Yalabusha last spring, it is certain that an increase in the number of river stations in the State would be valuable to many interests. They should be placed for the protection desired nearer the head of each stream than the highest limit of navigation, and possibly on important tributaries. I suggest that such information as these stations could furnish by telegraph in regard to rainfall and stage of water would afford valuable protection to many interests.

Such stations would be serviceable at Tupelo and Tibbee or Muldrow on the head waters of the Tombigbee; at New Albany and Grenada on the Tallahatchie and Yalabusha; at Durant or West's on the Big Black; at Jackson or Byram on the Pearl.

The channels of these streams are filling up year by year, and their valleys consequently rendered more liable to overflow.

MISSOURI.

(Levi Chubbuck, director; H. A. McNally, Weather Bureau, assistant director.)

The State legislature which met last year, recognizing the importance of and benefit to be derived from, extending and systematizing the work of the department of the State Board of Agriculture, included in its appropriations the sum of $1,000 to be expended annually in purchasing instruments and other paraphernalia to be loaned voluntary observers, publications of data obtained therefrom, more extensive dissemination of the weekly weather crop bulletin, and other necessary expenses incidental to the better equipment of the service and the facilities for carrying on the work. The benefits derived from this appropriation are obvious, and the general method of expenditure is discernible under the various headings noted later in this report.

The meteorological data for the year ending December 31, 1891, occupies 32 pages of the Twenty-fourth Annual Report of the Missouri State Board of Agriculture, and the briefness of this report as compared with that of one year ago is due solely to the fact that the force and time at the disposal of this office, while the matter was being prepared for publication was entirely inadequate to the compilation of the data at hand in a manner calculated to do justice to the amount of work performed during the year.

The weather forecasts, cold-wave and frost warnings (for flag display and whistle signal purposes) are issued from St. Louis and Kansas City, the poor telegraphic facilities of this office making such action advisable. The only forecasts issued from this office are 62 bulletins daily (Sundays and holidays excepted), which are distributed by the various trainmen to stations along the line of the Wabash Railroad from Columbia to Centralia, from Centralia west to Kansas City and east to St. Louis, and from Moberly north to Coatsville. A telegram is received at this office from St. Louis, its contents set in type and printed, bulletins inclosed in envelopes, and the packages, properly arranged, delivered to the 11 a. m. train for distribution. The average time of receipt of telegram, coupled with location of this office, off the main line makes the carrying out of this work in a satisfactory manner difficult, and distributing the blank bulletins to stations now receiving them from here and sending the forecast telegram through the train dispatcher of the railroad, for copy and display at proper points, is a scheme recently recommended, and the accomplishment of which would be a decided improvement. Four stations receive the forecasts by mail, but the cold-wave and frost warnings are sent there as well as the other stations by telegraph and at Government expense. In addition to 55 stations receiving cold-wave and frost warnings, there are 40 special frost-warning stations. This makes a total of 95 stations receiving frost warnings during the season when they are considered valuable, and the matter and method of enlarging the number is now under advisement. This material increase over last year, coupled with the attention paid by both press and public to this branch of the service, seems the best available criterion by which to attest its reliability and popularity.

The Weekly Weather Crop Bulletin is now printed in pamphlet form, and has been subject to considerable change and improvement as regards manner, form, and date of issue, the latter permitting a noticeable addition to number of copies furnished weekly papers of the State. The weekly issue is at present, in round numbers, 1,000 copies, divided as follows: Weekly State and general agricultural newspapers 350, crop correspondents 250, State weather services, grain exchanges, and private individuals, 400. Its extensive publication by the papers, thorough dissemination by the Associated Press, and receipt of numerous telegraphic requests for information derived therefrom, prove that the publication is rapidly increasing in popularity among those interested in the agricultural resources and interests of the State—a result incident to an undisputable reputation for thoroughness and reliability. As soon as the number of stations permanently established, and the available resources will permit, the issue of a normal and current weekly temperature and rainfall chart in connection therewith will be commenced, though it is hardly expected that such action will be deemed expedient during the present growing and harvesting season.

To aid in collecting the data necessary to the study of climatology and meteorology of the State, which in future years must prove of inestimable value and benefit, there are connected with this service 100 voluntary observers located at points carefully selected as regards geological formation and general topography of the State. These observers make daily observations of temperature, precipitation, prevailing wind direction, character of weather, heavy rains or snows, hailstorms, thunderstorms, and in fact all atmospheric disturbances or optical phenomena. A system for thorough and accurate collection of thunderstorm data is now being put in operation. Forty-four new stations have been established and nine old ones discontinued during the year. These changes coupled with 65 active stations of one year ago, make up the 100 mentioned above, and extra instruments now available, together with intended purchases, promise at least 125 fully equipped temperature and special rainfall stations by December 31, 1892. From the data thus collected and systematized a monthly bulletin is compiled, and 300 pamphlet copies of 20 pages each are issued for distribution to other State weather services, voluntary observers, professors in schools and colleges, and private individuals interested in the work. A most decided improvement in efficiency and number of tables, as well as other interesting data in this publication, has recently taken place, and an enlargement of the pamphlet is a matter of the near future.

The thanks of the service are due to the press of the State for the valuable assistance it has rendered in disseminating the forecasts, cold-wave and frost warnings, and the information issued by this office; to the voluntary observers and crop correspondents for the interest shown and the promptness and regularity with which they have performed gratuitous labor, and to the Chief of the Weather Bureau for detail of instructed and competent men, the use of the penalty frank for mailing purposes, supplies furnished and instruments loaned, as well as other effective coöperation and assistance rendered.

MONTANA.

(E. J. Glass, Weather Bureau, director.)

This service was organized in November, 1891. The director met with considerable difficulty in getting the service organized on account of want of time to devote to State work, as he had just assumed charge of Helena station on October 24, 1891.

In December quite an addition was made to the service by a circular letter sent to post surgeons of the four military posts in Montana, inviting them to send copies of their meteorological reports to this office each month. This was soon followed by authority from the Surgeon-General to have them send their reports through this channel to Washington.

The director has endeavored to give in his monthly report a full report of the weather conditions of the State, by publishing the daily readings of the maximum and minimum thermometers, mean daily temperature, and the daily precipitation from each of the stations. This has done more to get the people of Montana interested in the reports than anything else, for by it they can see that this service is a great advertisement for the State.

The Board of Trade indorsed this service when it started, and in March presented the service with a printing outfit, so that the report could be sent East and present a nice appearance.

Crop bulletins began April 16, and are sent to each newspaper of the State, directors of other State services, and to crop correspondents and voluntary observers of Montana service. This necessitates a weekly issue of 135 bulletins.

The monthly report has a circulation of 120 per month. The typesetting, folding, and binding are all done by the director. The presswork is the only part that is done by outside parties, at a cost of $10.50 per month. The total expense of editing the report is about $32. To defray this expense advertisements are inserted, and the funds derived therefrom have been barely sufficient to pay the expenses.

There are several additional features which the director wishes to add to the report. The most important is having two maps engraved, the size of the page, of the State of Montana, similar in style to the maps contained in the New York monthly report; one to be used for the precipitation and the other for temperature. Maps in a report of this kind form one of the most important features, as they enable a person to see at a glance the general features of the weather for the month.

The Montana service needs a great many more observing stations established, and also crop correspondents.

If the director was so situated that he could make a tour through the country where stations are needed, he is of the opinion that quite a number of stations could be established.

It is the intention to issue in January, 1893, an annual report of the Montana weather service, which will be a complete record of all observations taken during the year of 1892. It will contain a review of the weather and crops, and if data can be obtained it will contain the number of acres that was farmed and the number of bushels of grain harvested. The annual summary for each station will be published separately, and will contain the daily maximum and minimum temperatures, precipitation, and mean daily temperature by months. For this purpose the director is having matrices taken each month of the five tables published monthly. This issue will be quite large and will be sent mostly to the World's Fair at Chicago for distribution.

There is one difficulty which is an injury to the Montana service, and that is the poor exposure some observers in this service have for their instruments. At times the variations from the true temperature is so great as to call forth remarks and doubts as to the value of observations from those stations. I therefore recommend that instrument shelters be furnished to observers of this service, so as to have the conditions the same at all stations for the thermometers.

NEBRASKA.

(Prof. Goodwin D. Swezey, director; G. A. Loveland, Weather Bureau, assistant director.)

The Nebraska State weather service has continued during the past year in the same line of work and under the same direction as in the preceding year, but with increased appreciation of, and interest in, the work by the people of the State.

The State Board of Agriculture accords the service the same cordial support and financial aid that it did last year. Doane College, in addition to the generous aid that they have always given to the service and to the study of meteorological questions affecting the interests of the State, are preparing to build an office for the central station and equip it with a full set of self-registering instruments.

The daily weather forecasts and cold-wave warnings have been furnished at Government expense to forty points for display during the year. Owing to the location of the office and the poor telegraph and mail facilities, the work of distributing the forecasts has all been performed by the observer of the Weather Bureau at Omaha.

The most popular work of the service has been the issue of the Weekly Weather Crop Bulletin during the growing season. Reporters for this bulletin have now been secured in nearly every county in the State, and several in some of the counties, the total number reporting being 175. An average weekly issue of 400 copies is distributed, principally in the State. This bulletin is published in all the leading dailies in the State and in a large and constantly increasing number of weekly newspapers. The expressed appreciation of this bulletin has far exceeded that of previous years, and the large number of requests for the bulletin testifies to its real value to the people of the State.

A monthly bulletin has been published as heretofore, the edition being 200 copies. Commencing with the issue for January, 1892, in addition to the precipitation map formerly published, a chart has been used showing the prevailing wind direction and the monthly mean temperature, and also a third chart showing the daily temperature at the central station, with the daily temperature of the past month.

There are now 85 stations rendering meteorological reports monthly. There have been 14 stations established and 4 discontinued during the past year.

NEVADA.

(Charles W. Friend, director; Ford A. Carpenter, Weather Bureau, assistant director.)

Weather forecasts have been received by telegraph during last year at five stations: Carson City, Reno, Austin, Hawthorne, and Eureka. In this city the forecasts have been of value to the ranchers and market gardeners near town, and also have been of interest to the people at large. The daily telegram is published each afternoon in the Nevada (Evening) Tribune, and in this way the information is more widely scattered. At Reno the benefits are about the same as at this place, while at Austin, Eureka, and Hawthorne the reports from the displaymen are not of an encouraging nature, all of these places being mining towns, and consequently but little attention is paid to agriculture. In a few instances the signal flags have resulted in saving some vegetables and warning orchard-owners of frost, but unfortunately there are hardly any direct results. It is hoped that the increase in agricultural pursuits during the coming year will make the forecasts of much greater value.

The Nevada State Weather Service Review has been issued regularly on or about the 15th. This report has the usual weather and crop news, with the customary tables, charts, etc., together with a precipitation map and a temperature map, also diagrams illustrating the daily precipitation and temperature at the central station. Two hundred and fifty copies of the Review comprise the monthly edition.

Seven voluntary stations have been established during the year—Stofiel, Wabuska, Belleville, Tuscarara, Wellington, McDermitt, and Empire Ranch—not including the railroad stations which have commenced issuing reports to this office during the past year. Three stations have been discontinued—Sodaville, Candelaria, and Punch Bowl—no reports having been received within the period designated for delinquent voluntary observers, and no answer being received from communications addressed them on the subject. There are 35 stations reporting to this office.

NEW JERSEY.

(E. W. McGann, Weather Bureau, director.)

This important branch of the service, since July 1, 1891, has been greatly extended through the liberality of Prof. Mark W. Harrington, Chief of the Weather Bureau, who now furnishes not only the daily weather forecasts, frost and cold-wave warnings by telegraph, but also the necessary signal flags, at the expense of his Bureau. The high percentage of verifications from these forecasts has increased the confidence of the people to such an extent that many farmers drive several miles to obtain the information conveyed by the flags displayed. While visiting the several stations I have heard only the most favorable comments regarding their great value, not only for the agriculturist, but to all engaged in any of the several walks of life. Especially is this interest manifested by teachers and children attending the public schools, and from whose school buildings the flags are displayed.

The forecasts furnished to these stations are from three sources, viz, those determined from the 8 p. m. reports from the central office, Washington, D. C., and those from the 8 a. m. by the local forecast officials in New York City and Philadelphia—the former to the central and northern portions and the latter to the southern portions. The number of display stations at the close of the fiscal year 1891 was 16. During the past year to this number 23 stations have been added, so that at the close of the present year we have 36 stations which display the daily forecasts by means of flag signals and 3 by steam whistle signals, making 39 in all. But this number does not represent all the stations displaying the forecasts, as they are received and bulletined by many of the telegraph operators at the stations of the various railroads running through the State.

In the interest of the cranberry-growers of the State 25 stations were selected by Mr. A. J. Rider, secretary of the Cranberry Growers' Association, for their especial benefit. The importance and value of these warnings are set forth in the following letter received from Mr. Rider:

"I would say that we have again had the good fortune to be exempt from killing frosts in New Jersey till the cranberry crop was nearly if not all secured. I know of but one or two cases where the crop was not secured when frost came, and in those the warnings enabled the owners to flood and protect the fruit. I beg, on behalf of the cranberry-growers, to assure you of our high appreciation of your efficient and valuable services, and although the time has not come for a striking and telling illustration of the value of these warnings, we are thankful for the feeling of safety and confidence which your service has brought us during the critical period."

The publication of the weekly weather crop bulletins for the season of 1892 was commenced on Saturday, May 6. The total number issued each week is 1,500, making the total number of copies issued during the season 30,000. The producers of the

State are especially interested in these bulletins, having learned their value from the issue of previous years in estimating the yield of the various crops and the probable effect on the price of farm products. The press of the State regard the bulletin as one of the most valuable features of their papers. At the weekly meetings of the Farmers' Alliance the bulletin is read and is the chief topic for discussion. This branch of the service has continued, as in the past, to be its most important feature. In a letter received at this office the secretary of the State Board of Agriculture says:

"I must compliment you on your weekly crop reports. They cover our State very thoroughly and give a comprehensive idea of the progress the several crops are making."

The number of stations forwarding meterological reports to this office at the close of June, 1891, was 46. Of these 3 have been discontinued and 9 added, making a total of 52. These are now equipped with standard instruments, which greatly improve the reliability of the reports submitted. An increased interest has been manifested by all observers, and the reports received during the year show a degree of accuracy which is certainly most creditable to all concerned. These reports upon receipt are carefully examined, means determined, and printed in neat pamphlet form, of which 500 are issued monthly from this office. This branch of the service has also gained in public estimation. Prof. J. B. Smith, State entomologist, in his annual report says:

"The reports of this bureau will eventually form one of the most important factors in the determination of probabilities of insect injury. When we have sufficient data, we can say with some certainty whether climatic conditions do or do not exercise a marked effect on insect development. If they do, as is possible, the character of the season may often determine the measures to be adopted, or will enable us to decide whether it is worth while to adopt any at all."

Rev. T. S. Doolittle, D. D., vice-president of Rutgers College, in a letter received at this office, says: "Let me take this occasion to commend the work of the New Jersey State weather service. It is not only of great value to farmers, who get much knowledge from your bulletins and circulars in regard to the weather prospects and the gathering of crops, but is of interest to many others. It is this kind of accurate scientific information made productive of practical benefits that the people want and prize."

These resolutions were unanimously passed by the Burlington County Agricultural Society:

"Our board at the last meeting indorsed the weather bureau of the State, and advise appropriations by the State to insure its efficiency and continuance. As an educational organization the weather bureau stands preëminent. On the climate of a country depends its production and its habitation. Pleasant and salubrious climates and productive soils are sought after, and it is by this bureau that the information concerning the weather and crops is collected and disseminated.

"Schools and colleges are studying and making weather observations, thus training the minds of the young in weather wisdom and lore, giving to them an understanding of the physical laws under which all live and to which people owe their existence and products.

"The crop reports issued by our bureau have furnished the most valuable collection of statistics ever issued by the State. Coming with regularity and accuracy, the press and public have learned to depend upon them for information relative to the condition and prospects of the crops. They are of especial value to the farmer, for they furnish him with an approximate idea of the year's production, and thus enables him to regulate his sales to advantage. The intelligent, progressive farmer will study the crop weather report of his State and the world at large, and then sell his crops at the most opportune time.

"To railroads and merchants, and all classes of business men, they are invaluable. As agriculture is the backbone of this country, its productions affect all business enterprises; hence, nearly every citizen thus is shown the value and practical utility of the weather bureau.

"The laborer, the mechanic, the professional man, the horticulturist, viticulturist, each and all are affected by weather changes and conditions past, present, and to come."

In order to place this service on a permanent footing, and to obviate the necessity of asking for an appropriation each year, and the annoyance and uncertainty as to whether the legislature would or would not make the necessary appropriation, a bill was introduced January 18, 1892, and was unanimously passed by both branches of the State legislature early in the session, and was approved by his excellency, Governor Leon Abbett, April 7, 1892. The most important feature of this bill is, that it places the New Jersey State weather service on a permanent basis, with an annual appropriation amply sufficient to defray the expenses laid out by its board of directors.

NEW ENGLAND.

(J. Warren Smith, Weather Bureau, director.)

Up to March, 1892, the work of this service was continued under the New England Meteorological society, with the office at Cambridge, Mass. It consisted of the regular routine work of the society, as issuing monthly and weekly bulletins, correspondence, etc. In addition, the 5-year table of temperature and precipitation was completed and other work done on the annual report for 1890. The preparation of this table and of the account of the Lawrence tornado, by Prof. W. M. Davis and Messrs. Clayton and Mills, delayed the publication of that annual until May, 1892. This has hindered the work on the annual investigations for 1891, and very little has as yet been done on that. It will be printed by the society in the Annals of Harvard College Observatory, together with investigations of the thunderstorms of 1886 and 1887, as soon as the tables and summary can be prepared.

About the first of the year correspondence was carried on by the Chief of the Bureau and the director of the New England Meteorological Society relative to transferring the weather service work to the National Bureau, they to establish a New England weather service. Arrangements were finally made for the change and the office and effects were moved to the Weather Bureau office at Boston on March 29, 1892. A decided advantage has been found in being located at the center, and in connection with the local forecast official for New England. He has kindly given the use of one of his best rooms, and has extended every assistance possible, and is always ready with counsel and advice.

The several features of the work have increased in value and importance to considerable extent since the transfer and will be taken up separately:

The establishment of the display stations has gone on slowly, but gradually, and without any especial effort on the part of the service. All the information possible has been given, and whenever requests have been made, care has been taken to first learn if the proposed location was in a desirable place, and if the forecasts are desired by the people. In this way I think they have been generally situated in places where they are appreciated and are doing much good. Many are sending the forecasts to surrounding villages, and our aim is to increase that part of the work much more. Telephone lines will receive especial attention. The local and forenoon forecasts are most desired by the displaymen, and that they are greatly appreciated and generally found to be of value and importance in the daily life of those who see the flags or hear the whistles is shown by letters from the displaymen.

Considerable is being done in Maine in sending the daily forecasts by the railroad trains, and a good deal in Connecticut. The observer at New Haven deserves great credit for his efforts in this line in that State. If his plans succeed that he is now working on he will, through the railroads and the Southern New England Telephone Company, reach nearly every town in the State. But when this is accomplished all is not done. In very many cases the forecasts may be posted in the depots for days, almost, without being of any benefit to those most interested. In the busy season of harvesting the farmer does not take the time to drive several miles to read the forecasts. Some method must be urged for displaying the forecasts by flags or giving them by whistles. I believe that the grange can give the most assistance in this; and that through action of the local granges these forecasts can be taken at the depots and given to the people. The train service is good as far as it goes, but must be supplemented by something more. We hope that through the new association in New England the masters of the State granges may become interested, and thus set the local granges at work.

About a dozen frost-warning stations are now being established. We are, however, in correspondence with the president of the Tobacco Growers' Association and also of the New England Cranberry Growers' Association relative to these warnings, and both seem interested and promise to bring the matter up officially.

Reports are being received with a fair degree of regularity from 128 crop correspondents, well scattered over New England. Up to June 6 the crop bulletins were issued by the duplicating process, and about 275 copies were sent out to correspondents, newspapers, exchanges, etc.; but beginning with the following week, arrangements were completed with the Massachusetts State Board of Agriculture whereby the bulletins have been printed and the number sent out increased to over 2,200.

Through the winter months we issue an advance bulletin on the 3d or 4th of each month giving a brief summary of the weather for the previous month for publication only. It is sent to all newspapers on our list. In the summer it is considered that the weekly bulletins fill the place of the monthly. The monthly bulletin has been increased to 10 pages since the transfer, and is now issued about the 12th or 13th of the month following the one for which it is the record. The paper for the bulletin is furnished by the Bureau and the money for printing is furnished by the New England Meteorological Society, the Harvard College Obsevatory, the Massachusetts

State Board of Agriculture, the Massachusetts State Board of Health, the Massachusetts Agricultural Experiment Station (a small amount), the New Hampshire Agricultural Experiment Station, the Maine State Board of Agriculture. Next year we hope to have the New England association take hold of it, or else the different State agricultural experiment stations take the responsibility of printing it. We shall increase the pages as the funds for printing will admit, as there is no difficulty in finding interesting material enough to fill them.

There are now 164 voluntary observers reporting to this service, including the regular stations in New England. Of this number 18 are in Maine, 22 in New Hampshire, 14 in Vermont, 79 in Massachusetts, 11 in Rhode Island, and 21 in Connecticut.

NEW MEXICO.

(H. B. Hersey, Weather Bureau, director.)

Early in June, 1891, the observer in charge of this station called the attention of the Chief Signal Officer to the necessity of a weather service for New Mexico, but owing to the approaching transfer of the Weather Bureau to the Department of Agriculture no action was taken in the matter. Immediately after the transfer the new management gave the matter attention and the observer was instructed to organize a Territorial weather service.

The first monthly bulletin issued was for the month of August, 1891, and was based on the reports of 13 voluntary observers.

This work has steadily grown until at present reports are received from 33 voluntary observers throughout the Territory.

There have been many obstacles to overcome in organizing this service that are not met with in many of the States and Territories. A large part of the population of New Mexico are conversant with the Spanish language only. This is particularly noticeable in the outlying agricultural districts.

Another obstacle is in the poor mail facilities, making it impossible to get reports in time to issue the bulletins as early in the month as would be desirable. For this reason it was not thought advisable to issue weekly crop bulletins, but instead to issue them monthly.

The growth of the service has, I believe, been very satisfactory, under the circumstances. The Territorial press has kindly given its support from the start, and I am especially under obligation to Col. Max Frost, of the Daily Santa Fe New Mexican, whose strongest support can be relied upon in this work at all times.

Nothing has been done in the way of forecasts, flag warnings, etc., but that matter is receiving consideration at the present time.

It is believed that local forecasts would be of great benefit, and could be made with a good degree of accuracy by one familiar with the local climatic peculiarities of this country, with the aid of a sufficient number of telegraphic reports to refer to.

Two monthly bulletins are issued at the present time, a weather crop bulletin about the 3d of the month succeeding that covered by the bulletin, and is based on the weekly reports of about 30 crop correspondents. A weather bulletin is issued as soon after the close of the month as the monthly weather reports are received at this office, usually about the 12th of the month. This consists of a summary of the weather for the month, tabulated data from each station, and a map with the total precipitation and average temperature for the month charted thereon by the use of shaded areas and isotherms.

About 200 copies of each bulletin are issued monthly by the cyclostyle process, and distributed to the Territorial press and interested parties for the benefit of the public. The Territorial papers very generally publish the summary in full, and some publish the tabulated data also. Twenty voluntary observers' stations have been established during the year and 4 discontinued on account of the observers leaving the place and no other available person being found to continue the work. The general interest of the public is steadily increasing in this work, and several new stations will soon be established.

NEW YORK.

(Prof. E. A. Fuertes, director; R. M. Hardinge, Weather Bureau, assistant director.)

The work of the bureau has been carried on in the same general lines as heretofore pursued. The year closes with 77 voluntary stations (including 5 military posts) reporting on more than one element, and 34 special rainfall stations, while the reports from 6 Weather Bureau stations are also received and published in the monthly report. Endeavor has been directed rather to improving the value of reports from stations already secured than toward establishing new stations.

In September 10 anemometers, with self-registering attachments, were set up at 10 stations well distributed in the State. From 6 of these stations good records have been received, but owing to the stress of other work no use has yet been made of these valuable data.

The special thunderstorm reports are being received from about 80 observers in the State, but the discussion of these valuable reports has also been retarded.

There has been no radical change in the form of the monthly report, of which 650 copies are distributed monthly.

The Weekly Weather Crop Bulletin has steadily increased in popularity, as may be evidenced by the fact that of more than 100 applications received during the year 25 were from newspapers, and several more from the principal hay and produce exchanges in the State. The crop bulletin is that part of the service which can be directly appreciated by the public; and particular pains are taken to have the statements made in it comprehensive and unbiased. The present issue is 475 copies weekly. In general, the bulletin is published, in whole or in part, by the most influential papers in the State, particularly those treating of agricultural matters as a specialty; and many flattering notices have been received from the editors relative to the value which is attached to the publication of it by their patrons. A map of the State, charted with the weekly rainfall, is also published weekly in the New York Homestead and in the New England Homestead, and assurances have been received that it has met with very general appreciation.

Of the 75 crop correspondents 30 are regular observers, 34 special rainfall observers, and 11 report on the condition of crops alone.

Special endeavor has been directed during the year to a further dissemination of the official forecasts by the establishment of display stations. The papers were interested in the project, and with their aid and the very general distribution of circulars the proposed extension of this branch of the service was thoroughly advertised.

It was offered to furnish a limited number of flags to displaymen, and for this purpose 40 full sets and 80 cold-wave flags were purchased by the State bureau. As a result there have been established 107 full display or whistle signal stations, and 20 frost and cold-wave warning stations, during the year, making a total of 136 stations receiving the forecasts for flag display or whistle signals, and 20 frost and cold-wave warning stations in operation on June 30. Thirty-nine of these display stations were furnished flags by the United States, 58 by the State, and 59 furnish their own flags, sound the whistle signals, or post the forecasts in bulletin frames. This, however, by no means represents the total number of places in the State displaying or bulletining the forecasts. Many of the stations along the principal railway lines post the forecast message as received from the trains, while an indefinite number display the signals from press dispatches. The benefit derived from these displays is very great, especially in the grape and tobacco-growing sections and during the harvest times.

As the number of stations and the running expense of refurnishing flags increase, the need of a durable signal becomes more emphasized. A semaphoric signal, although originally more expensive than flags, would cost less in the long run.

In order to determine where the displays are properly appreciated, it is suggested that but one set of flags be furnished to the same displayman. This will have a tendency to weed out those stations where the displays are of no particular benefit to the community, but are used solely for advertising purposes.

NORTH CAROLINA.

(Dr. H. B. Battle, director; C. F. von Herrmann, Weather Bureau, assistant director.)

The work of the service during the past year has been the dissemination of forecasts, the preparation of the regular monthly and annual meteorological summaries, and the issue of the Weekly Weather Crop Bulletin. During the first half of the year 1892 efforts were directed to increasing the number of display stations and establishing a new system of frost-warning stations. A system of mailing forecasts to as many stations as could be reached the same day from the central office at Raleigh was also inaugurated.

In October, 1891, advantage was taken of the opportunity afforded by the presence of the Southern Interstate Exposition at Raleigh to popularize the work of the meteorological division, and, with the assistance of the Chief of the Weather Bureau, an exhibit was made of all the instruments employed in meteorological investigations, with many charts, pictures of typical cloud formations, etc. Complimentary tickets to the exposition were issued to all voluntary observers and displaymen, not as compensation, but as a token of appreciation of the services they have rendered the State by their voluntary labor. The exhibit was of a nature to attract attention and was viewed with great interest by many people.

The rooms occupied by the State weather service are located on the third floor of the Agricultural Building, corner of Edenton and Halifax streets, and are well lighted, large, and comfortable. The work at the central station is rapidly increasing. In April, 1892, the issue of the regular morning weather map was commenced. It is posted at 10 places in Raleigh, and mailed to 20 towns in the vicinity.

During the past year the number of stations receiving weather forecasts by telegraph has been increased from 24 to 55. The number of stations receiving frost warnings has been increased to 46. The forecasts and special warnings are disseminated by means of the regular system of flags and whistle signals used by the Weather Bureau. Stations receiving the daily forecasts are all provided with complete sets of 5 flags; those receiving frost warnings only have the cold-wave flag. The frost-warning stations are scattered chiefly in the tobacco-raising districts.

Since January 1, 1892, forecasts have been issued regularly every day (except Sundays) for a period of thirty-six hours in advance instead of for twenty-four as heretofore. This has enabled the director to establish a large number of stations, which receive the forecasts by mail from Raleigh on the same day they are issued. Small frames have been supplied and the forecasts are posted for the benefit of farmers. This system has met with marked approval. The number of stations receiving forecasts by mail is now 160.

The value of the forecasts is undisputed. It depends on the skill of the farmer in understanding and utilizing them. Many farmers who receive the frost warnings neglect to take precautions or make any effort to protect their crops, and hence suffer loss. In the spring the frost warnings are of special value in the southeastern part of the State, where early fruit (strawberries) and truck crops are raised.

The Weekly Weather Crop Bulletin has been received with increased favor. One thousand two hundred copies are printed and distributed every week. The appearance of the bulletin has been improved by a new heading and a rearrangement of the reading matter into more convenient form. The number of crop correspondents is 300, of which number 150 report with great regularity. A dozen new 3-inch rain gauges were issued in June, 1892, making the total number of correspondents who report rainfall about 36.

The change in the date of publication from Saturday to Monday has been very acceptable to the press of this State. Most of the weekly papers are published on Wednesdays, Thursdays, and Fridays, and under the new arrangement are enabled to publish the crop bulletin the same week as issued, which was formerly not the case.

As evidence of the value of the crop bulletin may be cited the fact that the substance of it is telegraphed to a number of papers; that a large number print the bulletin entirely or in part; that certain merchants at Raleigh have special lists of persons to whom they mail the bulletin at their own expense.

The monthly meteorological reports have been issued regularly during the year. An improvement in the arrangement of the matter was made at the beginning of the year 1892, the latitude and longitude, elevation, and name of observer being given for each station. The number of monthly reports issued is 600. Each report averages 16 pages in length.

The annual report of the State weather service for 1891 is nearly completed. The edition to be printed is 4,000 copies. The report will be used as part of the exhibit of the North Carolina Department of Agriculture (State weather service) at the World's Fair.

During the years 1891 and 1892, 6 stations taking meteorological observations were established and 4 discontinued.

The total number of stations from which reports are received is 52.

NORTH DAKOTA.

(W. H. Fallon, Weather Bureau, director.)

As instructed in letter from the Chief of the Weather Bureau, dated Washington, D. C., July 23, 1891, steps were immediately taken to inaugurate a North Dakota weather service, which was finally consummated August 15. Prior to that date the work was conducted conjointly with the service of South Dakota. The number of stations then established in North Dakota, 24, served to form a splendid nucleus for a beginning. At date, monthly meteorological reports are received from 40 stations, including 4 regular stations of the Weather Bureau and 1 army post. During the year 17 voluntary stations were established and 6 discontinued. Although the above figures show but a gain of 11 stations, there was an actual increase of 14, as 3 of those transferred never rendered a report.

At time of transfer, August 15, 1891, there were 13 stations receiving daily forecasts for display of weather and temperature signals. Since then 19 additional have been established and 7 discontinued, making at date 25 in coöperation. All but 5 of this number have procured their own flags. The forecasts are supplied to all stations through the St. Paul and Minneapolis offices, on account of their facilities for quick distribution. In addition to the above number of display stations, there have recently been established 9 stations for special warnings of frost.

The first issue of the Weekly Weather Crop Bulletin was made for the week ending April 9, 1892. Since that date an average of 250 copies have been issued weekly. The work of obtaining crop correspondents was pushed vigorously during the first two months of the present calendar year, and every opportunity taken since to secure additional ones. At date 110 names are on the list as correspondents, representing every county in the State under cultivation. On an average, 75 of the correspondents render a report weekly. The bulletins are printed in full every week by at least 5 dailies and 5 weeklies, and occasionally by 4 dailies (two in Minnesota) and 15 weeklies. In such a thinly populated State as North Dakota this fact alone shows the interest taken in the work. In fact, this branch of the State service is the most important feature of all, and it is safe to assert that at least three-fourths of the intelligent farmers of the State read the reports. Many commendatory expressions have been made and received.

For the first half of the fiscal year the monthly bulletin was an extremely condensed, crude affair. Since March it has steadily improved in appearance and increased in size, and to-day it contains as much important climatic data as any similar publication received from the other State services. This improvement in the bulletin and increase in its edition was brought about, firstly, by the assignment to duty at this station of an assistant, and, secondly, through the aid received from the Bismarck Chamber of Commerce in printing, at its own expense, the bulletins in pamphlet form. The number of bulletins issued monthly has increased gradually from 100 in August to 200 in June, making an average issue of 150 copies.

No aid is at present received from the State for prosecuting this work; but such aid is practically assured from the next legislature, in January. The Bismarck Chamber of Commerce has obligated itself to bear the expense of printing the bulletins and providing an additional office room until aid is received from the State, which fact alone will cause its members to work hard for the legislation. The subject was also broached to a large number of the legislators during a late special session and met with much favor and promises of help.

In reviewing the work accomplished by this service during the past year, it is respectfully requested that the Chief of the Weather Bureau consider that the entire population of the State is less than 200,000; that an extremely large number of this population are foreigners, unable to speak or read English; and that, excepting along the lines of the Northern Pacific and Great Northern Railroads, the western half of the State is practically unsettled, making it extremely difficult to obtain but a few voluntary observers in that section.

OHIO.

(L. N. Bonham, director; C. M. Strong, Weather Bureau, assistant director.)

During the last half of the year 1891 the general work of the service was carried on as in preceding years, reports being received and published monthly. The same plan was carried out until, by an act of the legislature on April 12, 1892, the Ohio meteorological bureau was abolished and a "State weather and crop service," under the auspices of the State Board of Agriculture, was established. The duties to be performed by the old service were strictly the reception and printing of reports from voluntary observers; under the new law the duties are enlarged, not only to include those of the old service, but also adding thereto the publishing of a weekly weather crop bulletin, the issuance and distribution of weather forecasts, frost, cold-wave, and flood warnings, and all other matters pertaining to the climatology and meteorology of the State. The law also created the offices of director, assistant director, and one or more local experts; the director and local experts to be appointed by the State Board of Agriculture.

The distribution of forecasts of weather and temperature, cold-wave and frost warnings from Washington, Cincinnati, and Cleveland was conducted through the local service during the year. At the opening of the year 25 points displayed these signals, but through the efforts of the service and the generous coöperation of the Chief of the Weather Bureau the number of points has been increased to 88 at the close of the year. Besides these, 6 points receive frost warnings only. The messages from Cincinnati and Cleveland are prepared by the local forecast officials at those points from the morning weather maps and telegraphed to the central office at Columbus; they are then distributed to points over the northern and southern sections of the State to which they apply. These messages cover the weather conditions for the thirty-six hours following. At the points receiving these messages they are either displayed by means of flags or sounded by means of whistles for the benefit of the surrounding communities. Of the two methods the latter is proving by far the most successful, as the signals can be heard by means of powerful whistles for miles away from the point of dissemination. The resulting benefits to all classes from the present wide distribution of these daily weather messages are proving to be very great. Thousands of farmers are enabled to obtain this information and act accordingly during the season of cultivation and harvesting, and have been enabled to carry their operations to a more successful issue than they were capable of doing before this information was at hand. Merchants are using it in their shipments, builders in building operations, and hundreds of others benefit by it in the common walks of life. The cold-wave warnings during the past winter were very successful, and were highly commended by the people in the different parts of the State. The local newspapers of the different communities have taken great interest in this branch of the work, and publish in each issue the weather forecast and such other information obtainable for the benefit of their readers. At all points where the messages are received they are regarded as indispensable, and are eagerly watched for and acted upon. It is the intention to carry this information to every community in the State that desires to receive it, as it is one of constant benefit and should be enjoyed by all.

The first issue of the Weekly Weather Crop Bulletin was made April 9, 1892, consisting of 1,500 copies; this number was increased to 2,000 copies weekly April 15, and to 3,500 copies June 13, 1892. Requests are received daily for the report, and the issue will have to be further increased before the close of the current season. The numerous applications for the report are satisfactory evidence of its value and popularity with the people, and the agricultural class in particular. It is eagerly sought after and published by the newspapers of the State at large, and by their means carried to thousands whom the service could not reach otherwise and supply with the information in the bulletins. Over 700 daily and weekly newspapers of the State are supplied with this report on the day of issue and publish the data in full or in part. The number of crop correspondents now exceeds 700; of these, on an average, 500 report weekly, and at times reports are received from the full list; the number of reports varying as the press of work permits the correspondents to meet the demands on their time; uniformly, however, the duty of reporting promptly is attended to, and sufficient reports are received from all counties to give an accurate and fair statement of the prevalent conditions. The correspondents are all men who make agriculture their business, and are to be depended upon for the reliability of the statements forwarded to this office. In connection with this work the establishment of rainfall stations reporting maximum and minimum temperature readings and amount of rainfall has been commenced, and 50 correspondents have been supplied with these instruments in different parts of the State during the month of June. It is the intention, as the means at hand permit, to supply all correspondents and thus render their reports of direct value as to statements in regard to temperature and rainfall in connection with the crop condition.

Reports were received during the year from 5 Weather Bureau stations and 71 voluntary stations. Fifty rainfall stations were established at the close of June.

Much more effective service could be secured in the distribution of the local weather forecasts if the local forecast official was stationed at the State central office, or by the distribution of the forecasts directly from the office where they are made. A great deal of valuable time is lost through the transfer of the message, averaging over an hour each day. A great increase in the distribution of these messages could also be secured by supplying each displayman with cards to send copies of the messages through the mails to surrounding towns and to persons who will be benefited by the information.

In this connection I desire to say that great credit is due to the voluntary observers of this State for their uniform willingness and promptness in rendering reports. At no time during the year has any complaint been made in the performance of the arduous duties imposed necessarily for a proper performance of the work. Very few reports are missing from the records, and their value is correspondingly increased by their continuity.

To further increase the efficiency of the local service, the suggestion is offered that it would be advisable to include the crop correspondents on the list of persons to whom the reports of the Department of Agriculture and the general Weather Bureau are sent.

The director desires to express to the Chief of the Weather Bureau the thanks of the service for his generous coöperation and assistance rendered during the year, without which the local service would have been seriously crippled and unable to have carried on the work so successfully.

OKLAHOMA.

(Louis Dorman, Weather Bureau, director.)

On July 23, 1891, the observer at Oklahoma City was instructed by the Chief of the Weather Bureau to take steps toward the establishment of a State Weather Service for Oklahoma Territory, and was at the same time appointed director of it.

Circulars were accordingly sent throughout the Territory, calling for voluntary observers, but it proved a difficult task to secure them, due in part to the recent settlement of this Territory and the unsettled condition of affairs in general at that time, and partly to the fact that everybody was intent on the opening of the new lands. No pains were spared, however, and the efforts of this office continued until at the present writing there are in active operation 20 stations of observation besides 2 stations which report rainfall only. The service is now established on a solid basis and will expand as the new counties lately opened are more densely populated and better mail facilities are provided. During the year 9 weather forecast and special frost and cold-wave stations have been established in the two Territories. The necessary flags have been furnished by the Government and the telegraph messages are sent to the different stations from Kansas City at Government expense. Although considerable benefit has been derived from these messages by the public, it has not been so great as it would have been had the a. m. forecasts been telegraphed instead of the p. m., as has been the case. At present the former are sent and the increased benefits are quite perceptible and the forecasts give much greater satisfaction to the general public.

The weekly issues of the national and State weather crop bulletins were resumed on April 9, 1892. Two hundred bulletins are issued at this station every week, printed in column size on sheets 10 by 15. A remarkable interest is taken by the farmers at large in these weekly crop reports and the local press comments very favorably on the same.

Fifty-seven crop correspondents report to this office.

The Evening Gazette prints the editorial portion and the rainfall report on Tuesday afternoon, the day of issue, and the whole report in the weekly edition on the following Friday. The Times-Journal prints the report in its entirety in the Wednesday morning issue and also in the weekly paper.

Sixty monthly reports are printed at this station. They contain meteorological data from 23 stations, comprising daily maxima, daily minima, and daily mean temperatures, daily rainfall, and a summary of miscellaneous data.

Twenty-two stations are in operation. Fourteen stations have been established during the year. One station (Chandler) was abandoned by reason of inability to secure an observer. One station (Sac and Fox Agency) was established in its place.

Six counties in the western portion of the Territory, opened to settlement on April 22 last, are not yet represented on the monthly reports. It is recommended that stations be established at each county seat of those counties as soon as mail lines will have been established, which will probably be done during the next six months.

OREGON.

(H. E. Hayes, director; B. S. Pague, Weather Bureau, assistant director.)

There has been an increase in the number of weather forecasts of from six displaymen in 1890-'91 to thirty-one displaymen on June 30, 1892. During the year special display stations have been established in the city of Portland, the forecasts being delivered by messenger. There has also been established a very complete system of railway train bulletins, covering 700 miles, representing 149 stations on the Northern, Union, and Southern Pacific railways, the Oregon and California Railway, and the "Oregonian Railway." This is the first year of general dissemination of forecasts in Oregon, and they meet with popular favor. There have been words of praise for the forecasts from every section of the State, but owing to the newness of the service the people have not learned to appreciate them and depend upon them as when they are more fully understood. Then, too, there is not that interest in the forecasts in Oregon at the present time that there is in other States, owing to the regularity of the climate and the fact of few interests to be affected. I am pleased to say, however, that where the forecasts are displayed the people appreciate them and would not wish to see them discontinued. By an extension of the forecasts to the more rural section, together with continuous and good service, there will be greater benefits and popularity will ensue.

The weekly crop weather reports have been the great feature of the service, and they have received commendation from the press and people of the State. Being issued with regularity, representing every county and almost every election precinct in the State, there has been most accurate and trustworthy information laid before the people. All reports are issued at the same time so as to prevent any sign of favor in their distribution and every newspaper is furnished with a copy.

The leading papers of the State base their editorial opinions relative to the crops on the weekly reports, and many papers rely entirely on the bulletins for their information as to the growing crops. In the editorial part of the weekly bulletins special attention is paid to the general development of the crops, conditions that will prove favorable to them, the general outlook and prospects; and in the four years of the service in Oregon the reports have proved to be accurate, and the outlined prospects as published have proven to be correct, hence the reports have a reliability for accuracy and are appreciated. There are 225 bulletins issued each week, mailed principally to the Oregon papers, and they are published in over 120 newspapers, sometimes as a whole, sometimes part, and then paragraphs are extracted and made as "locals" There are 285 crop weather correspondents. The monthly reports embody climatic matter, original articles on subjects pertinent thereto, and tables giving general meteorological data. They are printed by the State of Oregon in the State printing office; 2,000 copies are issued each month, and average from 25 to 35 pages.

The number of reporting stations has been increased from 53 to 65 during the year, and 90 per cent of the reports are regular, complete, and accurate. There were 3 discontinued during the year on account of the number of instruments broken and neglect of work.

Soil observations have been continued during the year at Pendleton and Corvallis.

Barograph and thermograph records are made at 4 stations.

The funds of the service, appropriated by the State, are expended for instruments and equipments. By the State constitution the printing is done by the State printer. The State has so far given the service admirable support, and judging from the interest taken in the service by the press and public, it is appreciated.

By coöperation with the Oregon Agricultural College a systematic study of the effects of the various climatic conditions on the growing crops is being carried on. The hot, dryings winds of May and June do the damage to the wheat crop, and this is especially the point for valuable study.

From personal experience I have found that the best thing for the service is to visit the various voluntary observers, become acquainted with the people, study their surroundings and occupations, attend the meetings of the agricultural societies, farmers' institutes, horticultural society meetings, grange meetings, etc., read prepared papers on subjects pertaining to the Weather Bureau and its relation to the people.

PENNSYLVANIA.

(W. P. Tatham, director; H. L. Ball, Weather Bureau, assistant director.)

During the year the work of the service has increased steadily, both in the accumulation and distribution of meteorological data. Special attention has been given to improving the system of disseminating the forecasts and warnings. To this end coöperation of the principal railroads was invited, and circular letters were sent to principal newspapers in the State, informing the public that display stations would be established wherever the needs of the community demanded such a display. The result of this has been a revival of the railroad bulletin system and the establishment of many stations at points where the forecasts were never before displayed.

On the Pennsylvania Raildroad system bulletins are displayed daily at 133 stations. On the Frederick division of this road the signals are displayed from the baggage car on two trains.

The Philadelphia and Reading Railroad display bulletins twice a day at 333 stations. In addition, 250 flag-display stations are in operation on this road.

Forecasts, cold-wave, and frost warnings are sent from Philadelphia, Pittsburg, and New York City to about 50 persons, who display them by flags or by steam whistles.

About 15 stations display flags from forecasts received from the railroad office without expense to the United States.

Other and important means of disseminating the forecasts are through the efforts of the voluntary observers. Some of them are centers from which bulletins and messages are sent to inland towns which would otherwise be deprived of the forecasts, being cut off from telegraphic communication or without means of obtaining the daily papers in time to make the forecasts of value. The observer at Phœnixville has six towns to which he telephones the forecasts. At Selins Grove the observer sends messages to three towns about 5 miles distant from his station.

At Johnstown bulletins are prepared and sent to about 30 stations on the Baltimore and Ohio, and Pennsylvania railroads.

I was surprised to learn while conversing with the voluntary observers of the great interest shown by the farmers of their neighborhood. They said that often farmers, whom they had never seen before, would call upon them for information in regard to the weather, and that they were frequently consulted by men of other occupations, as tin-roofing, plumbing, house-painting, etc., before entering upon work that would extend over several days. The constant and increasing demand for data furnished by the State service and the Weather Bureau best shows in what esteem and of what value their work is to the public.

Many letters have been received from men who may be considered to stand in such relation to the public as to voice its sentiment. The following is from the observer at Wilkesbarre, Dr. A. W. Betterly, and is but one of many: "Our farmers are deriving great advantages from the labors of the Weather Bureau. They are learning to consult the weekly bulletins which are being published in our local newspapers, from which they learn that like produces like. The wide publication of these crop bulletins is stimulating extra efforts among our cultivators to show their proficiency as compared with their brother farmers throughout the county; and notwithstanding their recognized intelligence and observing faculties, this general awakening has inspired a desire to still further advances in their methods to overcome the perplexities which arise from our varied seasons. Even those 'away back,' who once declared that education was not essential in their business. now admit that a knowledge of the changing seasons and disturbed elements surrounding them, is necessary for the intelligent and successful cultivation of their land. Truly the labor of the Weather Bureau is resulting in great improvements in agriculture."

In Pennsylvania most of the crops are safely housed before time of frost, unless the frost is unusually early. Tobacco is most exposed, and attempts were made to establish a system of stations from which warnings could be given to the growers. This crop is raised principally on a small scale—that is, fields of from 1 to 5 acres on a farm. Hence it would be difficult to establish a sufficient number of stations to make the warnings of benefit to many; but, as quoted from the foregoing letter, the farmers are awakening to a realization of the value of these warnings, and strenuous efforts will be made to establish a complete system for these warnings.

To do this, certain points must be selected as centers from which the warnings can be sent to inland towns and villages. This plan has already been started and will be followed up wherever practicable.

The Weekly Weather Crop Bulletin continues to be one of the most valuable features of the State service.

On an average 340 are issued weekly by duplicating process. These are widely distributed through the city and State, and are regularly published by a large number of daily and weekly newspapers. The number issued being limited by reason of having to use a duplicating process, we used strenuous efforts to make the bulletins of such interest as to attract the attention of the press throughout the State, and in this way many thousands can be reached who would never see the bulletins if printed and circulated by mail. Seventy-five correspondents furnish the data from which the bulletin is made. The correspondents are zealous in the work, and send reports from every section of their county.

I know of no way in which to express the value of these bulletins other than to say that they are highly praised by all, and judging from their extensive publication, they meet a long-felt want in giving accurate data to the public at regular and short intervals.

One hundred and forty copies of the monthly reports are issued by duplicating process. Great care is taken to make these bulletins accurate and attractive. These are regularly printed in full in the annual report of the Secretary of Internal Affairs, and of the Board of Health of Pennsylvania.

Fifty-eight voluntary meteorological stations are in regular operation. Some few are located at schools which close during the summer months.

The voluntary observers, as a whole, are deeply interested in their work, and are extending in many ways the usefulness of the service.

Most of them regularly furnish their local papers with meteorological data and with crop bulletins.

Nine voluntary stations have been established during the year, of which all but one were furnished with instruments belonging to the State; and two stations have been discontinued.

When appropriations are obtained from the State, each station will be visited at least once in each year.

About one-third of the stations were visited during March, and the resulting good was at once apparent.

By these inspections it is believed that many local improvements may be made in the way of disseminating the work both of the State service and of the Weather Bureau.

SOUTH CAROLINA.

(A. P. Butler, Weather Bureau, director.)

The service has been to some extent restricted in consequence of the State making no appropriation of funds to supplement the amount appropriated by Congress to enlarge and carry on the work.

Previous to 1891, the weather bureau was run as a branch of the work of the State Department of Agriculture, and had both the encouragement and assistance of the commissioner, as well as liberal financial support. The legislature refused to grant the amount asked for, thereby crippling the extension of the service.

The correspondents have responded to the call made upon them, and have generously contributed to the success of the crop reports which have been appreciated by the public. These reports have been condensed and published in the daily local papers immediately after issue from the central office, and is furnished to all of the State dailies and to 82 country papers; to correspondents, as well as to a number of stations, individuals, and daily papers in other States.

From the date of the last annual report to the 30th of June, 1892, there were 24 stations receiving the daily weather indications and cold-wave warnings, and displaying the proper signal flags to the public, and many more could have been added if the flags could have been furnished to parties who were anxious to display them.

There are at present 21 stations which furnish this office with miscellaneous data, temperature, rainfall, sunshine, and other phenomena. The data is collected and summarized and sent to the Chief of the Weather Bureau and published in a daily paper of this city.

SOUTH DAKOTA.

(Sam. W. Glenn, Weather Bureau, director.)

Under instructions from the Chief of the Weather Bureau dated August 18, 1891, all property, etc., relating to North Dakota was transferred to Bismarck, N. Dak. Since that time only the South Dakota service has been under my charge.

I feel justified in saying that the improvement in the service has been marked, and the benefits to the people, and their appreciation of them far greater than in former years. The aims of the service have become more widely known and better understood, and the reports issued from the central office are looked upon as more accurate and reliable.

There is, also, more care evinced by persons coöperating in the work. One of the most marked indications of growing influence is the number of visitors to the office from this and other States through local or scientific interest. The presidents of the several important educational institutions in the State have called upon the director and found great interest in his work. Members of the several faculties and superintendents of public schools have also found time and occasion to examine the work and be instructed in the working of the instruments at this station.

In the Huron schools a class in meteorology was formed, before whom the director read a paper on "practical meteorology." This class visited the office and received instruction in the practical work of meteorological observations, and had the mechanism and operation of the instruments in use explained to them. It is the intention of the principal to greatly increase the facilities for instruction in this science during the coming scholastic year, in which work the director, by request, will coöperate by practical instruction and lectures.

There is also a class in meteorology in the State Agricultural College, and the president, Prof. L. McLouth, speaks very highly of the weather chart as an aid in their instruction. Prof. Mauck, president State Institute, Vermillion, has several times expressed his appreciation of and interest in the work, and Prof. Akely, of the faculty of the same institution, expresses a high appreciation of the work and the value of the weather charts as aids to the study of meteorology.

Farmers are beginning to look upon this office as a bureau of information for their benefit, and there is hardly a day when several do not call. Prospective settlers are very frequent visitors.

Information requested by letter is always promptly furnished, and in this way the work is becoming widely known.

All but 4 of the stations now receiving forecasts have been established since July 1, 1891. Nine have been discontinued during the year—1 because displayman removed from the town, 1 temporarily, and 7 because of continued failure of displaymen to comply with the requirements.

There are now in operation in the State, outside of regular weather bureau offices, 63 stations receiving the forecasts.

It is believed that the forecast service in the State, as a whole, is very satisfactory, and that confidence in the daily forecasts and warnings is growing. It is found that the longer a station can be kept in operation the more the people appreciate the forecasts, although the displayman may occasionally lapse in his attention to the display.

Whenever it is convenient interested persons prefer inspection of the forecasts to depending alone upon the displays, especially with regard to thirty-six-hour forecasts.

In response to a circular letter relative thereto, it is found that at most points the service is highly appreciated, and, while of value to all classes and industries, the farmers are undoubtedly the most benefited, especially by frost and cold wave warnings.

During the autumn of 1891 and spring of 1892 frost warnings were disseminated by mail to all points that could be reached in season to be of value, and telegraphed to Rapid City and Pierre. They were generally heeded, and were utilized by farmers and "truck" gardeners.

The observer at Rapid City reports that the cold-wave warnings based on the p. m. charts would have been of more value had they been transmitted to him from Omaha immediately after he had filed his a. m. signals, which was possible by his office being connected with the main line by "loop." The forecasts are published daily in the Black Hills by the Deadwood Times and the Spearfish Bulletin, with appropriate symbols.

The Weekly Weather Crop Bulletin continues to be a very important and highly appreciated feature of State service work, and is in demand.

Through an arrangement with local newspaper publishers, it now appears in printed form, with a neat heading, and thereby attracts more attention than formerly, and is much more easily read.

The average weekly issue is 300 copies, for actual demand, while 25 copies are made as a reserve supply from which to draw for needs subsequent to the day of issue.

In seeking reporters for the bulletins of the present season, care was taken to obtain practical and responsible men, engaged in, or closely related to agricultural pursuits; consequently the editorial portion of the bulletin presents more closely the actual facts than formerly and gives more general satisfaction. In order to accomodate the bulletin to the limited space available for its publication in most of the newspapers, it is condensed as much as possible.

It is published in two daily papers issued from Huron; two at Pierre; one at Sioux City; three at Minneapolis; three at St. Paul; four at Chicago, and four weekly issued from Huron.

Through an arrangement made with the Publishers' Printing Company, Aberdeen, S. Dak., they use it in their ready prints, and, according to a list just furnished to this office by the manager by this means, it appears in 48 weekly papers published in South Dakota.

There are 125 correspondents, and the number is increasing as fast as the proper men can be found.

A monthly meteorological summary is issued, embodying all of the data contributed by the voluntary observers, also showing in charted form the conditions of temperature, precipitation and wind, and the normal temperature and departures therefrom. In addition, advance normal data for the State is exhibited, and comparative data from the records at this station.

The monthly summary is attracting much favorable attention, and has served to stimulate the voluntary observers in their work. It is looked for with interest, and this office is soon informed if one miscarries. Many of the recipients file them away carefully.

A carefully transcribed and compared copy of all data appearing on the reports from the several stations is preserved at this office for use in future reviews and essays, and for reference and the information of the people in individual cases of inquiry.

One hundred and sixty copies of the summary are now issued for actual demand, and 15 kept for occasions of need.

During the year 16 stations reporting temperature, precipitation, etc., and 14 reporing precipitation only, have been established, while 8 others, where unreliable private, or only "dry" W. B. thermometers were in use, have been equipped with W. B. self-registering instruments.

There are now in operation 44 stations reporting temperature, precipitation, etc., and 14 now, or will soon be, reporting precipitation only.

It is believed that most of the latter can be established as full reporting stations at the pleasure of the Chief of the Weather Bureau, as all of the observers are men who appear to take interest in their work.

Under authority of the Chief of the Weather Bureau (S. W. S., Div. 2-27-92) a limited number of gauges of exact dimensions and proportions of the standard W. B. gauge, made of tin and galvanized iron, were manufactured here, and sold to persons at certain selected points in the State at a merely nominal sum, in order to induce them to coöperate in the work as special rainfall reporters. Fifteen of these gauges have been located (limit 20) and doubtless good results will follow.

I beg to submit, that could the Bureau supply the voluntary observers with instrument shelters, it is believed much improvement would be seen in the records. While very many have constructed shelters, some very rude, and some good ones, there are doubtless some instruments exposed to danger of injury from storms and unauthorized persons.

I have reason to believe that could all stations in the State receiving forecasts be supplied with Government flags, more attention would be given by the displaymen to the prompt and continuous display of the signals.

TENNESSEE.

(J. B. Marbury, Weather Bureau, director.)

This service was known as the Meteorological Department of the State Board of Health, and its work was done under its supervision, with Dr. J. P. Plunkett as director, until October 16, 1891, when the State weather service was organized.

On December 16, 1891, as per instructions from your office, the title was changed to the Tennessee Weather Crop Service.

The changes in the list of voluntary observers since the last report have been comparatively few.

As a rule, the reports now received from observers are much more complete and accurate than they were one year ago. This improvement is due to a great extent to the numerous letters of instruction sent out during the year. The close of the year finds a very efficient corps of observers who report regularly to this office each month. They deserve a great deal of credit for giving their time and energy to this work, with no pecuniary returns. This is additional evidence of the growing interest in this branch of the general Government.

The number of unbroken records of rainfall is now sufficient to arrive at a reasonably correct normal for the State for each day of each month during the period of ten years. This data is now being tabulated in convenient form which, as soon as completed, will form a valuable addition to the records of this service.

It is also intended to work up the temperature, etc., in a similar manner, as soon as possible.

Immediately after organizing the Tennessee Weather Crop Service the director made strenuous efforts to obtain the coöperation of the department of agriculture of this State, so that the monthly reports of this service could be published in connection with those of this Bureau, but failed.

In order that these reports might have a wider circulation and be presented to the public in a better manner, I arranged for the publication of a monthly journal, the expense to be met by the money received from advertisements. This I am glad to say has proved successful, and on December 16, 1891, was issued the first number of the "Tennessee Journal of Meteorology," which has made its appearance regularly each month since. Through the liberal patronage of its advertisers and the friends of the service, I have been enabled to gradually improve each number, and the last issue is a marked improvement over the first. I have reason to think that I can make still greater improvements in this feature, as well as the general service during the ensuing year. The "Journal" now has a circulation of 1,000.

The most important of this service is the issuance of the weekly weather crop bulletin from the 1st of March to the 1st of November. Five hundred of these bulletins are printed by the milliograph process each Tuesday, and immediately mailed to the various State weather services, the press of this city and State, crop reporters, and others.

The daily forecasts, frost, and cold-wave warnings have been sent regularly to various persons throughout the State. The interest in these is on the increase, and more confidence is now felt in them than ever before. Many others could be furnished with these reports did the time of departure of mails admit of their reaching their destination in time to be of benefit.

Data collected by this bureau has been furnished the press, colleges, and railroads, during the year, and has been of much value.

It is earnestly hoped that during the coming year several new stations may be organized and equipped with a full set of instruments, and some that are now using their own instruments, many of which are of an inferior quality, be furnished a standard set.

TEXAS.

(D. D. Bryan, director; Dr. I. M. Cline, Weather Bureau, assistant director.)

The Texas weather service is a local organization receiving no aid whatever from the State. It is operated by the National Weather Service coöperating with the Galveston Cotton Exchange. The national service furnished the necessary instruments and the force at the central office for managing the business and handling the reports. The Galveston Cotton Exchange has appropriated $400 per annum, to be expended in publishing bulletins and reports, and for collecting any special data which may be desired in the interests of the service, While the number of new stations opened during the year has been small, there has been a marked improvement and an increased interest in the work of the service on the part of the voluntary observers. There are 71 voluntary observers, 6 post surgeons, and 7 regular observers, who render reports to this office monthly, making a total of 84 stations which are fairly well distributed over the State, although additional stations are desired, and application will soon be made for some new ones; 80 stations were discontinued during the year and 11 new ones established. The voluntary records are upon their receipt at this office, carefully examined and corrected, and the daily temperatures, maxima and minima, together with the daily precipitation, are published in the monthly bulletin, 500 copies of which are distributed free each month.

A weekly bulletin is issued by the typo-stencil duplicating process each week in the year, and the already marked popularity of this feature of the service was greatly augmented at the opening of the present growing season by the issue of a supplementary shaded chart (shaded by the Dey shading apparatus) showing the distribution of precipitation over the State. This chart has been prepared by the duplicating process up to the present, but the interest in this feature has become so great that the Cotton Exchange has authorized an additional expenditure for county maps of the State on which to exhibit the precipitation by shades, both weekly and monthly. Three hundred and fifty weekly bulletins are issued and distributed each week. This bulletin is telegraphed on the date of its issue to the following daily papers in Texas, outside of Galveston, which publish it in full: Dallas News, Fort Worth Gazette, Austin Statesman, Waco Day, San Antonio Times, and Houston Post. The substance of the bulletin is telegraphed to a large number of daily papers outside of the State. Special reporters have been secured in about two hundred counties, and these men display an interest which is deserving of very high commendation.

Weather forecasts and special warnings are sent to 36 places by telegraph at Government expense, and are furnished with the p. m. map to about 30 towns which are reached early the following morning. All communities receiving the forecasts express themselves as highly gratified, and state that they are of great value. It is hoped that this feature of the service may be considerably extended during the coming year.

The assistant director has continued the collection of data during the year relative to indigenous plants growing in different sections of the State with particular reference to the time of germination, flowering or fruiting, and ripening the fruit, for use in making a study of the agricultural climatology of the State. The extensive area covered by this State (nearly one-eleventh of the area of the United States, Alaska included), its varied topography, and elevation, ranging from sea-level to about 6,000 feet above, give it a diversity of climatic characteristics, and these call for a diversity in agricultural pursuits which is attracting considerable attention, but of which very little has yet been learned. It is believed that a carefully compiled report giving statistics bearing on the above subject will result in great benefits to the agricultural interests of the State generally.

With a view of improving forecasts issued from this office, the collection of information relative to thunderstorms was commenced in May, and special reports of each separate storm are received from about 200 counties, which will be studied to the best advantage possible by the assistant director.

In closing this report I desire to say that the generosity of the Chief of the Weather Bureau in extending and supporting this service is highly appreciated by the public generally.

UTAH.

(George N. Salisbury, Weather Bureau, director.)

During August, 1891, in obedience to directions, effort was made to establish a service, the first circular being issued on August 12 to the press of the Territory and others likely to be interested, and to aid in developing the service. Not enough interest was thus awakened to be encouraging, as no party or corporation decided upon the purchase of instruments or flags, though there were some responses, chiefly applications for the position of observer by those who thought there might be "something in it."

In September the Utah service was organized by the transfer of the voluntary observers of the national service in Utah to the charge of the director of the Utah service at Salt Lake City. Of these, all but 3 stations were supplied with Weather Bureau instruments. Since then 5 stations have been established, equipped with instruments supplied by the Bureau.

On the 23d of September the forecast official at San Francisco began to telegraph a forecast for Utah to the observer at Salt Lake City, but before the service was fairly organized, it was announced in letters from the Chief of the Bureau that no more funds were available for telegraphing forecasts at Government expense, and no more flags available for issue to display stations. As the forecast was at first an experiment, it was necessary to wait some time to learn if it would apply to a greater part of Utah as well as to Salt Lake and vicinity. Although the community, in circulars and bulletins was urged to do so, no party or place agreed to purchase flags or pay for telegraphing predictions. In November the Rocky Mountain Bell Telephone Company began transmitting the daily forecast to their stations, viz, Alta, Bingham, Logan, Ogden, Park City, Provo, Stockton. In January the Rio Grande Western Railway began telegraphing the forecast to their agents at Springville, Pleasant Valley Junction, and Green River, for display in bulletin frames. No special warnings have been made for the agricultural interests. It is not known that there have been any decided benefits from the dissemination of forecasts. Warnings during the periods when frost affects the young crops in spring and the unmatured crops in fall, would be of decided benefit, if timely and well displayed.

The weather-crop bulletin service was organized, in a tentative way, during last spring, and the first bulletin issued for the first week in April. Since then it has been issued weekly; average number of copies 60, which gives a copy to each correspondent, and to the press of the Territory, and various other parties. Its value has not been well determined; it has been published by the weeklies of the Territory, and the dailies of this city; it appears to be appreciated by the recipients. There are 27 regular correspondents representing 20 counties; 6 counties are unrepresented, 5 of which have almost absolutely no agricultural interests.

A monthly meteorological report has been issued since September; its readable summary has been much copied by the newspapers, and the report is apparently read with interest. Facilities for its preparation have been very poor, and with the present state of the mails it can not be prepared before the 15th of the month succeeding that for which it is the record; some interest in it is manifestly thus lost. Every reasonable effort will be made toward its improvement. The average issue has been 75 copies.

Twenty-nine voluntary stations are in active operation at date. They have all been established during the year; 24 of them were transferred from the national service; 3 stations are delinquent and practically "dead;" 4 have been discontinued.

The work of the service in this Territory has been experimental, as I have suggested above, and also frequently in letters, and it must of necessity be so. I do not know whether I have done so or can make perfectly plain the conditions that exist. In the first place, farming is carried on only in narrow, scattered valleys, and by means of irrigation only, scarcely any rain falling during the summer months; hence the advantage of weather knowledge is not so self-evident as in most of the States and Territories. Then, too, communication by mail is slow, and the telegraph is not sufficiently extended. The "Deseret" telegraph line is the only one available for reaching many of the southern communities.

VIRGINIA.

(Dr. E. A. Craighill, director; J. N. Ryker, Weather Bureau, assistant director.)

On April 15, 1891, the Virginia State Board of Agriculture passed resolutions providing for the establishment of the Virginia weather service, and authorized the expenditure of $15 per month for the publication of reports, to be made up from the reports of the voluntary observers in the State.

Of the 21 voluntary observers of this State who previous to the establishment of the State weather service had been reporting to the central office at Washington, D. C., 19 agreed to continue to furnish monthly reports through this office. The first number of the regular monthly bulletin of the Virginia weather service was issued on September 24, 1891, for the month of July, 1891, and consisted of an edition of 250 copies of an 8-page pamphlet containing 2 pages of summary and 5 pages of tabulated reports; the August and September numbers were issued on October 7 and November 7, respectively, and since that time each number has consisted of an edition of 250 copies, and published about the 25th to 30th of the month succeeding that for which it is a report. Copies are furnished to all the State officers, members of the Board of Agriculture, all State schools and institutions, superintendents of high schools, etc., and directors of other State weather services. During the year 11 additional voluntary observers have been appointed and 6 have been discontinued; 24 voluntary observation stations were in operation on June 30, 1892; 15 of which are equipped wholly or in part with Government instruments and 9 with private instruments of good quality.

Weekly weather crop bulletins were continued until October 3, 1891, and resumed March 19, 1892; the average weekly issue is now 165, and much interest seems to be manifested in them by the general public, and they are published as a whole or in part by the leading daily and weekly newspapers of the State, while the Richmond Times, Richmond Dispatch, and Atlanta Constitution have them telegraphed at their expense. Beginning with June 7, 1892, the date of issue was changed from Saturday to Tuesday; this is resulting in an increase of their publication in the weekly newspapers of the State, and seem to be acceptable to all interests. Thirty correspondents send weekly reports to this office.

Regular weather forecasts are sent direct from the chief office, Washington, D. C., to 23 displaymen in the State, 21 of whom display flag signals, and two use whistle signals, while the chief train dispatcher of the Atlantic and Danville Railroad at Lawrenceville, Va., repeats the p. m. forecast messages over the company's wires to 25 other stations along that railroad, and the displayman at Bedford City repeats the a. m. forecast by mail to Peaksville, Va. In December, 1891, steps were taken looking to the distribution of p. m. forecasts by bulletin to be sent out by train and mail service, which resulted in the same being established, beginning with April 1, 1892; said bulletins are being distributed by mail to four points and by train service to 151 regular railroad stations; all the roads radiating from Lynchburg. (viz, N. & W., L. & D., C. & O., and R. & D. systems) have taken up the work, and I am informed that it is highly approved and appreciated by the public.

Cold-wave and frost warnings were also issued, as occasion justified, to the regular displaymen and to a number of other points. During the coming frost and cold-wave season it is expected to increase the distribution of the same by telegraph, while if such warnings can be issued along with the p. m. forecasts, they can be included in the bulletins issued by train and mail service.

We hope to be able to make arrangements whereby the p. m. forecast bulletins will also be distributed on some of the railroad lines intersecting the lines out from Lynchburg.

If a uniform style of instrument shelter could be furnished to all the voluntary observers, additional observers could be more easily secured in sections not now represented, and records would be more absolutely correct.

During the last session of the Virginia legislature, beginning in January, 1892, a bill was introduced which provided for an appropriation to furnish instruments and instrument shelters for additional voluntary observers, and to increase the size and issue of the monthly reports of the State service; it passed one branch of the legislature, but it failed of final action in the other branch. This delays for another two years any additional aid from the State, but the board of agriculture have continued, and will continue its monthly allowance of $15 per month for publication of the regular monthly reports.

The interest in the reports of the National and State weather services is increasing throughout the State, and this will no doubt help to enlarge the work during the coming fiscal year.

WEST VIRGINIA.

(W. W. Dent, Weather Bureau, director.)

The work of establishing a State weather service in West Virginia was begun October 1, 1891. On account of the many difficulties met with the service has not attained that degree of usefulness throughout the entire State which is desired. The telegraph, telephone, and postal facilities are not as yet complete, but with the building of new railroads the sections of the State which do not now possess these facilities will be able to partake of the benefits to be derived from the work of the Weather Bureau.

On July 23, 1891, the Chief of the Weather Bureau informed the observer at Parkersburg that it was his desire to organize a State weather service for West Virginia, and pursuant to instructions contained in that letter the observer entered into communication with persons in various parts of the State relative to the establishment of such a service. In the progress which has been made in this work the director has been given valuable assistance by Hon. A. B. White, Messrs. W. M. Cox, and A. C. Love, and the State Journal of Parkersburg. By invitation of the State Board of Agriculture of September 28, 1891, the director went to Morgantown, W. Va., to consult with them relative to the contemplated organization of the State weather service. At this conference the board promised active coöperation in the work, and accepted a proposition to print the monthly meteorological reports of the State service, and to furnish a list of crop correspondents, etc. The first monthly report was issued on October 1, 1891.

In March arrangements were made for the issue of the Weekly Weather Crop Bulletin, and the first number of that bulletin was issued on April 9, 1892. The number of crop reporters has been constantly increasing, and at present these reports are received from thirty-five counties. The expense of printing the crop bulletin is also borne by the State Board of Agriculture.

Monthly reports are received from 35 stations, to which the Weather Bureau has furnished maximum and minimum thermometers and rain gauges; 10 stations report rainfall only; 25 stations display weather signal flags; 28 stations receive cold-wave and frost warnings.

The voluntary observers give close attention to their work, and interest generally in the State weather service is increasing.

WISCONSIN.

(Willis L. Moore, Weather Bureau, director.)

On July 20, 1891, the present official assumed charge. With the narrow field of action prescribed by the Signal Service and the numerous restrictions thrown around the observer in charge, it is probable that as thorough a service was then in operation as it was possible to establish, and my predecessor had blazed the way for much valuable work, which was strictly in the line of the progressive policy adopted by the Agricultural Department Weather Bureau. There is no question about the popularity of the service in this State to-day. By carrying out the directions of the chief its usefulness has been so extended that it is safe to say that hundreds are now receiving substantial benefit from our work who never before had given a thought to the subject.

One hundred and seventy weather display stations are now in operation against 42 on the previous July. Of these 153 receive their forecasts by telegraph daily from Milwaukee. In the majority of cases the display station is the nucleus of a thrifty farming settlement, and, owing to the contour of the country, the flags are usually visible from a radius of several miles. In former years the rule was to establish these stations only in large towns or cities. That this effort of the bureau to reach the agricultural interests is appreciated is evidenced by the fact that the expense of equipping these stations with flags, halliards, etc., and attending to the displays has been borne either by appropriation of the town councils or by popular subscription; and many places are now anxiously awaiting vacancies on our telegraphic forecast list.

It is hoped that it may be found consistent to authorize this office to establish 25 more display stations at such towns as apply for the same.

The authority given the local forecast official director to make forecasts for the State and issue frost warnings for the benefit of the cranberry and tobacco growers has resulted in greatly enhancing the value of the work of the Weather Bureau. One hundred and seventy display stations receive forecasts and frost-warning messages, 19 of which receive frost messages only. Four railroads carry frost signals; the M. L. S. & W. send all forecasts to their agents, and the C. M. and St. Paul send special in formation to their agents.

Forecasts now reach displaymen fully two hours earlier than was possible when they were sent from Washington, the a. m. forecast reaching displaymen nearly as early as the Washington p. m. can. It is also believed that a higher degree of accuracy has been obtained in the making of these forecasts than was possible where the official is compelled to predict for the whole country with a limited period of time allowable to consider the local characteristics of each State.

The frost forecasts of 1891 were completely verified in nearly every instance, and added greatly to the public estimation of the value of the work. In this connection it is respectfully recommended that the authority to telegraph warnings to frost display stations be changed so as to begin May 15 instead of May 1. The water is not drawn from the cranberry marshes or tobacco plants set out until between May 15 and June 1. It was stated by the press and interested parties that the frost warnings issued from this office between August 24 and September 4, 1891, alone resulted in a saving of one-third of the cranberry crop, estimated at $125,000.

Cold-wave warnings have been of immense benefit to commission men, railroad lines, farmers, and others having perishable goods to ship. Not an unfavorable criticism has appeared in print or been received from any quarter. Several times the papers have commented on the timely arrival of the cold waves predicted. There is such confidence placed in these predictions that I feel justified in saying that not a carload of perishable freight leaves this city during the display of the flag.

The issue of the weather map has been increased from 67 to 252 daily. The total number printed during the year was 55,000 against 18,000 the year before. Success has attended the efforts of the office in inducing teachers to make a daily study of the weather, and to instruct their pupils in its general principles. The director was urgently invited to address the annual meeting of the Southeastern Wisconsin Teachers' Association on this subject. This he did on April 9, at the normal school building at Whitewater. The presentation of the subject was received with so much favor that he is encouraged to continue such line of work whenever occasion offer and the numerous demands on his time will permit.

Including this station and the 6 regular Weather Bureau stations in or on the borders of the State, the Wisconsin State weather service consists of 77 observation stations. The monthly meteorological tables for the three months past has contained reports from 64 stations. Eight stations have been discontinued and 10 established during the year.

Special efforts have been made to promptly reach the lake captains with warnings by special messenger in case of severe storms, and the produce and commission dealers in case of cold waves. No severe storms have passed over the lake during the past year without special bulletins announcing its approach from twelve to twenty-four hours in advance, being placed in the hands of interested parties. The reports are fully appreciated. The lake captains daily visit the office during stormy seasons and place great credence in the information given. Large shippers are making far more use of the office than ever before. It is a frequent occurrence to have practically all shipments of perishable goods from this city held for several days until notified that it is safe to forward.

Publication has been made in State papers that this office would cheerfully furnish to the agricultural, commercial, maritime, scientific, or professional interests any information in our possession that would be of interest or value to them, and special directions given as to the particular interests which would be likely to profit most by such knowledge. The result has been numerous applications by letter, telephone, and in person—from persons in all walks of life. In nearly every case it has been practicable to furnish information fully covering the needs of each particular applicant. Invalids, tourists, physicians, engineering and claim departments of all railroads in the State, vessel-owners, lawyers, courts of justice, and many others comprise the list. The opinion of employés who have been in the office during the past two years, as well as the office records, bear out the statement that fully three times as much special information was given out as during any previous year. The station force has been worked to its fullest capacity in meeting the demands made upon it.

On January 1, 1892, was begun the publication of the Wisconsin Weather Crop Journal. It is supported entirely by advertising and subscriptions. It has been a most acceptable medium through which the work of the State service can be presented to the public. Sufficient advertising contracts were secured to cover the cost of printing and mailing; no special efforts have been made beyond making it self-sustaining. It required an expenditure of $300 by the director before this was attained. It may be considered as successfully established to-day.

The Weekly Weather Crop Bulletin has steadily grown in favor until there are now 160 papers on the exchange list of this office. About fifty clippings are made each week of the published bulletin. This feature of the work is highly appreciated by the State press. Five hundred copies are issued weekly.

Ninety thunderstorm reporters have been supplied with cards on which to report the occurrence of these storms. This data is being summarized, and will unquestionably furnish the means for more comprehensive study of this important subject. A few weeks ago arrangements were made to issue special thunderstorm forecasts, but sufficient opportunity has not been had to test the efficacy of the work.

From the editors of the principal papers an honest criticism of the work of the bureau has been invited, and assurance given that their suggestions as to methods of improvement would be given thoughtful consideration. The most cordial relations exist between the official in charge and the principal newspaper men in the vicinity, and as an evidence that our work is appreciated by them and that the bureau enjoys their hearty good will, the fact is cited that but one adverse criticism has appeared in print during the year, while many papers have highly commended the department for the character of its work, both in their news and editorial columns.

If it is considered advisable to allow additional instruments for this service, effort will be made to establish more stations in the northern part of the State.

COMMENTS ON THE WORKING OF THE BUREAU.

Mr. L. C. Whitney, general western agent of the Flint and Pere Marquette Railroad, says, in a recent letter to this office: "The masters of our fleet of five steamers have come to place implicit reliance in your bulletins, and they communicate with your office for special information when in doubt with a confidence hitherto unknown. A marked improvement, and one most gratefully appreciated, is your thoughtfulness in giving out special bulletins on the approach of storms of unusual severity, thus enabling me to warn all our steamers, during the winter months, at points having no weather service during closed navigation."

G. Hurson, general traffic manager, Goodrich Transportation Company, says: "I desire to express my gratification for the benefits that our company has received from the weather office in this city. It is my opinion that the weather reports have been more accurate during the past year than at any time during the twenty years that I have been here. Your official in charge here gave us timely warning of severe gales, and in no case has he been very wide of the mark; we appreciate the excellent work of your bureau."

A. Grossenbach & Co., commission merchants, say: "We are pleased to add our testimonial to the very efficient service you have rendered us in our business during the past year. In shipping fruits and other perishable goods it is necessary for us to make calculations as to the weather, and in this you have furnished us an invaluable service. By relying upon your predictions we have come out pretty near correct, and we depend largely upon your knowledge of the elements to aid us in our business. We thank you for uniform courtesies extended to us."

Thurston, Russell & Co., oyster packers: "The weather reports at this station have been a great benefit to us in our line of business. We found them more reliable than in former years, and they have saved us many dollars."

The Diamond Ink Company: "During the past year we have been guided largely by your forecasts in shipping freezable goods, and were more successful in avoiding loss from freezing than formerly."

George Hiles, Dexterville, Wis.: "These frost warnings are of inestimable value to us, especially during the cranberry growing season. We thank you for the good work you are doing in this matter."

Anson Brothers, wholesale grocers: "The reports have been a material benefit to us, and we have come to rely largely upon them. We regard them more reliable than formerly and believe them most beneficial to a large class in all branches of industry."

R. Stafford Company, wholesale fruits: During the winter months we are greatly benefited by these reports as the greater part of our business is in green fruits. Our shipments are governed by your reports, which in the main, during the winter of 1891-'92, were accurate; in following them we had but few complaints from our customers that their fruits arrived frozen."

Jos. Schlitz Brewing Company: "The timely information of a coming cold wave has frequently caused us to keep back shipments which would otherwise have suffered by frosts."

Mr. H. Shackell, agent D. G. H. & M. Ry., and G. H. & M. Trs. Co.: "Our captains speak very favorably of the weather reports. They make numerous inquiries ot your office during the winter months and express themselves as finding the information very reliable, and of good service to them."

A. J. W. Pierce & Co., wholesale produce and fancy grocers: "The Milwaukee weather bureau has been of great benefit to us during the past season. We consider that we have been saved from loss in many instances through your advice. We wish to thank you for the careful and courteous manner in which all our special inquiries were answered by your office."

WYOMING.

(E. M. Ravenscraft, Weather Bureau, director.)

The only warnings furnished this State are the cold-wave warnings, and they are only furnished the observer, Weather Bureau, Cheyenne, and O. K. Garvey, Casper, and there seems to be no desire on the part of the public in other portions of the State to avail themselves of the opportunity to receive the warnings. As this is principally a grazing State there can be little said of the benefit derived from the warnings other than that of the sheltering of stock where possible.

The average issue of the Weekly Crop Bulletin is about 100. There is not as much value placed upon them as should be, but the interest is gradually increasing, and would increase more rapidly but for the condition of local affairs in this State that have tended to obliterate all other public affairs without regard to their origin or purpose.

There are at present about 20 regular correspondents.

There are about 100 copies of the monthly bulletin issued, and the number is constantly increasing.

There are at present about 16 voluntary stations in operation including those of the State Agricultural College and the military posts. There were 7 voluntary stations at the beginning of the year and 7 others have been furnished with instruments, but part of these have failed to report and have ignored all communications regarding reports or instruments. Several hundred circular letters have been sent out during the year in the endeavor to secure observers; also the names of reliable parties have been secured and personal letters written with the hope of securing observers, but with the State affairs in the condition they now are a move in this direction could hardly be expected, but it is hoped that a few months will see a marked change in the working of the weather service in this State.

SPECIAL REPORT ON TEA-RAISING IN SOUTH CAROLINA.

SIR: In compliance with the suggestion of the Assistant Secretary of Agriculture, I have the honor to submit the following report upon experiments in the cultivation of the tea plant at the Pinehurst Experimental Tea Garden, near Summerville, S. C. It embraces, also, certain general observations regarding the varieties grown, yield, profit and loss, and an account of the damage to the plants by the winter of 1892–'93.

Very respectfully,

CHARLES U. SHEPARD.

Hon. J. M. RUSK,
Secretary.

THE TEA PLANT IN THE UNITED STATES.

The first tea plant in this section was set out by the French botanist Michaux in 1804, at Middleton Barony, on the Ashley River, and distant some 15 miles from Charleston; with it was planted out the first representative of its cousin, the *Camellia japonica.* As I saw the former a few years ago, it had grown into a small tree about 15 feet in height, while of the latter there were many specimens fully twice as tall.

The publications of the U. S. Patent Office and the U. S. Department of Agriculture record the results of many subsequent attempts to inaugurate an American tea industry. Nor is it strange that repeated failure has not checked the ardor of those experimenters who constantly enjoy the realization that their climate is especially favorable for the outdoor cultivation of the *Camellia japonica*, *Azalea indica*, and many other subtropical plants, and have read that the flora of the tea-producing countries of the East finds, to a certain extent, its counterpart here. The little patches and, in some instances, larger gardens which have resulted from these attempts have produced tea of fine flavor, although very generally devoid of that strength of infusion which appears to constitute a most desirable quality for very many drinkers. It may be presumed, however, that this failure in pungency was largely due to defective curing, and especially to inadequate rolling of the leaf, in consequence of which the cup qualities of the tea were not fully developed. So far as is generally known, it remained for the National Department of Agriculture to begin, about ten years ago, the first serious attempt to produce American commercial tea on a scale sufficiently large to arrive at a decisive result.

The retirement from office of Commissioner William G. Le Duc, to whose great interest in this subject the inception of the experiment was due; the death of Mr. John Jackson, under whose experienced management the gardens were established; the great distance of the station from its source of management, and the opinion of Commissioner George B. Loring that "the climatic conditions are not favorable for it" (Report for 1883), combined to cause the total abandonment by the Government of the gardens which it had established, at great expense, on a portion of the Newington plantation, and only a mile or so distant from Pinehurst farm, which also constituted a part of the same large estate.

The present experimentation owes its undertaking to the belief that the previous trials to produce American tea were arrested before reaching definite conclusions; that more careful cultivation and preparation, which might be the result of a lengthier local observation, and the subsequent production of a higher class of teas, might reverse the generally entertained opinion that, as an industry, the cultivation of tea in this country must always prove a failure; and that, if successful, this new field for agricultural enterprise would furnish a wide and comparatively easy outdoor employment for many who are unequal to those rougher operations whose accomplishment under a summer's sun can be borne by but few in this climate.

It needed only the announcement of a revival of tea experiments in this country to excite the liveliest interest in and assistance for the undertaking. The U. S. Department of Agriculture, under the direction of the honorable Secretary, J. M. Rusk, and Assistant Secretary, Edwin Willits, has manifested a deep concern in the project, and has generously borne a very considerable part of the expenditure for procuring consignments of tea seed from far Asia. The Department of State has kindly issued orders to its consuls at the tea ports to obtain these samples, and our foreign representatives have spared no effort to secure the best quality of seed. At our own chief ports and marts the most experienced tea-tasters and merchants have freely given their valuable opinions and advice on the samples of tea which have been submitted to them, and the press has spread over all our wide land whatever reports have appeared concerning the progress made.

It is in deference to this general interest that a report of progress is herewith made, with the intention of limiting its scope to the consideration of the climatic obstacles which have been regarded as insurmountable, and the addition of some of the experience which has been gained during the past few years at Pinehurst. There is an extensive tea literature, but it is not intended to reproduce it here. Those desirous of gaining a general knowledge on the subject are referred to a lecture by Mr. William Saunders, Superintendent of Gardens and Grounds, U. S. Department of Agriculture, delivered before the New York Horticultural Society October 7, 1879, and constituting Special Report No. 18, Department of Agriculture, on "Tea Culture as a Probable American Industry;" as also to the prize monograph of Col. Edward Money, "The Cultivation and Manufacture of Tea," 4th edition, 1883, London, W. B. Whittingham & Co.

REQUISITE CONDITIONS OF THE TEA INDUSTRY.

The requisite conditions for success in the tea industry are numerous; they embrace sentimental, commercial, and agricultural factors. Under the first belongs the special taste of the people who are to be asked to buy the product. Not only does one country frequently prefer green to black tea, or *vice versa*, but in the same land different sections demand different sorts or "blends." Any general change in taste is naturally slow. The sentimental factor in deciding whether a tea is to its liking is the final judge, so far as the success of any particular sort is concerned. "*De gustibus non est disputandum.*" Consequently, and from the outset of the Pinehurst experiments, the representation of all the leading varieties has been sought for, and to-day there are gardens of Japanese, Chinese (including Formosa), and Assam hybrid from Ceylonese and American seed. That practically all are not represented is due to the great difficulty experienced in procuring sound seed at this great distance from their sources. By carefully adapting to each sort the manufacture most suited to develop its best qualities, it may be possible to offer to a considerable portion of the community its favorite teas, and thus to secure patronage, and, subsequently, profit.

The question of morals does not extend beyond the duty of the Government to suppress injurious teas or to expose adulterations. Of the former, excepting the usually faced green teas, there appear to be very few on the American market.*

A sufficient reason why tea, in a commercial sense, suffers so little adulteration lies in the cheapness with which it is grown in some countries; there is hardly anything that can be profitably substituted for it without speedy detection. That an immense amount of trashy tea is sold on the American market does not require further comment, that fact being known to all.

The prominent commercial factor is competition from the Asiatic tea countries, including the price of labor there. A brief consideration shows that the cost of picking tea leaf per pound of the cured tea (it takes about 4 pounds of fresh leaf to make 1 pound of cured tea) hardly exceeds 1 cent in Asia, as against not less than 6 cents here. The difference, 5 cents, constitutes a large part of the gross price which the Asiatic producer receives for his cheaper grades. The long transportation costs only a bagatelle, say 1 to 2 cents per pound, on shipments to American markets. As the production of American teas must be accomplished at a price which shall permit them to be offered, at our main distributing points, at least on a parity with the same grades of foreign goods, it follows that it is idle to expect to compete with any except the superior foreign teas; but the American grower should realize that with an increase in the price of his product he must diminish the number of possible purchasers. Among the agricultural conditions, none exceeds in importance that of climate; and it will be well to reproduce here the following rather ominous predictions and observations, as they probably constitute the greatest obstacle to our success in the minds of most persons. Col. Moncy has written:

The climate required for tea is a hot, damp one. As a rule, a good tea climate is not a healthy one. The rainfall should not be less than 80 to 100 inches per annum, and the more of this that falls in the early part of the year the better. Any climate which, though possessing an abundant rainfall, suffers from drought in the early part of the year is not, *cæteris paribus*, so good as one where the rain is more equally diffused. As any drought is prejudicial to tea, it stands to reason hot winds must be very bad. These winds argue great aridity, and the tea plant luxuriates in continual moisture. The less cold weather experienced where tea is the better for the plant. It can stand and will grow in great cold (freezing point and lower in winter is found in some places where tea is), but I do not think it will ever be grown to a profit on such sites. That tea requires a temperate climate was long believed and acted upon by many to their loss. The climate can not be too hot for tea if the heat is accompanied with moisture. Tea grown in temperate climates, such as moderate elevations in the Himalayas, is quite different to the tea of hot, moist climates, such as eastern Bengal. Some people like it better, and certainly the flavor is more delicate;

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* *Vide* "Foods and Food Adulterants," Part VII, "Tea, Coffee, and Cocoa Preparations." Bulletin No. 13, Division of Chemistry, U. S. Department of Agriculture.

but it is very much weaker, and the value of Indian tea (in the present state of the home market, where it is principally used for giving "body" to the washy stuff from China) consists in its strength. Another all important point in fixing on a climate for tea is the fact that, apart from the strength, the yield is double in hot, moist climes what it is in comparatively dry and temperate ones. A really pleasant climate to live in can not be a good one for tea.

Nevertheless, in describing the various tea districts of India, Col. Money does not hesitate to speak highly of the tea produced in several of the elevated and more temperate climates, as for example: "The teas produced in Kangra (elevation 3,000 feet) are of a peculiarly delicate flavor, and are consequently highly esteemed in the London market." Or again: "Some of the teas (from the Neilgherries, 7,490 feet elevation) have sold very well in the London market, for as regards delicacy of flavor they take a high place." And in reference to the generally elevated Ceylon tea gardens, he remarks: "I believe, take it all in all, Ceylon tea is no better and no worse than Indian teas."

"Tea Cultivation in India" contains the following reference to climate:

Tea, it may be premised, will grow almost anywhere, but not very many climates will enable it to pay. To describe the best climate in two words, we point confidently to eastern Bengal—a hot, moist climate, where the thermometer in the shade never exceeds 95°, never falls below 55°; where the rainfall yearly aggregates 100 to 130 inches; where there is never any long drought, but where rain falls at reasonable intervals all the year round; where heavy dews are frequent; where morning fogs are not uncommon; where the sun shines hot in an atmosphere perfectly free from dust; where at no season can a breath of hot wind be felt; where light, penetrating rain is more common than furious downpours. Fever and tea go together. It may be a painful fact for tea-planters, but it is no less true. No highly successful tea district can ever be a healthy one.

In at least partial controversion of the preceding quotations, Mr. Armstrong has written in "Tea Cultivation in Ceylon," as follows:

The higher the elevation the less rainfall is required, and *vice versa*. Light showers, alternating with sun, if we could order them so, would give us 1,000 pounds an acre at 5,000 feet elevation. The higher we go the better our soil must be. I have known many instances of estates up to 3,000 feet giving 400 to 600 pounds per acre up to 5 years of age; and at 4,000 to 5,000 feet, from 360 to 420 pounds per acre.

It will be noted that these yields of tea are exceptionally good and that the climate at the latter elevation can not be otherwise than temperate.

But granting that the production under the Assamese climatic conditions is exceedingly favorable, of what transcendent importance is it if the public dislikes the tea? Mr. Samuel Baildon, in "The Tea Industry in India," writes:

Many Indian planters, while finding their teas too strong for their own drinking, have, through insufficiently reasoning the matter out, thought that Indian tea might be drunk alone, and that an injustice was done to the industry in using their teas for fortifying weaker China ones. But as some of the Indian growths are much too strong for use by themselves, and as a large proportion of the China tea imports into England require strengthening, these strong growths from India—which can not be used alone—are valuable for giving strength to inferior Chinese teas, and for this reason only. Indian teas of unpalatable strength predominate over those of medium strength. Planters whose only experience of Indian tea has been obtained in Assam, or districts where the strongest kinds are grown, have no idea of the really fine, delicately flavored teas that are sent to England from other districts—teas that undoubtedly are well suited for drinking alone. I well know the regular cries about Indian teas being far more economical than Chinese ones, and I believe in and advocate the practice whenever I can, but only as applied to Neilgherry, Kangra Valley, or finer Darjeeling teas. Some of the produce from these districts is delicious and possesses a delicacy of flavor which can not be compared with anything coming from Assam.

The accompanying table exhibits the mean monthly temperature and rainfall, together with other interesting data, of the climates of several of the most important Indian tea provinces; of Charleston, S. C.; and of some Chinese and Japanese stations. It is interesting to compare the Indian and Japanese temperatures and rainfall with those of Charleston. There is obviously much more difference in the annual precipitation of moisture than in the mean annual temperature. The mean annual temperature of Summerville, on whose outskirts Pinehurst farm is situated, is $65\frac{1}{4}°$ for the past sixteen years. It is hoped to ultimately establish a simple meteorological station here. The maximum temperature of 104° (July 12, 1879) and minimum of 10° (January 11, 1886) have constituted the extremes for twenty-one years at Charleston; the average date of the latest frost, March 21, and of the earliest frost, November 5, also for the same period. Neither, in regard to these observations, would there be much difference between Charleston and Summerville.

Comparison of climate of Charleston, S. C., with some Asiatic tea climates.

	Latitude.	Elevation above sea.	January.		February.		March.		April.	
			Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.
	°	*Feet.*	°	*In.*	°	*In.*	°	*In.*	°	*In.*
Goalparah, Assam	26	386	61.7	0.42	63.0	0.76	72.6	1.84	77.6	4.85
Seebsaugor Assam	27	370	60	1.18	64.1	2.43	69.3	3.77	73.8	10.15
Darjeeling	27	6,952	42.2	0.76	43.8	1.60	52	1.65	58.7	3.62
Hazoreebaugh, Chotanagpore	24	2,010	62.7	0.42	67.1	0.52	73.7	0.75	85.6	0.42
Charleston, S. C	32	52	49.9	4.07	53.7	3.46	56.7	4.01	64.2	4.06
Fogau, China	27	......	56	......	58.5	......	57.5	......	64.5	......
Canton and Macao, China	23	......	60	0.65	59	1.20	65	3.14	70	......
Macao	......	......	58	0.67	60	1.70	65	2.15	72	......

	May.		June.		July.		August.		September.	
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.
	°	*In.*	°	*In.*	°	*In.*	°	*In.*	°	*In.*
Goalparah, Assam	76.0	11.72	80.3	23.72	82.1	21.33	81.6	12.69	80.5	10.93
Seebsaugor, Assam	78.5	11.04	82.4	15.56	83.6	14.87	83.5	13.88	83.1	11.13
Darjeeling	62.1	7.01	63,7	27.50	64.9	29.40	64.4	29.09	63	18.06
Hazoreebaugh, Chotanagpore	88.6	1.37	83.8	10.99	77.8	14.63	79.3	11.44	77.5	6.26
Charleston, S. C	72.7	4.06	78.8	5.28	82.3	7.40	79.8	7.31	75.4	6.09
Fogau, China	77.5	......	77.5	......	86.5	......	84	......	81	......
Canton and Macao, China	77	11.88	82	10.19	82	14.35	82	11.30	80	12.5
Macao	78	11.85	82	11.10	83	7,75	83	9.90	81	10.92

	October.		November.		December.		Annual average.		Rainfall, monthly average.	Temperature.	
	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.	Temperature.	Rainfall.		Maximum.	Minimum.
	°	*In.*	°	*In.*	°	*In.*	°	*In.*	*In.*	°	°
Goalparah, Assam	77.5	5.61	69	0.39	64.6	0.20	73.8	94.44	7.87	97	48
Seebsaugor, Assam	78.3	4.46	69.4	1.29	62.4	0.69	74	90.45	7.54	......	......
Darjeeling	57.3	6.56	49.4	0.20	44.7	0.14	55.9	129.50	10.78	80	28
Hazoreebaugh, Chotanagpore	72.6	3.51	64.8	0.19	61.4	0.02	74.5	50.52	4.21	107	44
Charleston, S. C	67.7	4.36	58.9	3.26	51.9	3.62	66	56.98	4.75	104	10
Fogan, China	72	......	64	......	57	......	70	......	......	......	......
Canton and Macao, China	77	6.54	68	1.32	59	0.19	72	78.96	6.58	94	29
Macao	77	6.50	68	2.42	59	0.97	71	70.62	5.88	......	......

Average temperature.

	Winter.	Spring.	Summer.	Autumn.	Whole year.
	°	°	°	°	°
Nangasaki, Japan	46	59	81	70	63
Canton, China	58	71	83	75	71.7
Peking, China	26.42	56.30	82.58	54.32	54.09

In regard to the climate of the Chinese tea-producing provinces, Mr. Samuel Ball has afforded the following information in "The Cultivation and Manufacture of Tea in China:"

The quantity of rain which falls at Canton and Macao during the southwest monsoon (May to October), when the winds come charged with moisture from the sea, amounts to 67.85 inches, whereas during the northeast monsoon (November to April), when the wind blows over the land, there falls 11.11 inches; thus making the total quantity 78.96 inches. But the annual quantity which falls at Peking is only 27.98 inches. Hence it appears that the southerly winds, in their passage over this extensive Empire, deposit the moisture with which they are saturated gradually and less copiously as they advance to the north, till finally both one and the other become exhausted as they reach Peking. * * * In the center of these two extremes, Peking and Canton, and between the latitude 23° and 33° north, the tea plant was found indigenous at a remote period of the Chinese history. This comprises the central as well as the most populous and flourishing provinces of the Empire, and includes that part most suitable to its growth, and where it is found to flourish in the present day. In this division of the country between north latitude 27° and 31° are also situated the districts connected with the foreign trade, whence the greater part of the tea most esteemed by the Chinese is also procured for their home consumption.

In the green-tea country, situated in the district of Wheychew-fu, north latitude 29° 58′ 30″, from December until March the weather continues cold; frost frequently prevails, and snow occasionally; water freezes in the house. In July the summer regularly sets in, and the intensity of the heat is equal to that of Canton. * * * The Bohea (black tea) country, in Fokien, differs little from the Hyson districts in point of temperature. The tea men describe the cold as less severe, and the fall of snow, as well as the thickness of the ice as somewhat less. * * * At Amoy (latitude 24° 27′ 36″), which is a tea district producing teas suitable to the foreign markets, and some of very delicate flavor, the temperature seems hardly to vary from that of Canton. Annual mean temperature was 69.7°, the lowest temperature marked being 49° and the highest 90°.

The preceding remarks are sufficient to show that severe frost and occasional snow prevail in the tea districts, and on some occasions, though rare, so late as the vernal equinox. Yet there is reason to believe, on average of seasons, that the frost is not very intense or of long duration.

CLIMATIC REQUIREMENTS.

We may, therefore, assume that a deficiency in one of the conditions usually insisted upon as being requisite for successful tea cultivation, viz, an equable and rather elevated temperature and somewhat excessive rainfall, does not preclude the establishment of that industry on a safe foundation. It is probable that the strength of tea may be considerably impaired by a material deviation in what is regarded as the normal climate; it may not serve to fortify weak teas, but there is ground for hope that it may occupy an independent position, at least in a country where the strongest teas are not relished and where a delicate flavor is highly appreciated by a sufficiently large class to warrant the fullest deference to its demands. So far as concerns any American tea that is likely to be produced during the next generation or two, there will be no occasion to look beyond our own markets, and at present they are almost wholly supplied from China and Japan. If, therefore, it be contemplated to cater to the American taste, it must

Tea Report, U. S. Dept. of Agriculture, 1892.

TEA GARDEN AT PINEHURST—ASSAM HYBRID, THREE YEARS OLD, WITH TEA PICKERS. BEFORE PRUNING.

TEA GARDEN AT PINEHURST—ASSAM HYBRID, THREE YEARS OLD. AFTER PRUNING.

ASSAM HYBRID TEA PLANTS AT PINEHURST, THREE AND A HALF YEARS OLD AND LESS, SHOWING VARIATION IN SIZE OF LEAF AND GENERAL VIGOR OF GROWTH.

surely prove more remunerative to manufacture an article similar to those in use here, rather than to imitate (even if it were possible) the more pungent Indian teas, which at present are only slightly imported. It is said that the tea from Formosa commands the highest price in this country, but some fine grades from Ceylon and India find a high price in rather limited quantities, the former being generally preferred.

It should not be understood that the attempt to produce strong as well as delicate teas has been abandoned at these gardens. The best writers on tea concede that delicacy of flavor and strong raspiness do not go together. The ideal beverage should possess both strength and flavor, as may be attained by picking only the youngest and tenderest leaves and a generous application of manure.

The idea that a colder climate than the Bengalese plains (it being immaterial whether the result of a greater elevation or a higher latitude), and one that may be regarded at least as healthy, is not suited to the production of the largest crops of superior teas, seems to have been refuted by the experience of the mountain gardens of Ceylon; but special stress is laid, in this case, on the richness of the soil as compensating for the deficiency in temperature. That ordinarily severe cold, as evidenced by ice and snow, seriously curtails the annual yield there can be no doubt, be it from the shortness of the growing season or the too intense hibernation of the plants; nor is it probable that the most generous cultivation can atone for an extreme winter. It is to be regretted that further meteorological data are not at hand. Nevertheless it may be urged that the citations given above afford a reasonable basis for the hope—which is the corner-stone of our undertaking—that the climate of this section does not necessarily proscribe success in establishing a successful tea industry here. It is anticipated that natural deficiency in some directions must be counterbalanced by extraordinary artificial stimulation in others. But it ought not to be regarded as stranger, should ultimate success crown our efforts, that unusual care and attention can compel the remunerative cultivation of tea outside of its natural zone any more than in the case of tobacco and many other crops.

QUALITY OF THE TEA PRODUCED.

This past summer some of the Pinehurst plants were sufficiently advanced to warrant picking the leaf. The great majority of them had been raised from seed in 1889, and set out that autumn. A limited number were a few months older. They belong to the "Assam hybrid" variety, *i. e.*, the cross between the Assamese and Chinese sorts, and came from stock that had been thoroughly acclimated by probably thirty years' growth in this country. The plants had been systematically "topped" with garden shears and afterwards carefully pruned with a knife during the winter of 1891–'92, and throughout their growth had been carefully cultivated and generously manured. (Plates I–III.) They covered small areas on various soils, viz, underdrained pond and high swamp, the slope of a clay hill, and a flat, sandy pine land. So free had been the artificial enrichment of all of these plats that no material differences in the quality or quantity of yield were observed. It was designed to test by these first experiments whether commercial tea could be raised at all. Below are given the results from picking and curing such leaf as appeared to be suitable for manufacture, and might be spared without impairing the subsequent luxuriant development of the plants.

A proper regard for the space that can be allowed this article necessarily limits the publication of the reports which have been received from those who have tested the Pinehurst tea of 1892. As the Assam hybrid leaf is better adapted for the manufacture of black (*i. e.*, fermented) tea, that mode of preparation was followed. It is not claimed that all the responses were equally enthusiastic, but all were favorable. Some of the experts, as might have been expected, did not hesitate to express the doubt whether the Pinehurst teas would find favor in their sections of country. But we shall be pardoned if only the more flattering testimonials are published, especially as it is our object to demonstrate that superior teas may be grown here.

(1) Letter from Hon. Edwin Willits, Assistant Secretary of Agriculture, dated November 2, 1892:

I wish to say that we are very much pleased with the samples. Not only this, but we sent a sample to the traveling agent of a large tea firm in Detroit for his judgment, advising him as to where the tea was produced. He took the tea to the store, and without giving them any information with regard to the same, it was tested by two of the leading members of the firm, each making a separate test. They pronounced it very excellent English breakfast tea, and, as I recollect, claimed that it was better than any breakfast tea they had in the store, or at least equally good; and when the information was given them as to the place of production they were very much surprised and wished to know if any considerable amount could be purchased.

(2) Letter from Mr. N. W. Burchell, of Washington, D. C., under date of July 16, 1892:

The No. 2 tea is the best American tea I ever saw, and would bring at wholesale a good price. If sold as American tea, and thereby creating a sentiment for a season or so, it would bring more than the same high grade of India tea.

(3) Opinion of Mr. Gillet Gill, of Martin Gillet & Co., the celebrated tea merchants of Baltimore, Md., as published in the Sun, of that city, and other papers:

The first marketable tea ever produced in the United States was brought to Baltimore to-day by Charles U. Shepard, of Summerville, S. C., who grew and cured the plant on his farm. The American tea was tested by Mr. Gillet Gill, who pronounced it equal to the best high-grade English breakfast tea and superior to many grades that come from India and China. The samples brought here by Mr. Shepard are all of one quality and character—black, crisp, and well scented. It makes a strong beverage. This quality of the American tea is said by Mr. Gill to be due solely to its treatment in fermentation and curing. Other methods of curing the American product will produce tea similar to the several brands that come from India and China. Judging from Mr. Shepard's samples, Mr. Gill says he believes the successful growing of tea in the United States is established, and that the industry should be encouraged and fostered.

(4) Opinion of Mr. Charles Kerr Reid, tea expert and merchant, of Philadelphia:

Picking of June 14, season of 1892. Report on samples from the four grades into which the tea was sifted:

No. 1. Rather handsome, rather small, even blackish leaf with Pekoe flower. Strictly extra fine tea; strong, full, and rich South Carolina Pekoe flavor. Value, 32 to 35 cents wholesale.

No. 2. Blackish, even leaf, with a few Pekoe tips. Fine to extra fine tea; strong, brisk South Carolina Souchong Pekoe flavor. Value, 25 to 30 cents wholesale.

No. 3. Rather bold, evenish, curled black leaf; middling tea (or preferred), strong, brisk, fresh-burnt South Carolina Souchong flavor. Value, 22 to 25 cents wholesale.

No. 4. Bold, black, uneven curly-leaf middling tea; rather strong, fresh-burnt South Carolina Souchong flavor. Value, 20 to 21 cents wholesale.

The retail prices are generally more than double the wholesale on the finer grades, and from 50 to 100 per cent higher on the lower qualities. Mr. Reid has kindly added the following remarks:

Your teas I find have an individual, distinct, and pronounced character, different from the teas of any other country, consequently, I describe their character flavor as "South Carolina flavor." They have merit and intrinsic value of a high order. I have very much pleasure in offering you my sincere congratulations on the complete success of your enterprise in having produced from the soil of the United States of America the commercial article "tea leaf," equal in style and value and on a par with the fine teas of the world.

(5) Concerning the best of these samples, and after submitting it to a thorough trial, a friend in New York, who was formerly and largely interested in the tea trade, has written:

It is good original stock and is unusually well prepared; has all the characteristics of an Indian or Ceylon tea, and is particularly brisk or toasty in firing, which is desirable. I am inclined to believe that it is better tea than Tettley's, which is sold in dry goods stores at 50 cents for a half-pound package; that would make the original value before packed somewhere about 35 cents per pound.

The same authority subsequently wrote in reference to some similar teas of a later manufacture:

The sample B, as well as the sample which I valued in New York at 38 cents, interested me. Yours is not a showy tea, but has the "solid merit," holding its fine quality in taste as it becomes cold; it is what we would call a "deceptive tea" to the tea-tasters, not to the consumers, and if the consumer were once accustomed to it, he would think other teas trash, which the tea-taster might have called "only a trifle poorer."

Based on Mr. Reid's valuations, 100 pounds of Pinehurst tea, divided into classes by sifting, should have the following valuation, viz:

	Yield.	Value.	
		Wholesale.	Retail.
	Pounds.		
No. 1 passed through one-fourteenth-inch openings	16.00	$5.36	$10.80
No. 2 passed through one-eighth-inch openings	30.00	8.25	16.50
No. 3 passed through one-fourth-inch openings	52.50	12.34	19.19
No. 4 coarser than the above sizes	1.50	.30	.49
Total	100.00	28.25	46.98

The result, then, of sorting by size of finished leaf is to obtain a bulk valuation of 28¼ cents per pound, or 47 cents retail price in the larger cities; in the country, the latter price would be from 60 cents upward.

As an interesting fact may be mentioned that the picking of August 22, 1892, was prepared as a whole—that is, without division by sifting. Concerning it Mr. Reid reported, "Rather bold, rather uneven, curly black leaf, with bloom and Pekoe flower. Fine tea, rather rich, strong, brisk, malty, Pekoe touch and flavor. Wholesale value in this market in bulk, 30 to 32 cents; retail value in the same, about 60 cents."

Very truly has Col. Money remarked, in referring to the teas made by Mr. Jackson in this country, "No reason why the teas should not be good;" and we hope later on to successfully combat his further suggestion, "but the labor difficulty will, I think, prevent tea paying there."

YIELD OF TEA.

Col. Money gives the following estimate of the probable yield per acre on flat land, good soil, in a good tea climate, and with hybrid plants, if really high cultivation and liberal manuring is carried out:

Year.	Tea per acre.	Year.	Tea per acre.
	Pounds.		*Pounds.*
First	0	Sixth	400
Second	0	Seventh	480
Third	40	Eighth	560
Fourth	160	Ninth	600
Fifth	320	Tenth	640

The Pinehurst plants had been set out at greater distance than is the practice in the East, with the object of substituting cultivators and plows drawn by mules for hand labor and the spade. After making due allowance for this difference and for average vacancies (where plants have died), and thus estimating the production by the same number of plants, we find the average yield of the Pinehurst gardens for the past season to have reached about 37½ pounds of (cured) tea per acre. Of the earlier "flushes" (as the successive crops of young and tender leaf are called), purposely very little was picked; of the midsummer ones we were careful to confine the picking to the smallest leaf, and in the autumn at least one abundant flush was permitted to remain on the bushes. In other words, the standard production as laid down by Col. Money might readily have been attained. Indeed, in view of subsequent events, it would have been better to have picked the late (October) flush, as probably thereby we might have prevented the florescence of the plants, with all of its attendant drain on their resources, and the subsequent entailed cost of picking off the incipient seed in order to prevent the yet further exhaustion of the bushes by its full development through the next season. But we will assume that the Indian grower exercises as much care with his own gardens, and we will rest our case on the actual figures submitted.

The results at Pinehurst are all the more gratifying as they were obtained on plants exhibiting great difference in form and luxuriance of growth and in flushing. The seed from which they sprang had been brought from India long before the inauguration of the recent successful attempt to raise the grades of those teas by a judicious selection of seed and most careful cultivation. From the gardens now being established at Pinehurst, and in consequence of the great care bestowed on their composition, it is hoped to obtain much finer teas in the future.

The results obtained at Pinehurst during the past summer are certainly gratifying, and yet the partial success already achieved carries with it great anxiety as to the future. The summer of 1892 was specially favorable for the growth of tea, and the bushes made great strides under the influence of abundant rain in the picking season. The rainfall was as follows for that period, viz: May, 3.03 inches; June, 10.32 inches; July, 10.33 inches; August, 4.73 inches; September, to 28th, 11.77 inches; for picking season, 40 inches. The meteorological statistics for this region do not extend the hope of the frequent repetition of such weather. Then, again, who can tell how soon some detrimental or even fatal blight may attack our gardens? This does not appear probable; but the red spider or some other wretched enemy may suddenly swoop down and create great destruction. For the present, the plan is to develop the utmost luxuriance of growth on the part of the better plants and to extirpate all feeble bushes.

PROFIT OR LOSS.

It is as yet too early in our experimentation to exhibit calculations as to the cost of production. Our gardens are small (altogether not exceeding 12 acres), and under no circumstances capable of bearing the "fixed charges," which with little advance might apply to a much larger acreage. For the immediate future there is no necessity of erecting and conducting a regular factory such as may be found on almost all Indian and Ceylonese plantations; although it would be desirable to impart to all tea the uniformity of preparation which the perfected machinery of to-day affords. With the substitution of steam machinery for hand labor and the attendant economy, and an enlargement of the gardens to warrant such outlay, the difference between the actual cost of Asiatic and American teas would be reduced to those manual operations in the field where it is impossible to replace hand labor by machines. Nor has the public had, as yet, an opportunity of forming an opinion on the merits of American tea, and as an industry it must rely on the patronage of our people.

It is, however, natural to presume that some "ciphering" on the question of profit has been indulged in. With some misgivings, but nevertheless that this article may not be incomplete in this respect, we submit the following (hoped-for) estimate of the expense involved in raising and curing a pound of tea in this section, if the future results corroborate those of the past. The following quotation is taken from an article recently prepared for "American Gardening:"

Estimated cost of tea to be produced at Pinehurst, when the gardens shall produce at the rate of 400 to 500 pounds per acre and per annum, and after the introduction of machinery, whenever it is possible to substitute it for manual labor:

	Cents.
Picking leaf	6.00
Withering leaf	0.50
Rolling by machinery	1.50
Breaking roll and sifting by machinery	0.50
Firing by machinery	0.50
Packing and boxes (in India, 2 cents)	4.00
Cultivation of land	5.00
Incidental expenses	2.00
Cost per pound of (cured) tea	20.00

This estimate does not include the proper fixed charges, which must amount to a large sum by the end of the sixth year after planting a garden, when under favorable conditions the outlook should equal 400 pounds of (cured) tea.

The reader must decide whether this exposition of the present outlook of the Pinehurst farm is sufficiently encouraging to warrant the rather roseate predictions that its friends have indulged in; as also whether there is justifiable ground for anticipating the successful establishment of an American tea industry.

The U. S. Department of Agriculture has kindly consented to place on exhibition at the World's Columbian Exposition some of the Pinehurst teas.

EFFECT OF INTENSE COLD ON TEA PLANT.

Beginning with the 27th of December, 1892, and terminating January 22, 1893, an exceptionally long period of intense cold prevailed in the South Atlantic States and produced a marked effect on the local tea gardens. Although considerable injury followed this cold wave, it was well that this severe test should have been encountered thus early in the experiment, especially if the proper lessons can be drawn from the unusual experience.

Mr. L. N. Jesunofsky, observer in the Weather Bureau at Charleston, has very kindly prepared the accompanying table, which demonstrates in a very lucid manner the exceptional duration of this winter's cold. The table permits the following important deductions:

December, 1892.—The mean of three consecutive coldest days was 27° F.; lower than any record for the same month.

The number of days with a mean daily temperature below 32° F. was 2, only equaled in 1872. The minimum temperature, 25° F., was surpassed only in 1876 (23° F.) and 1880 (13° F.). The number of days with minimum temperature below 32° F. was 5; only surpassed in 1872 (7 days), 1876 (10 days), and 1880 (6 days).

January, 1893.—The mean of three consecutive coldest days was 24° F., only surpassed in 1886 (20° F.). The number of days with a mean daily temperature below 32° F. was 5, surpassed only once in 1886 (6 days). The minimum temperature, 20° F., was surpassed in 1873 (19° F.), 1884 (13° F.), 1886 (10° F.), and 1887 (17° F.). The number of days of minimum temperature below 32° F. was 13, which is far beyond any previous record.

	° F.
The mean temperature for January for twenty-three years was	50
The mean temperature for January, 1886, was	43
The mean temperature for January, 1893, was	43
The coldest December was in 1876	44
The coldest January was in 1886 and 1893	43
The coldest February was in 1886	48

January, 1886, was regarded as the coldest weather experienced for fifty years.

If the weather for thirty days from December 27, 1892 (inclusive), be compared with any of the above records, it will be seen that its mean temperature is 39.8° F.* Thus there is ample ground for believing that the duration of extremely cold weather in the winter of 1892-'93 was larger than any year of which there are records.

The cold was much more severe at Pinehurst than in Charleston, as the following notes show:

The week following Christmas was very cold, so that much ice was formed and the ground frozen to the depth of about an inch for several mornings, although in the afternoon it generally thawed out. The week January 8 to 15 was also cold, so that all pruning was abandoned for the time being. But the week January 15 to January 22 has been unusually severe, as the following observations show: Saturday, January 14, 17° F. at 8 a. m.; Monday, January 16, 20° F. at 8 a. m.; Tuesday, January 17, 14° F. at 7 a. m.; Wednesday, January 18, 18° F. at 7 a. m. On the 18th 2½ inches of snow fell in the forenoon, followed by sleet in the afternoon, and the whole was frozen in the early night. Thursday forenoon all vegetation was covered with ice, and of such weight as to cause great destruction among the largest trees (yellow pine and oaks) of this region.

Freezing weather continued steadily until Friday afternoon, when a slight thaw occurred. Ice covered all the tea bushes until Saturday afternoon, and those in a sheltered position until Sunday, the 22d, at midday. The cold weather continued with frozen ground every morning until Wednesday, January 25. The depth of frost in the ground rarely exceeded 2 inches.

The effect of the prolonged cold upon the tea gardens has sufficiently developed since the return of the usual winter weather and the occurrence of several showers, so that now it may be possible to judge of the injury inflicted.

Quite young plantations have suffered considerably by the loss of their tenderest leaves; but they will probably recover almost entirely, with the exception of one garden of very tender and young Ceylon plants, which have been very generally killed to the ground. These last may spring up again from the roots. Nevertheless enough of these plants have survived the trial to furnish abundant material for propagation by cuttings another autumn, so that there shall be a garden devoted to the most hardy of this tender and valuable variety. Partly from a belief that the location of the Ceylon tea garden was unusually exposed and partly from our confidence that by a judicious mulching

* This is half a degree lower than the mean temperature of the thirty days (January 9 to February 8, inclusive), covering the phenomenal cold of 1886.

with pine straw during the first winters serious damage may be averted, even on the repetition of the weather of 1892–'93, several acres are now being planted with the best Ceylon tea seed.

Other seedings and young plants, particularly in exposed situations, have not infrequently lost their top foliage; but the loss is inconsiderable, although involving the retardation of their development.

Among the larger and older plants the injury from the cold weather shows itself in two directions, viz, a splitting of the bark of the trunk, whereby the latter becomes denuded and the plant dies. This form of damage has happened to not exceeding 1 or 2 per cent, but the plants thus affected were (as might be expected) among the thriftiest and finest in the tea gardens. The other injury was the loss of the youngest leaves and twigs on plants of apparently greater susceptibility. But it does not seem to involve further destruction, except in comparatively few cases. Very careful examination of the older gardens shows that the total loss from cold during the past winter is decidedly less than 5 per cent of the total plants.

The location and drainage of the tea gardens are of the first importance in climates where there is liability to such extreme cold. Even tender Assam survived the experience of this winter where sheltered by trees from the wind and on a dry hill. It may be well to avoid encouraging by autumnal manuring the growth of plants during the winter where it is apt to be cold.

TABLE 1.—*Showing frequency of prolonged periods of low temperature at Charleston, S. C., for January, February, and December, 1871, to date (January, 1893), inclusive.*

[Furnished for C. U. Shepard, M. D., Summerville, S. C.]

Year.	January.				February.				December.			
	I.—Mean of 3 consecutive coldest days.	II.—No. of days mean daily temperature below 32°.	III.—Minimum temperature.	IV.—No. of days minimum temperature below 32°.	I.—Mean of 3 consecutive coldest days.	II.—No. of days mean daily temperature below 32°.	III.—Minimum temperature.	IV.—No. of days minimum temperature below 32°.	I.—Mean of 3 consecutive coldest days.	II.—No. of days mean daily temperature below 32°.	III.—Minimum temperature.	IV.—No. of days minimum temperature below 32°.
	°	*Days.*	°	*Days.*	°	*Days.*	°	*Days.*	°	*Days.*	°	*Days.*
1871	42	0	28	2	47	0	36	0	38	0	26	4
1872	35	0	25	5	40	0	30	3	33	2	25	7
1873	35	1	19	5	45	0	33	0	41	0	27	2
1874	46	0	29	2	44	0	36	0	47	0	33	0
1875	39	0	30	5	38	0	28	5	43	0	25	1
1876	39	0	28	1	43	0	31	1	33	1	23	10
1877	36	0	26	5	44	0	35	0	43	0	33	0
1878	38	0	30	3	44	0	32	0	38	0	25	2
1879	32	2	23	7	43	0	30	2	46	0	34	0
1880	50	0	33	0	46	0	36	0	31	1	13	6
1881	34	0	30	0	38	0	26	4	47	0	33	0
1882	40	0	26	1	46	0	32	0	38	1	24	3
1883	38	0	25	1	49	0	39	0	41	0	29	1
1884	29	2	13	5	48	0	28	1	39	0	26	2
1885	39	0	28	2	36	1	22	3	42	0	28	2
1886	20	6	10	8	31	2	13	4	35	0	25	5
1887	29	2	17	8	49	0	34	0	40	0	29	2
1888	41	0	26	1	44	0	28	2	34	0	28	2
1889	39	0	29	1	39	0	26	1	52	0	37	0
1890	47	0	36	0	47	0	39	0	55	0	34	0
1891	43	0	32	0	47	0	29	1	43	0	29	1
1892	41	0	29	5	46	0	32	1	27	2	25	5
1893	24	5	20	13	......	......	......	......	......	......	......	......

Cold periods and extent.

1872, Dec. 9 to 16 and 22 to 31.
1875, Feb. 4 to 10.
1876, Jan. 12 to 15.
1877, Jan. 1 to 5.
1881, Jan. 1 to 4; Feb. 2 to 7.
1884, Jan. 2 to 10 and 20 to 23.
1885, Jan. 17 to 23.
1886, Jan. 5 to 18; Jan. 25 to Feb. 9; Dec. 2 to 8.
1887, Jan. 1 to 13; Dec. 26 to 31.
1888, Jan. 17 to 30.
1892, Dec. 27 to 31.
1893, Jan. 6 to 25.

Record of thickness of ice formation as recorded in Weather Bureau Daily Journal by the observer, L. N. Jesunofsky.

1892, Dec. 27. $\frac{1}{4}$-inch ice formation this a. m.
28. $\frac{4}{10}$-inch ice formation this a. m.
29. $\frac{1}{10}$-inch ice formation this a. m.
30. Very thin ice formation this a. m.
1893, Jan. 6. $\frac{1}{10}$-inch ice formation this a. m.
7. $\frac{1}{8}$-inch ice formation this a. m.
9. Very thin ice formation this a. m.
11. $\frac{1}{10}$-inch ice formation this a. m.
14. $\frac{8}{10}$-inch ice formation during last night and this a. m.
16. $\frac{8}{10}$-inch ice formation during last night and this a. m.
17. $\frac{5}{10}$-inch ice formation during last night and this a. m.
18. $\frac{4}{10}$-inch ice formation during last night and this a. m.
18. Snowfall 9:18 a. m. to 3:08 p. m; total depth, 1.9 inches.
20. $\frac{5}{10}$-inch ice formation during last night and this a. m.
21. $\frac{5}{10}$-inch ice formation during last night and this a. m.
22. $\frac{4}{10}$-inch ice formation during last night and this a. m.

NOTE.—Observations on thickness of ice made between 7:45 a. m. and 8:15 a. m. daily.

L. N. JESUNOFSKY,
Observer, Weather Bureau.

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