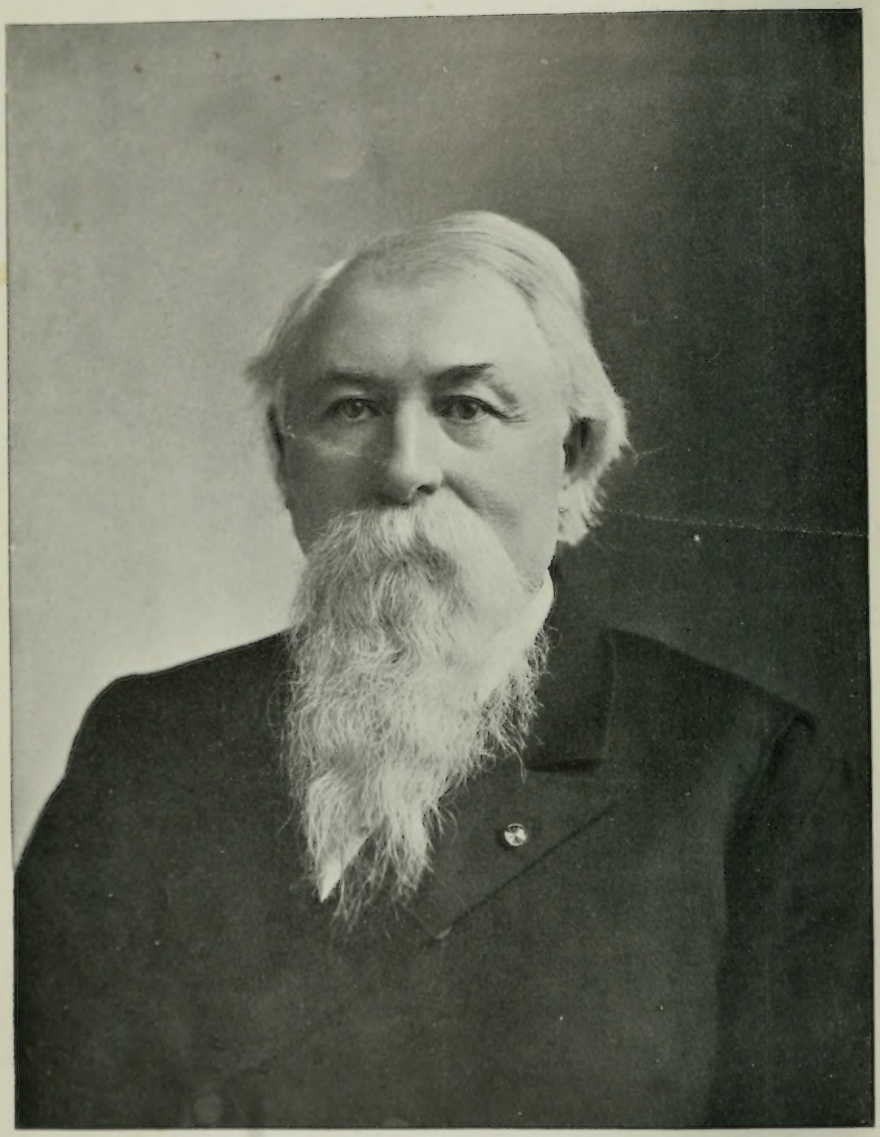


JEREMIAH M. RUSK.

(Secretary of Agriculture, 1889-1893.)

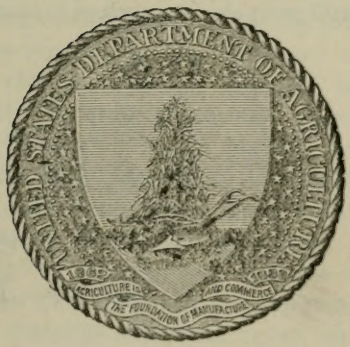
YEARBOOK

OF THE

UNITED STATES

DEPARTMENT OF AGRICULTURE.

1898.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1899.

[PUBLIC—No. 23.]

AN ACT providing for the public printing and binding and distribution of public documents.

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Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part one, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; part two, which shall contain such reports from the different bureaus and divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of part one, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of part 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; and the title of each of the said parts shall be such as to show that such part is complete in itself.

PREFACE.

The present Yearbook does not in form differ materially from its predecessors, with the exception of the Yearbook for 1897, to which, as explained in the preface to that publication, a special feature had been added by direction of the Secretary of Agriculture, consisting of articles from each chief of Bureau, Division, and Office outside of those that are purely administrative, presenting "in plain terms the relation of the work of his Bureau, Division, or Office to the farmer." This addition made the Yearbook of 1897 consist of four distinct parts instead of three, as usual. While the form has been changed, the spirit of this special feature has by no means been neglected in the present volume. No attempt was made to secure an article for this book from every chief relating to the general work of his Division to the farmer, as was done last year—a course which would have inevitably resulted in more or less repetition; but the chiefs understood that it was the wish of the Secretary that the practical service rendered to the farmer by the Bureau, Division, or Office contributing the article should be made apparent. A perusal of the articles composing the present volume will show that in this respect the Secretary's injunction has not been overlooked. It has not, however, been found necessary to segregate such papers; hence, the present Yearbook conforms to the plan originally adopted, and consists of three parts: (1) The report of the Secretary of Agriculture to the President for 1898, thus complying with the law, which prescribes that the volume shall "include a general report of the operations of the Department;" (2) miscellaneous papers, prepared with very few exceptions by the chiefs of Bureaus, Divisions, and Offices of the Department or their assistants; and, (3) a summary of useful information, published in the form of an appendix.

To the third feature of the present volume special attention has been given with a view to increasing its scope and usefulness. While preserving the main features of former years, an effort has been made to give the Appendix of the present Yearbook the character of an agricultural directory. Thus, in addition to the usual Department directory and the directory of colleges and experiment stations, there have been included lists of the principal officials having charge of agriculture in the several States; of managers of farmers' institutes; of national and State dairy officials; of the several associations of cattle,

horse, and sheep breeders, with their secretaries; of the State veterinarians and State health officers; of the forestry officers of the different States and of the forestry associations; of the officers of the horticultural and kindred societies, etc. In this connection the Editor may be permitted to call attention to the great difficulty of securing such information, and to suggest that its publication in an edition of 500,000 copies for distribution to the farmers of the country should make it worth while for the several officials interested, to themselves supply the Department with the necessary data for the presentation of this information in the Yearbook. If possible these data should be in the hands of the Editor by January 31 of each year.

In addition also to the usual statistical matter, including the crop statistics and prices of farm products and the imports and exports of agricultural products and transportation rates, and in view of the natural eagerness of the people for information regarding the new dependencies, figures are given showing the foreign trade of Cuba and of the Philippine Islands. Similar figures are not given for Puerto Rico and Hawaii owing to the fact that in the main body of the book are to be found special articles upon these islands.

Attention is also called to the review of the weather for the past year, prepared by an expert of the Weather Bureau, and which presents a detailed weather record in comparatively simple form. This review is continued from year to year, and promises to grow constantly in interest and usefulness.

GEO. WM. HILL,
Editor.

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YEARBOOK

OF THE

U. S. DEPARTMENT OF AGRICULTURE.

REPORT OF THE SECRETARY.

TO THE PRESIDENT:

I have the honor to submit a report of the work of the Department of Agriculture for the year ending June 30, 1898. This report contains a review of the operations of the several Bureaus, Divisions, and Offices through which the work is carried on. For your own convenience and that of those who shall have occasion to peruse this report, I have preceded this general review with a summary, in which some salient feature of the work undertaken by each of these several Bureaus, Divisions, and Offices is very briefly indicated. Several considerations are also presented of a more general character relating to the work of the Department and the services which I conceive it should seek to render to the country, upon which some earnest recommendations are based, and which have also been made the basis for some of the estimates submitted by me for the appropriations for the Department for the ensuing fiscal year, and to which the favorable consideration of Congress is earnestly invited.

SUMMARY.

WEATHER BUREAU.

Observation and forecast stations have been extended around the Caribbean Sea, to warn our fleets and merchant vessels of danger from cyclones, and increased through the interior of the country, especially in the mountain States, to enable the observer to inform fruit growers of precipitation and sudden changes of temperature.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

Good work has been done by the Division of Vegetable Physiology and Pathology in hybridizing the orange and other citrus plants, and in the crossing of pineapples, whereby the size and vigor of the fruit are much increased and the flavor greatly improved.

SECTION OF FOREIGN MARKETS.

Our knowledge of the islands of the Caribbean and China seas is increased by timely publications of the Section of Foreign Markets.

Our foreign trade in agricultural products is very extensive, being over two-thirds of our domestic exports. It is steadily growing, while the production at home of field products that have been introduced from foreign countries is rapidly increasing, causing a corresponding decrease in agricultural imports.

BIOLOGICAL SURVEY.

While the Department is searching the world for seeds and plants to diversify our crops and add new varieties to meet sectional requirements, the Biological Survey is determining the areas best adapted to various crops and mapping the natural life zones of the United States. It is a court of last resort, where birds and animals get a final hearing regarding their relations to the farm and orchard. Their stomach contents witness for or against them.

FARMERS' BULLETINS.

The Department is unable to give Members of Congress as many Farmers' Bulletins as their constituents desire. As fast as scientists find facts bearing on production, I think it wise to send them to the farmers. The farmers want them, Congressmen desire to send them, and appropriations to this end should be enlarged.

SCIENTIFIC EXPLORATION.

The Department has four scientific explorers abroad, getting seeds and plants—one in Russia, one in the countries around the Mediterranean, one in the China seas, and one in South America.

FORESTRY.

The treeless region is now getting vigorous attention from our Forester, Mr. Pinchot. Species adapted to dry regions are being introduced. The destruction of forests in the Northwest leaves deserts in many cases. The life history and rate of development of white pine have been investigated and facts concerning them are in press. Mr. Pinchot, is planning to introduce better methods of handling forest lands in public and private ownership, the private owners paying the expenses of Department agents who give instruction. A million acres in twenty States are offered for experimentation and 100,000 acres are now under management. Economic changes in lumbering will be the result. Forest fires cause floods and droughts and consequently interfere with production, especially in irrigated regions. A study of fire prevention and fire fighting is being made. Wood supply is becoming a matter of such interest that the Department deems it wise to give it special attention.

SOILS AND TOBACCO.

Many States are interested in the heredity, flavoring, and fermentation of tobacco, and the Department has these features under

research. Farmers in the mountain States, who are making their lands sterile by using too much water, require information regarding its use in irrigation. The Division of Soils is getting facts for them.

POST-GRADUATE WORK IN THE DEPARTMENT.

After graduation at agricultural colleges, the Divisions of the Department of Agriculture might be opened for post-graduate study in special lines, so that the best facilities in the land may be offered for preparing teachers for the agricultural colleges and economic scientists for Department work.

THE GRASSES.

The best pastures produce animals at least cost. The Division of Agrostology studies grasses and the grass requirements of localities. Five hundred varieties grow in the Department gardens, and grasses suitable for pastures, lawns, woods, and sand are studied. Foreign grasses are tried in congenial zones. Legumes are brought from abroad to meet peculiar conditions here. We have grass gardens in arid and semiarid regions, where varieties from similar conditions in the Old World are studied. The Department is endeavoring to find grasses and legumes for worn-out lands in the East and South, and binding grasses, to arrest sand drift, are getting attention.

DIVISION OF BOTANY.

The Division of Botany is at work to reduce our importations of the little things that have been costing us $8,000,000 annually. Western States are now growing chicory. In 1896 we imported 16,317,888 pounds; in 1898 we imported only 315,707 pounds of raw chicory. The farmers of Michigan, Nebraska, and other States will now furnish our supply. Ginseng is also a promising plant for cultivation. This Division will make tests to protect farmers and merchants against foul and fraudulently imported seeds, and test the importations of the Department before distribution.

ECONOMIC CHEMISTRY.

We are not giving economic chemistry the attention it deserves. We pay foreign countries very large sums for coal-tar products, for example, while we have skilled chemists, capital, and raw material in abundance at home. Our raw material is wasted along these lines, while we are content to buy abroad; we employ, indirectly, foreign chemists to work up for us foreign raw material. Attention to this by the law-making power will find the remedy.

CROP STATISTICS.

The reason for having a Division of Statistics is that it will collect and publish information regarding the condition, acreage, and tendency of production of the principal crops, and the number of farm

animals at home and abroad, so that the isolated producer may get notice of quantities and probable demand as soon as those who deal in these commodities. When this is well done, its value to the producer is inestimable. Strenuous efforts are being made to get the truth concerning production, and great care is taken to publish results for general information only.

AGRICULTURE IN ALASKA.

A practical scientist was sent to Alaska to select sites for experimental work—to test grains and grasses, legumes and vegetables, and study the possibilities of future production. He grew all of these crops with great success. Alaska will grow, along the coast, oats, barley, flax, rye, grasses, legumes, and vegetables of as good quality as many of our Northern States produce. All the conditions for making fine dairy products are favorable. We shall have the interior explored next summer, in order that its capacity to support population may be learned.

ROAD INQUIRY.

Good roads save time and expense. Steel rails are perhaps the coming material where hard rock is not convenient.

EXPERIMENT STATIONS.

The experiment stations are more effective than ever before. The annual appropriation by Congress of $720,000 is supplemented by $400,000 from the States, and the stations are doing more original work. The Department presents their results in Farmers' Bulletins. The feeding of mankind is being studied in connection with State institutions, and information is distributed to form the basis of courses of instruction. All of our country west of the Missouri River is interested in irrigation, and facts are being collated regarding soil moisture, the supply and distribution of water, uniformity of laws and court decisions relating to irrigation, and the requirements of different crops in this regard.

NATURE STUDY IN THE COMMON SCHOOLS.

Congress endowed agricultural colleges that are revolutionizing methods of production. Nature studies, however, should be introduced into the common schools, so that the young farmer's mind may be turned early to life-work studies. The teacher should get instruction in the normal school or agricultural college.

ANIMAL INDUSTRY.

REMEDY FOR FEVER TICKS OF CATTLE.

The Bureau of Animal Industry has continued its experiments in dipping cattle to destroy the fever ticks, and a substance has been found in which cattle may be dipped and which will destroy all the

ticks on an animal in a single dipping. This method has been in practical use for a short time only, and experiments are now in progress to perfect it, so that dipped cattle from the infected districts may be shipped north of the quarantine line during the entire year; heretofore they have been restricted by quarantine during ten months of the year. The value of this measure is beyond computation, both to the stockmen south of the quarantine line and to the cattle feeders and grain producers north of it. Demand is increasing at home and abroad for fine beef, and this discovery is destined to remove one of the impediments to its production.

REMEDY FOR HOG CHOLERA.

The Bureau has continued experimentation with antitoxin serum for the prevention and cure of hog cholera. Congress, at its last session, made an appropriation for this work, which became available at the beginning of the present fiscal year. Buildings were erected at our experiment station, and animals purchased to make the serum in sufficient quantities to conduct extensive research. The results of the previous year have been corroborated. Eighty per cent of the animals treated were saved, while a like per cent of the check herds not treated died. This justifies the Department in efforts to supply in future to herdsmen throughout the country such serum as can be made. It is for Congress to determine whether serum shall be given free or a charge be made covering the expense of manufacture, which would be about 15 cents for each animal.

EMERGENCY APPROPRIATION.

The nature of the work in the Department is such that future requirements can not all be anticipated specifically in an appropriation bill. Urgent needs of producers call for expenditures in special directions through some of our scientific Divisions; the sudden appearance of a bacteriological or insect pest; investigation of animal or crop conditions in some section of the country; inquiry into conditions in foreign countries where we sell or with whom we compete; assistance to a struggling scientist to complete work of general agricultural interest; exploration by scientists of islands coming into the possession of the United States, and such like, suggest the wisdom of appropriating a lump sum to be used by the Secretary of Agriculture, subject to the laws regarding vouchers and auditing.

INSPECTION OF FOREIGN GOODS.

There is an evident necessity for the inspection of many articles imported from foreign countries that contain substances injurious to the public health. The Department chemists are doing work along this line which suggests a more comprehensive inquiry. At present the Department buys samples for analysis in the open market. It

may be necessary, where there is ground for suspicion and a necessity for the identification of source, to open packages at ports of entry, as it is proposed in foreign countries to do with our exports in certain cases.

BUTTER SHIPMENTS.

The experimental exports of butter by this Department to Great Britain, which were commenced in the spring of 1897 and partially reported upon a year ago, were continued until the close of the active creamery year of 1897 and resumed at the opening of the season of 1898 upon an enlarged scale.

Without anticipating the results of the present (or second) season of these trial exports, it can now be confidently stated that much additional information has been obtained in the line desired, and a decided gain is evident in the favorable impression made by butter of the first quality from creameries in the United States upon the best class of the butter trade in London and Manchester.

THE DEPARTMENT LIBRARY.

The books of the late Prof. F. von Baur, of Munich, have been added to the collection on forestry in the Department Library, making that collection very complete. The total number added during the year was nearly 5,000, bringing the whole number of volumes in the Library close to 65,000. This forms one of the largest collections of books on agricultural topics in the world.

The Library is constantly used in the investigations conducted by the scientific Divisions, and is kept up to date in its various branches by the purchase and addition of the latest standard publications relating to matters in which the Department is interested. It is also used to a considerable extent by persons not connected with the Department, especially by teachers in the public schools and by students in the science classes of the various educational institutions of the city.

EXPERIMENTAL GARDENS.

The distribution of young plants to various parts of the country was continued during the year, reaching a total of nearly 190,000, including bulbs. Among these were olive, fig, and camphor plants and cuttings. Attention is called to the fact that the growing of rubber plants even in the most favorable localities of Florida can hardly be commercially successful.

The propagation of plants for general distribution has been continued, resulting in the accumulation of many thousands of plants of various kinds.

PARIS EXPOSITION IN 1900.

Congress has imposed upon the Secretary of Agriculture the duty of preparing for the Paris Exposition in 1900 an exhibit covering the

agricultural resources of the United States (Groups VII, VIII, and X—Agriculture, Horticulture, and Food Products). I am fully alive to the importance to American agriculture of this opportunity to enlarge the knowledge and appreciation of the people of the Old World of the extent and variety of the products which the bounty of nature enables the American farmer to draw from Earth's prolific bosom. The first steps have been taken after consultation and in cooperation with the Commissioner-General, and every effort will be made to see that American agriculture is properly represented at this great celebration. Should the appropriations already provided prove inadequate, I feel confident Congress will not hesitate to enlarge them rather than to have this important exhibit lacking in any single respect.

PRACTICABILITY OF EXPORTING DAIRY PRODUCTS.

Owing to better home demand for dairy products, it is not commercially profitable to send butter to Europe at the present time. The home demand for our best butters absorbs the supply. This is not always the case, however, and the Department regards it wise to obtain for dairymen all the facts relating to the export of this article to the several commercial centers of both continental and insular Europe. For this purpose the Department sent an agent to Paris to ascertain what encouragement there would be to ship butter to that point. It was found that no line of steamers sailing direct from the United States to French ports could furnish refrigerator space, and so shipments could not be made during the heated period. An agent was also sent to Hamburg, to ascertain for our people what the facts are regarding customs duties, as well as prohibitions and other difficulties that might meet exporters of butter to that country.

Our finest butter can be profitably made and sent to both France and Germany whenever the home supply is greater than the home demand for first-class goods. The American farmer is selling cheap grains and mill feeds to European dairymen, who meet us in European markets with products made from raw material furnished by us. There is every reason to believe that the tendency is growing within our own country toward the consumption of grains and mill feeds at home, exporting the higher-priced products of skill. As our producers manufacture more and more on the farm and the great volume of raw materials is turned into the higher-selling articles, we can furnish fine dairy products to European countries at a lower rate than they can be produced under European conditions on dearer lands and with dearer feeds.

The trade in American farm products is growing in the China seas. Scientific inquiry into the principles that underlie the making of fine dairy products is preparing our people to furnish butter in condition to be exported in air-tight packages, so that they will remain sweet for long periods in tropical countries. In order that markets may be

opened up in Japan, China, and other countries of the Pacific Ocean, an agent is now in that region establishing agencies to which the Department will make trial shipments with a view to ascertaining all the facts for the benefit of the dairymen.

INSPECTION OF DAIRY PRODUCTS.

The existing system of Government inspection and certification of meats and meat products for export may be extended (with suitable modifications) to include butter, cheese, and condensed milk for export from the United States.

The combined efforts of the Government and of commercial enterprise may succeed in the early establishment of a high reputation for American butter in desirable foreign markets. But as soon as accomplished, this becomes liable to be destroyed by the cupidity of those who, trading on this reputation, flood the same market with butter of low grade, yet still entitled to export and sale as "produce of the United States." This will disgust merchants and consumers alike and reverse the reputation of our butter, just as the fine market in Great Britain for our cheese was recently ruined by the quantity of low-grade and counterfeit cheese which was exported without being marked to show its true character.

The remedy seems to lie in extending and adapting the provisions of law regarding the inspection of meats exported from this country so as to make them apply to butter and cheese. The brands of "pure butter" and "full-cream cheese" should then be affixed by United States inspectors to such products only as are of a fixed minimum standard of quality. Such precautions, duly legalized and properly executed, would place the good butter and cheese of this country in foreign markets under the identifying label and guaranty of the United States Government, leaving similar merchandise of lower grade to find a place for itself, upon its own merits. It should be borne in mind that dairy products of Denmark and Canada, which are the chief competitors of the United States in the markets of Great Britain, bear the inspection certificate and guaranty of quality from their respective Governments, and thereby maintain a great commercial advantage.

Such a system of inspection is much desired by the most reliable exporters, and the proposition has met with decided approval wherever considered by fair-minded, interested parties.

NATURE-TEACHING IN THE COMMON SCHOOLS.

There is growing interest in education that relates to production. All classes of intelligent people favor it. Congress endowed colleges to teach it, and progress is being made, but not so rapidly as the growth of our country demands. More knowledge concerning what

the farmer deals with every day would enable him to control conditions, produce more from an acre, and contribute more to the general welfare. The education of our people in common school, high school, and college has not been designed to prepare them for producing from the soil, excepting the very few who have found their way into our agricultural colleges. It is evident to educators in agricultural science that elementary study should be introduced into the common schools to give direction early in life.

Agriculture, horticulture, forestry, gardening, and landscaping are delightful studies that attract people in all walks of life, but there is enough to be learned regarding each of these to require the devotion of a lifetime. The colleges and experiment stations endowed by the Federal Government provide for training along this line for longer or shorter periods at the institutions of the several States and Territories designed for this purpose; but while encouraging progress has been made in building up courses in these institutions that teach the sciences relating to production, instruction before going to college and after graduation is lacking. Nothing is being done in most of the common schools of the States to cultivate a taste for and lead the mind to inquire into and store up facts regarding nature, so that the young farmer may be directed into the path that leads to education concerning his future life work.

The great prerequisite is the education of the teacher. Most of the States have institutes where teachers are required to assemble for instruction in their work; there they should be met by lecturers from the agricultural colleges who may be qualified to outline methods of nature studies in the common schools. The normal schools of the States could give courses of instruction along these lines to those who are fitting themselves for teaching in the high schools, so that instruction of a more advanced character might be given their graduates, preparing them for and inclining them toward, the agricultural college.

PRACTICAL EXPERIMENTS IN NATURE TEACHING UNDER STATE AUTHORITY.

In New York, the College of Agriculture of Cornell University has a special State appropriation of $25,000 per annum to be used in aiding the introduction of nature teaching into the common schools and the carrying on of simple agricultural experiments in different parts of the State. The plan followed has been to employ experts in the different sciences to prepare brief leaflets containing lessons on different subjects for the use of teachers in the common schools. These leaflets are distributed to teachers throughout the State, and there has been such a large demand for them from teachers in other States that arrangements have been made to sell them at a nominal price.

The professors and other agents of the university attend meetings of teachers from time to time, to explain the scope of this work and to

show the teachers how to carry out simple instruction on nature topics. Many of these leaflets relate directly to agricultural subjects. For example, in one leaflet the teacher is instructed to have the children plant squash seeds, take some of them up at intervals to learn how the seeds germinate, and watch what happens to the little plants as they grow. At another time the children are encouraged to plant little gardens and carefully watch some of the things that grow in them; or they study some insect which preys upon fruit, or make collections of the insects about their homes, or watch them to see whether they are doing things good or bad for the farmer. This movement has rapidly increased in popularity, and the leaflets are used in many city schools as well as in those in the country. Hundreds of simple experiments with fertilizers on potatoes have been carried on in different parts of the State with some of the money above referred to. For carrying on all this work the university has employed its teaching force and a small corps of special agents and clerks.

In Indiana, Purdue University has undertaken a similar work, though its funds have not permitted it to make this very extensive. A number of leaflets have been prepared by different members of the faculty and have been sent out to teachers throughout the State. In a number of other States nature teaching has been introduced into the common schools, but for the most part in the schools in the larger towns and cities, where there were teachers who had had some training in natural science. As a result of the widespread interest on this subject, teachers' manuals and text-books for instruction in this branch are being prepared.

Without doubt the greatest difficulties in this matter are to overcome the conservatism of local boards managing the country schools and to get competent teachers.

FACILITIES OF THE DEPARTMENT FOR POST-GRADUATE INSTRUCTION IN AGRICULTURAL SCIENCE.

George Washington, by his will, left property to be devoted to university education in the District of Columbia. There is no university in the land where the young farmer may pursue post-graduate studies in all the sciences relating to production. The scientific Divisions of the Department of Agriculture can, to some extent, provide post-graduate facilities. Our chiefs of Divisions are very proficient in their lines; our apparatus the best obtainable; our libraries the most complete of any in the nation. We can direct the studies of a few bright young people in each Division, and when the Department requires help, as it often does, these young scientists will be obtainable.

They should be graduates of agricultural colleges and come to the Department of Agriculture through a system of examination that would bring the best and be fair to all applicants. The capacity of the Department is limited, but something can be done that will indicate to Congress the value of the plan. The Department often needs

assistants to take the place of those who are tempted to accept higher salaries in State institutions. The opening of our laboratories to post-graduate work would provide an eligible list from which to fill vacancies as they occur, supply temporary agents, and be a source from which State institutions might get assistants in scientific lines.

INVESTIGATION OF AGRICULTURAL RESOURCES OF INSULAR DEPENDENCIES OF THE UNITED STATES.

In the territories recently brought under the control of the United States Government the agricultural interests urgently call for attention by this Department. While in all countries the agricultural industry is admittedly of the first importance, this is especially true of Hawaii and the West India Islands, which depend almost exclusively for their prosperity upon their agricultural productions. It behooves the Department to place itself at the earliest moment possible in a position to extend to the agriculturists of those territories which have, or may, come under the United States flag, the services and benefits which it renders to the farmers of the United States. The increased trade relations which may be looked for between the United States and its insular dependencies, moreover, render the conditions of agriculture in the latter and the character and extent of their productions matters of profound interest to the people of the United States. In the interest of our own agriculture, not only must the agricultural resources of these islands then be studied closely and intelligently, but the dangers which threaten agriculture in these territories in the form of plant diseases or insect pests must be made the subject of special investigation with a view to providing agriculture there with preventive or remedial agencies, and also to securing our own agriculture from the possibility of their introduction into this country. It is urgently necessary, therefore, that Congress should as speedily as possible provide a sufficient fund for the use of this Department in making such investigations as may be necessary into the agricultural resources and conditions in Hawaii, Puerto Rico, Cuba, and the Philippines.

WEATHER BUREAU.

The presence of more than two hundred naval and transport vessels belonging to the United States in West Indian waters made it apparent during the latter part of the fiscal year that the methods of gathering information of the approach of West Indian hurricanes were wholly inadequate. The safety of the fleet during the time of severe atmospheric disturbances made it imperative that precautionary measures should be taken at once.

OBSERVATION STATIONS IN WEST INDIES AND ON CARIBBEAN SEA.

A bill was therefore drafted and submitted to Congress June 16, 1898, authorizing the establishment and operation of observation

stations throughout the West Indies and along the shores of the Caribbean Sea. The provisions of the measure were incorporated in the general deficiency bill, but did not become law until after the close of the fiscal year.

Arrangements had already been made, however, to establish stations for making meteorological observations and displaying hurricane signals at Kingston, Santiago de Cuba, Santo Domingo, St. Thomas, Barbados, Dominica, Trinidad, Curaçao, and Barranquilla.

When the West Indian service is fully established twice-daily reports will be received, not only from the stations named, but also from Habana, Nassau, Vera Cruz, Tampico, Coatzacoalcos, and Merida.

Although the primary object of the extension of the storm-warning system to the West Indies was the protection of our large naval force, other considerations of great importance make it a wise and beneficent undertaking, and the improved storm-warning service will largely benefit the commercial interests throughout the West Indies.

The Central Meteorological and Magnetic Observatory of Mexico has begun the equipment of about thirty stations in the Mexican Republic, with the most approved meteorological instruments, and will establish a meteorological service similar to our own. When completed, an exchange of reports, especially those relating to the approach of West Indian hurricanes and "northers" in the Gulf of Mexico, will be effected.

NEW STATIONS IN ARID AND SUBARID REGIONS.

Congress last session made an appropriation for the purpose of increasing the number of stations in the arid and subarid regions of the country, and provision has already been made to establish stations at Kalispel, Mont.; Boise, Idaho; Mount Tamalpais, Cal.; Flagstaff, Ariz., and Fort Worth, Tex. Additional stations will soon be located at Meridian, Miss.; Macon, Ga.; Lexington, Ky.; Elkins, W. Va.; Evansville, Ind., and Escanaba, Mich. These additional stations, besides assisting in the development of agricultural and industrial interests in the States in which they are located, will be of material benefit in improving the warnings and forecasts, especially for the regions west of the Rocky Mountains.

AERIAL OBSERVATIONS.

Aerial observations by means of kites were continued during the year. It was hoped to establish at least twenty stations, but it was found that only sixteen could be completely equipped. The observers chosen for the work were called to Washington and given a practical course of instruction in the art of flying and managing kites. It is too early to express an opinion regarding the value of the observations already secured in the aerial work of the Bureau.

LAKE CHARTS FOR VESSEL MASTERS.

To increase the usefulness of the Bureau in the Great Lake region, a monthly chart was issued showing the lake ports at which storm warnings are displayed, the localities in ports where information respecting the weather can be obtained, the regions of fog, the prevailing winds, and other statistical information respecting the wind and weather on the lakes.

LOSSES TO FARM PROPERTY BY LIGHTNING.

The Bureau has begun the collection of statistics of loss to farm property, including live stock in the fields, by lightning, so as to determine the frequency of lightning stroke and the amount of property destroyed annually by that agency.

EFFICIENCY OF THE BUREAU.

The efficiency of the Bureau was fully equal to the high standard of the previous year. Four hurricanes which visited the Atlantic and Gulf coasts during the fall were duly announced. The most severe of these storms was that of October 23 to 26, which moved slowly from off the Florida coast to the vicinity of Hatteras. It there increased greatly in intensity, and caused violent northeast gales along the coast as far north as New England.

Owing to the duration of the storm in the vicinity of Hatteras, the Bureau was enabled to make a definite prediction with regard to the tide at Norfolk, Va., where, owing to the low level of the city, much valuable property is liable to damage by inundation. Cotton and other property valued at $850,000 were removed to places of safety. As a result of the warnings issued for this storm, between 800 and 900 vessels remained in port along the Atlantic coast.

During the prevalence of one of three severe storms which passed from the interior to the eastern seaboard during November, 1897, the steamer *Idaho*, with 19 of her crew of 21, was lost on Lake Erie. This vessel, disregarding the warnings of the Weather Bureau, left Buffalo during the afternoon of the 5th in the face of storm signals which had been flying since daybreak.

A remarkably violent wind and snow storm swept over eastern New York and New England January 31 and February 1, 1898. The greatest violence of the storm was felt along the New England coast, where nearly two score mariners lost their lives and many vessels were wrecked. Warnings of this storm were sent out the morning of the 31st and given the widest possible circulation.

Early in January and February, 1898, forecasts of freezing weather in Florida were made in time to enable the residents of that State to protect their early vegetables and fruit trees. Similar notices were given regarding unusually low temperature in California.

There were five important floods during the year, and but for the timely warnings given by the Bureau the losses would have been much greater than they were.

Forecasts and warnings were at all times distributed with the utmost dispatch, and the daily press has not only greatly contributed to the success that has attended our efforts in circulating forecasts, but has rendered valuable aid in disseminating special warnings of cold waves, storm winds, frosts, etc.

There has been a great improvement in the instrumental equipment of the Bureau, and no other similar territory in the world is covered with such a complete equipment of instruments, recording climatic and meteorologic phenomena.

CLIMATE AND CROP SERVICE IN ALASKA.

An agricultural experiment station having been established in Alaska in April, 1898, an official of the Weather Bureau was sent there to organize a climate and crop service. The central station is located at Sitka, and continuous registers of wind velocity, sunshine, temperature, and pressure will be made there.

TELEGRAPH SERVICE.

At one time the Federal Government owned and operated about 5,000 miles of seacoast and frontier telegraph lines. In 1891, 633 miles of these lines, mainly on the seacoast, were turned over to the Weather Bureau. These lines enable the Bureau to receive early information of changes in weather at exposed points on the coast, to display storm warnings near several of the great highways of vessels entering or leaving our ports, and also to contribute largely to the safety of vessels navigating our coasts.

STUDY OF METEOROLOGY.

The importance of the study of meteorology in the United States has been kept in mind, especially in the assignment of observers to duty at points where there are colleges or universities not already provided with instructors in meteorology, and during the past year the courses in meteorology have been strengthened in a large number of high schools and academies.

NEED OF AN ASSISTANT CHIEF.

Almost the entire time of the Chief of the Weather Bureau has during the year been consumed in executive work, leaving him but little time to attend to other duties. That work is constantly increasing; therefore I recommend that an assistant chief of the Weather Bureau be provided for.

BUREAU OF ANIMAL INDUSTRY.

MEAT INSPECTION.

The Bureau maintains a system of thorough inspection of meat products at one hundred and thirty-five abattoirs in thirty-five cities. This is an increase of seven abattoirs and two cities over the fiscal year 1897. The work done has greatly exceeded any former year, especially in the matter of pork products. This necessitated a large increase in the force of employees, who were obtained through examination by the Civil Service Commission. Their service has been efficient and satisfactory.

From the tables furnished by the Chief of the Bureau of Animal Industry it is learned that during the year there were 9,228,237 antemortem inspections of cattle, 10,028,287 of sheep, 468,199 of calves, and 31,610,675 of hogs, making a total of 51,335,398 inspections. This is a total gain over 1897 of 9,025,291 animals, divided as follows: Cattle, 1,178,212; sheep, 1,983,932; calves, 19,216; hogs, 6,043,931. The condemnations at abattoirs were 104 cattle, 741 sheep, 67 calves, and 9,679 hogs—a total of 10,591. The rejections in stock yards were 27,491 cattle, 9,594 sheep, 2,439 calves, and 66,061 hogs—a total of 105,585. The number of condemned animals at abattoirs was 3,275 fewer than in 1897, and the number rejected in stock yards was 27,247 greater. These differences show the careful work of the officials in detecting disease previous to the slaughter of the animals.

The records for the post-mortem work show 4,433,181 inspections of cattle, 5,501,675 of sheep, 245,155 of calves, and 20,936,840 of hogs. Of the carcasses condemned, 10,018 were of cattle, 3,567 of sheep, 344 of calves, and 77,579 of hogs; and of the parts of carcasses condemned, 12,591 were of cattle, 287 of sheep, 52 of calves, and 35,250 of hogs.

In addition to the above there were killed by city inspectors 1,785 cattle, 1,509 sheep, 192 calves, and 14,698 hogs which had been rejected in the stock yards by officers of the Bureau of Animal Industry.

The meat-inspection tag, or brand, was placed on 14,815,753 quarters and 968,014 pieces of beef, 5,448,477 carcasses of sheep, 217,010 carcasses of calves, 680,876 carcasses of hogs, and 394,563 sacks of pork.

The meat-inspection stamp was affixed to 4,433,569 packages of beef products, 5,163 packages of mutton, and 10,145,048 packages of hog products, of which 374,131 contained microscopically-examined pork.

The number of cars sealed containing inspected meat for shipment to packing houses and other places was 18,631.

There were issued 35,267 certificates for meat products which had received the ordinary inspection; these covered exports comprising 1,256,716 quarters, 67,120 pieces, and 735,814 packages of beef,

weighing 339,650,091 pounds; 5,163 packages of mutton, weighing 324,996 pounds; 39,212 hog carcasses and 653,564 packages of pork, weighing 244,956,482 pounds.

The cost of this work was $409,138.09, which makes an average of 0.8 cent for each of the 51,335,398 ante-mortem inspections, besides covering all the subsequent work of post-mortem inspection, tagging, stamping, etc.

The cost of inspection has been growing gradually less year by year. The average cost per head was 4¾ cents in 1893, 1¾ cents in 1894, 1.1 cents in 1895, 0.95 cent in 1896, and 0.91 cent in 1897.

The number of animals inspected before slaughter is shown in the statement below. The figures for 1897 are given also as a means of comparison.

Animals inspected before slaughter for abattoirs, 1897 and 1898.

Fiscal year.	Cattle.	Calves.	Sheep.	Hogs.	Total.
1897	4,289,058	259,930	5,179,643	16,813,181	26,541,812
1898	4,552,919	241,092	5,706,092	20,713,863	31,213,966
Increase	263,861	[1] 18,848	526,449	3,900,682	4,672,154

[1] Decrease.

MICROSCOPIC INSPECTION OF PORK.

The examination of pork and pork products shows that better results are obtained by making the inspection in the carcass than when samples from cured meat are examined. The following table shows this fact quite clearly:

Comparison of inspections from carcasses and from pieces.

Samples.	From carcasses.		From pieces.	
	Number.	*Per cent.*	*Number.*	*Per cent.*
Class A	1,892,131	98.148	864,042	98.747
Class B	15,729	.816	5,064	.579
Class C	19,978	1.036	5,902	.674
Total	1,927,838	100	875,008	100

The samples of pork submitted for microscopic examination were classified as follows: Class A, samples in which no sign of trichinæ, living or dead, or calcified cysts are found; Class B, samples in which degenerate trichinæ cysts are found, but in which the body of the parasite is not recognizable; Class C, samples in which recognizable bodies, living or dead, of trichinæ are found. All hogs belonging to the latter class must be condemned and disposed of according to section 20 of the regulations dated June 14, 1895.

The number of certificates issued for microscopically examined pork

was 20,158, covering shipments aggregating 373,366 packages, weighing 120,271,659 pounds. Of this quantity, 698 packages, weighing 161,303 pounds, were exported to countries not exacting a certificate of microscopic inspection.

The cost of microscopic inspection was $171,040.94, an average per specimen examined of 6.1 cents, or an average of 0.142 cent for each pound exported. This cost per pound for the inspection of pork shows a remarkable reduction from the cost in 1897, when it was 0.256 cent. The cost in 1896 was 0.264 cent; in 1895, 0.2 cent; in 1894, 0.248 cent.

The microscopically inspected pork for 1898 reached the enormous amount of 120,271,659 pounds. Only 161,303 pounds of this went to countries not requiring inspection. In 1897, 43,572,355 pounds of pork were inspected microscopically, 1,001,783 pounds of which went to countries not requiring inspection. These figures show that countries requiring inspection received from us in 1898, 120,110,256 pounds of pork, as against 42,570,572 in 1897—an increase of 77,539,784 pounds. It is worthy of note here that the amount of pork microscopically inspected in 1898 exceeded the total amount of the three previous years by 18,703,906 pounds.

The number of samples examined increased 49 per cent over last year, the expense increased 53 per cent, and the exports increased 176 per cent.

INSPECTION OF VESSELS AND OF ANIMALS FOR EXPORT.

The number of inspections of American cattle for export was 859,346, and 1,438 head were rejected; 297,719 inspections of American sheep were made and 180 head rejected. The number of Canadian cattle inspected was 19,397, of which 5 were rejected; 29,497 Canadian sheep were inspected and 38 of them were rejected.

The number of clearances of vessels carrying live stock was 971, as against 954 in 1897.

Inspectors of the Bureau of Animal Industry in Great Britain inspected cattle from the United States to the number of 381,420 and sheep to the number of 151,863; cattle from Canada, 17,164; sheep from Canada, 27,912. This shows an increase of 20,898 cattle and a decrease of 9,408 sheep when compared with the report for 1897. The number of head of cattle lost in transit in 1897 was 2,323, or 0.61 per cent, as against 907 head or 0.23 per cent for this year. The number of sheep lost in transit in 1897 was 2,676, or 1.39 per cent, as against 1,618, or 0.89 per cent, for this year.

The cost of the inspection of export animals, the supervision of Southern cattle transportation, and the inspection of animals imported from Mexico was $101,210.55. It is estimated that half of this expense is on account of the export inspection, and, with this as a basis, the cost of inspecting the 548,419 domestic cattle and sheep exported was

$50,605.28, or 9.2 cents per head. The number of inspections made of these animals in this country was 1,157,065, and in Great Britain 533,283, making a total of 1,690,348, the average cost of each inspection being 2.99 cents.

Following is a statement showing the inspection of domestic cattle and sheep for export, and number exported for 1898, compared with 1897:

Inspections and exports of domestic cattle and sheep, 1897 and 1898.

Year.	Cattle.		Sheep.	
	Number of inspections.	Number exported.	Number of inspections.	Number exported.
1897	845,116	390,554	348,108	184,596
1898	859,346	400,512	297,719	147,907
Increase (+) or decrease (—)	+14,230	+9,958	—50,389	—36,689

SOUTHERN CATTLE INSPECTION.

During the quarantine season of 1897 there were received and yarded in the quarantine division of the various stock yards 35,317 cars, containing 972,224 cattle; the number of cars cleaned and disinfected was 35,280.

In the noninfected area in Texas 225,096 cattle were inspected for the identification of brands, prior to removal to other States for grazing.

INSPECTION OF IMPORTED ANIMALS.

The number of animals imported from Mexico and inspected at the ports of entry along the boundary line comprised 177,772 cattle, 64,207 sheep, 104 swine, and 3,053 goats.

There were imported from Canada for slaughter, milk production, grazing, feeding, etc., and not subject to quarantine detention, 79,907 cattle, 184,352 sheep, 374 swine, 2,998 horses, 2 goats, 8 mules, 1 deer, and 6 buffalo, of which 385 cattle, 6,867 sheep, and 217 swine were for breeding purposes.

INSPECTION OF HORSES AND HORSE PRODUCTS.

The appropriation bill for the fiscal year 1899 contains a provision "that live horses and the carcasses and products thereof be entitled to the same inspection as other animals, carcasses, and products thereof" named in the bill. Two abattoirs have so far been established, one at Linnton, Oreg., and one at Brighton, Mass. The latter has been in operation but a few days. The former commenced operations on August 1, and during that month 721 horses were inspected, 88 of which were condemned. In September there were 905 inspections and 33 condemnations. The percentage of condemned animals

is large, and is an indication that no mistake is made in extending inspection to horses. These abattoirs slaughter horses exclusively.

Regulations are being formulated for the inspection of live horses for export. It is believed such inspection will stimulate the demand abroad for our horses, especially in England, where the question of inspection of American horses has already been discussed to some extent.

PAYMENT FOR MICROSCOPIC INSPECTION.

While the work at the abattoirs becomes more thoroughly systematized from year to year and the cost of inspection per pound of meat has become gradually less, the great extension of the work necessarily increases the total expenditures. The question as to whether the Government should continue to pay the cost of this inspection, or whether the expense should be borne by the slaughterers, is one which, in my opinion, ought to receive early consideration. As bearing upon this feature of the question, I quote from my report for 1897:

> While I believe the general inspection of meat for sanitary purposes should be made by the Government, without charge to the slaughterers, the microscopic inspection to a great extent is a commercial inspection, and the cost of it could be more legitimately assessed against the trade which it benefits. If the packers paid the cost of the inspection there would be no longer any reason for declining to extend it to all who apply for it.

EXPERIMENTS WITH HOG CHOLERA.

The experiments conducted in the fall of 1897 upon hog cholera and swine plague proved so encouraging that Congress made a special appropriation for the purpose of continuing the work. The bill was late in passing, and further time was consumed in making the necessary preparations to carry on the work on a sufficiently practical scale. Material to inject about 1,000 animals was sent to the agent of the Bureau of Animal Industry in Iowa, where the first test is being made, and reports already received indicate that about 80 per cent of the animals treated were saved, while in the check herds barely 20 per cent were saved.

On account of the time required to secure a supply of this serum, the quantity so far produced has not been adequate to give sufficient data upon which to base definite conclusions; but the results so far obtained are gratifying indeed, and it is deemed advisable to continue the work another year. The production of serum is being steadily increased, and in a short time a large and regular output will be assured. It remains only to test the remedy upon a sufficient scale and to perfect the method of procedure.

A grave question now presents itself in connection with this subject. I refer to the manufacture of the serum in quantities sufficient to supply the prospective demand. The necessity for its manufacture

without the temptation inseparable from purely commercial undertakings to cheapen the product is manifest. It is obviously of the utmost importance that this serum should be produced of the requisite strength and purity until the efficacy of the treatment is thoroughly understood and appreciated and a reliable standard is established, as in the case of other remedial agents, and the interest of the public demands that this discovery, having been made by public officials at public expense, should not be diverted to private profit. It must be supplied for the benefit of all at a minimum of cost; and, under the circumstances, I can see no alternative but that the manufacture should be continued under Government control, at least for some years to come.

TUBERCULOSIS.

The study of tuberculosis, with reference to both men and animals, has been continued, and the results so far obtained indicate that experiments already begun in this line should be continued, as there is a prospect of more satisfactory results.

TEXAS FEVER.

Experiments in dipping cattle to kill the ticks which cause Texas fever were continued, with the gratifying result that a substance has been found which will destroy all the ticks on an animal at a single dipping. In order to test the experiment on a large scale, about a thousand head of cattle were dipped at Fort Worth, Tex., and thence shipped to northern Illinois and placed in pastures with susceptible cattle. The ticks were all killed by the dipping and the cattle did not communicate the fever to the susceptible cattle. An equal number were dipped at Mammoth Spring, Ark., with equally successful results. The importance of this measure can hardly be overestimated, and prominent stockmen consider that it is worth millions of dollars, both to cattle raisers below the quarantine line and to the feeders and grain producers north of the line.

These encouraging results have led to a demand for dipping stations at many other points, and arrangements are now being made for perfecting the dipping process and for securing the establishment of such stations before the next quarantine season at points convenient for shipment and inspection.

INVESTIGATION IN BLACKLEG.

The demand for blackleg vaccine has increased very much during the year. More than 355,000 doses have been sent out. The results received from its use indicate that the percentage of loss in herds has been reduced from 10 to 20 per cent to less than 1 per cent. This means not only an immense saving to cattle raisers, but, if generally used, will tend to eradicate the disease completely.

DIVISION OF CHEMISTRY.

The Division of Chemistry during the past year has continued its work on the composition and adulteration of foods. An elaborate bulletin, treating of the composition of cereals and all cereal products, represents the results of the principal amount of work in this direction. Another bulletin is devoted to the composition and uses of Indian corn, and this bulletin was prepared especially for presentation at the Third International Congress of Applied Chemistry in Vienna, which met in July, 1898. The bulletin has proved of such interest to Europeans that permission has been asked for its translation both into Italian and French.

OFFICIAL AGRICULTURAL CHEMISTS.

The cooperation of the Division with the Association of Official Agricultural Chemists has continued with mutual benefit. As a result of the systematic study of methods of investigation of soils, fertilizers, and agricultural products, the United States has now a uniform method of research, everywhere practiced and recognized as official by both trade chemists and the courts of justice. European nations have been impressed with the value of this cooperative work, and are now organizing similar associations. In view of these facts, the propriety of recognizing in some official way the Association of Official Agricultural Chemists is evident. Congress should enact some special recognition of this association, so as to establish more fully its official character and render its proceedings more valuable, not only in scientific matters, but also in the courts.

STREET SWEEPINGS, ETC.

The importance of disposing of street sweepings, garbage, and other refuse of cities has engaged the attention of the Division, and a considerable degree of progress was made in studying the agricultural value of these matters.

STUDY OF TYPICAL SOILS.

In the study of typical soils in the vegetation house it has been developed that meteoric influences other than those relating to precipitation have a great influence on crop production. The solar influences are evidently of great importance, and the distribution of solar heat is a factor not to be neglected. Excessive or deficient temperatures at critical stages of the growth of a crop are factors of prime importance in final products.

COOPERATIVE WORK.

The Division has been engaged in important cooperative work with the Treasury Department and other Departments of the Government.

The Chemist was appointed, with my approval, by the Secretary of the Treasury, chairman of a commission charged with the work of preparing the regulations for determining the amount of duty to be collected on imported sugars. The commission also instituted a series of investigations in the several ports of entry to investigate the manner in which the regulations were carried out. The Chemist, as a member of the international commission for unifying methods of sugar analysis, presented at the Vienna congress an important contribution in regard to this desirable agreement.

A further cooperation of the Division with the Treasury Department resulted in obtaining data in the examinations which were conducted of a character that served to save the Treasury a very large sum of money claimed as rebates under a provision of the law permitting the repayment of taxes collected on alcohol which was used in certain arts. Important cooperation of the Division was also secured in connection with the Post-Office, State, and War Departments. The Division of Chemistry holds itself in readiness to comply in the shortest possible time with all reasonable requests of the other Departments for chemical services.

SUGAR-BEET AND FOOD INVESTIGATIONS.

The Division continued during the year its investigations of the possibilities of producing high-grade sugar beets in various parts of the United States. As a result of the extensive chemical studies conducted, the area suitable to the production of the best beets has been more definitely delineated. A few years more of studies of this kind will mark out in a practical manner the areas where beets of the highest grade can be produced.

In the work on food adulteration interesting investigations have been instituted in the examination of food products imported from foreign countries. Critical studies of agricultural imports from the countries which exclude similar imports from our country on the ground of adulteration or unwholesomeness will be continued.

NEW LABORATORY.

The old quarters used by the Division of Chemistry having proved inadequate for the rapidly increasing work of the Division, a new laboratory has been leased, where more ample facilities will be afforded.

DIVISION OF ENTOMOLOGY.

GENERAL INVESTIGATIONS.

General investigations have been carried on in this Division through the year upon insects injurious to garden crops, to shade trees, and to citrus trees and fruits. The general experimental work, with remedies,

has comprised especially careful investigations of the availability of hydrocyanic-acid gas in the disinfection of seeds in bulk and of plants and nursery material, and further experiments with arsenicals and various oil mixtures in order to determine their effects on plants in dormant condition and in foliage. One of the expert assistants of the Division visited Europe for the purpose of studying the methods of controlling injurious insects in the Old World, with a view to determining their value and applicability to our own country, and in order to study the conditions of climate, forest growth, and method of culture in their bearing on the abundance or absence of injurious insects and the methods of prevention of insect injury.

SPECIFIC INVESTIGATIONS.

Specific investigations of importance may be mentioned under the following heads:

WORK ON INSECTS FROM ABROAD.

Careful investigation of the so-called Morelos orange fruit worm, a species which it is feared may be accidentally introduced into the orange groves of California and Florida, has been made. The distribution of this insect in Mexico was unknown even to Mexicans, and the fears of this country were considered by Mexicans to be largely imaginary. This season's investigations, however, prove that this destructive fruit worm is distributed throughout all of Mexico east of the Sierra Madre Mountains, and that it may at any time be introduced into California in early fall oranges imported from that region.

A preliminary attempt has been made to introduce from southern Europe into California an insect which is responsible for the fertilization of the Smyrna figs of commerce. The Entomologist visited California in the spring of 1898 and found that conditions were ripe for such an attempted introduction, and an agent in Europe will, during the coming year, endeavor to take the necessary steps to bring about this introduction, which, it is hoped, will result in the production by California of a fig equal to the Smyrna fig.

A successful importation has been made of an important parasite of certain large scale insects.

THE GIPSY MOTH.

By direction of Congress, the Entomologist made a careful study of the work which has been done by the State of Massachusetts against this imported insect pest, and has reported that after careful field study extending over practically the whole summer, he is convinced that Massachusetts is taking the proper course in making large appropriations to exterminate the insect, and that the work is being carried on in a manner worthy of all praise.

THE MEXICAN COTTON-BOLL WEEVIL.

The work which has been carried on during the season has developed a new and important spring remedy against this insect, and this, together with earlier results achieved by this Division, have now put Texas cotton planters into possession of a knowledge of how to economically keep their fields free from this injurious species, which was recently thought to threaten the destruction of the entire crop of the State.

CHINCH BUG AND HESSIAN FLY.

During the year investigations have been made upon these two well-known and very injurious insects, and a comprehensive bulletin upon each species has been completed and is now ready for the printer.

OTHER INVESTIGATIONS.

Other important work carried on under this Division during the year has included the sending successfully of beneficial species to foreign Governments suffering from outbreaks of the white or fluted scale, the preparation of an account of the work accomplished during the past two years against the San Jose scale, an investigation of the injurious grasshoppers of the Western States, work upon remedies to be used against the house fly, suggested by the growing belief in the importance of this insect as a carrier of disease, work upon the geographic distribution of injurious insects of the United States, and experimental work in apiculture.

BIOLOGICAL SURVEY.

LIFE ZONES AND CROP ZONES.

With a view to determining the areas best adapted for various crops, the Biological Survey has been engaged for several years in collecting data for mapping the natural life zones of the United States. A detailed study of the distribution of the native animals and plants has been made in the belief that areas inhabited by indigenous species coincide with those most suitable for certain varieties of fruit and cereals and for breeds of domesticated animals. This investigation has now progressed far enough to permit the publication during the past year of a revised map of the life zones of the United States and two reports containing the results, of more general interest to farmers and horticulturists.

One of these reports comprised a description of the life zones and crop zones of the United States, with lists of the more important varieties of fruits and grains adapted to each area; the other an investigation of the geographic distribution of some of the more important cereals. The latter bulletin, based on reports from more than a thousand grain growers, showed the areas in which about thirty of the

more important varieties of corn, wheat, and oats are now profitably cultivated, and the regions where these varieties may be expected to succeed. Field work was continued during the year in Washington, Oregon, California, Nevada, British Columbia, and northern Mexico for the purpose of obtaining data for use in outlining the life zones with greater precision than had hitherto been possible in these regions.

ECONOMIC RELATIONS OF MAMMALS AND BIRDS.

The Biological Survey is often called upon to determine the value of birds and animals to practical agriculture. It is in effect a court of appeal in which complaints are investigated concerning those species which are considered injurious to crops. A careful study is made of the food of useful and injurious birds and mammals, and thousands of stomachs of birds are examined in the laboratory. Two thousand three hundred and twenty-nine stomachs, mainly of sparrows, swallows, and woodpeckers, were examined during the year. A report has been prepared on the native cuckoos and shrikes, and reports on flycatchers and native sparrows are in preparation. Several of the latter birds feed largely on weed seed during the winter, and it is a matter of no little interest to determine how far they can aid the farmer in checking the increase of noxious weeds. The importance of this work is emphasized by the increasing demand made on the Department for information and publications on birds, in consequence of the recent widespread popular interest in ornithology.

FUTURE WORK.

As the work of the Biological Survey becomes more generally known, the demands for information, maps, and reports increase far more rapidly than the means for meeting them. Biological maps of certain States and maps showing the distribution of particular mammals or birds are sought not only for reference but for purposes of instruction. Local biological surveys have been planned or have already been inaugurated in several of the States, and the Department has been appealed to for assistance in this work, but it has thus far been unable to actively cooperate through lack of sufficient appropriations for the purpose.

The work for the immediate future comprises a combination of field work outlining the life zones of the Pacific coast, investigations on varieties of fruits, vegetables, and field crops similar to that already undertaken in the case of cereals. An investigation which is of special interest at this time is a thorough examination of the fauna and flora of the tropical region which lies along our southern border and enters the United States at several points. Our new island possessions are entirely within this region and present an inviting field for

exploration. As their resources become more generally known the question of what semitropical or tropical products can still be profitably grown in Florida and the Gulf States is likely to become a very important and practical one in several of the Southern States.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

The work of this Division is carried on with a view of obtaining additional light on the conditions governing the growth and productiveness of cultivated plants, with special reference to diseases, nutrition, and development of new and improved sorts by breeding and selection.

RESULTS OF INVESTIGATIONS.

During the year valuable knowledge was obtained relative to increasing the sugar and starch producing power of plants and the effect of soil foods on their growth and productiveness.

The study of diseases of truck and garden crops and of crops grown under glass has been continued, and methods of preventing several of the most destructive, such as black rot of the cabbage and the leaf-spot disease of melons, celery, and violets, given to growers of such crops through bulletins or by correspondence.

Smuts and rusts of cereals have received much attention. The latest and best methods of preventing smut were given to the public through a Farmers' Bulletin, and much valuable knowledge relative to rust was gained.

In the study of diseases of citrus fruits and other subtropical plants special attention was given to sooty mold and blight of the orange and blight of the pineapple.

On the Pacific coast peach-leaf curl, apple canker, a bacterial disease of English walnuts, and a new bacterial bulb disease have received especial attention. Important results have also been obtained from a study of other diseases prevalent in different parts of the country on the apple, pear, peach, plum, and other fruits, on crops of various kinds, and on forest and shade trees.

HYBRIDIZING.

The work of hybridizing the sweet orange with the hardy trifoliate, with a view of obtaining a variety resistant to cold, was pushed, and about one hundred and fifty hybrids obtained. In addition to this about one thousand hybrids of other citrus plants were obtained. Considerable work was done in crossing pineapples, and as a result two hundred and fifty-nine hybrid seedlings were secured. These produced plants of great vigor and confirmed the belief that by this means there may be produced fruits which will be larger, of better quality, better shippers, and more resistant to blight. Similar work was carried on with pears and with wheat and other crops.

ROUTINE WORK.

About six thousand letters relating to diseased plants and other lines of work were answered during the year, and about twelve thousand specimens of disease-producing fungi, representing six hundred different species, were prepared for distribution to the experiment stations. Much time was also devoted to the preparation of bulletins and papers on results of investigations.

SEED DISTRIBUTION.

Finding it desirable to separate the seeds to be distributed by the Department into three classes and to place the distribution of each class of seeds under the control of a Division or Section, which in a greater or less degree is interested in the character of the seeds distributed, I assigned to the Seed Division the distribution of vegetable, flower, and field seeds; to the Section of Seed and Plant Introduction the collection and distribution of foreign seeds, and to the Division of Chemistry the distribution of sugar-beet seed, the entire work of seed distribution being placed in charge of the Assistant Secretary of Agriculture.

Every effort is made to so place the seed that the best results may be obtained. Nearly all requests were complied with, none being refused when it was possible to send seed. In a number of cases special purchases of seeds not included in our contract were made for that purpose.

With few exceptions the reports from persons who have received and planted the seed have been favorable.

While it is too early to determine the value of the seeds introduced from foreign countries, I am satisfied that some varieties will prove very desirable.

The vegetable, flower, and field seeds were distributed by our contractor at Toledo, Ohio, under the supervision of the special agent and with the aid of clerical help sent from this Department.

CONGRESSIONAL AND MISCELLANEOUS SEED DISTRIBUTION.

The seeds distributed under direction of the Seed Division during the fiscal year ending June 30, 1898, aggregated 15,702,914 papers and cloth bags, as follows: Vegetable, papers, 14,243,527; flower, papers, 1,254,037; field, papers and bags, 205,350.

Of the 15,702,914 papers and bags of seeds distributed, 13,599,586 papers and cloth sacks of vegetable and field seed were distributed to Senators, Representatives, and Delegates in Congress (by their allotments); 751,170 papers of flower and vegetable seeds to correspondents of the Division of Statistics; and 889,460 papers and bags of vegetable, flower, and field seeds to the State granges. The remainder were distributed to Weather Bureau observers, experiment stations, etc.

DISTRIBUTION OF FOREIGN SEEDS AND PLANTS.

Prof. N. E. Hansen was appointed a special agent of the Department for the purpose of securing foreign seeds and plants valuable for introduction into this country. Under the direction of the Section of Seed and Plant Introduction, Professor Hansen during the past year visited portions of Russia and Siberia and succeeded in collecting 57 varieties of vegetable seed, 289 of melon, 75 of fruit and berry plants, 150 ornamental plants, 70 wheat, 14 barley, 20 oats, 6 rye, 70 forage plants, 5 oil-producing plants, and a large number of miscellaneous seeds of desert plants, etc.

Upon arrival, these seeds and plants were put up into about 5,000 packages by the Section of Seed and Plant Introduction and sent out largely to State agricultural experiment stations, and to such reliable cultivators as had shown a willingness to cooperate with the Department by making reports as to the success of these imported plants.

While it is too early to predict the value of most of the introductions, the most promising are a variety of alfalfa, seedlings of the Siberian apple (imported for experimenting in the Dakotas), a new orange-fruited raspberry, and a Russian sand vetch.

DISTRIBUTION OF SUGAR-BEET SEED.

In the distribution of sugar-beet seed, they were sent to the sections that were thought best adapted to their use. The agricultural experiment stations were included in the distribution, and persons to whom sugar-beet seed were sent were advised that the State experiment stations would make analyses of the sugar beets grown in each State. Very cordial cooperation has been brought about between the Department and the State experiment stations.

The sugar-beet seed were purchased from Vilmorin, Andrieux & Co., in Paris, and from Dippe Brothers, in Quedlinburg, Germany, and distributed by the Division of Chemistry. In all, 34,436 pounds of seed were purchased, and partly distributed in bulk and partly in packages containing about 18 ounces each. Large quantities were distributed by Members of Congress, and 40 pounds of extra high-grade seed were distributed among experiment stations for use in the production of seed.

SECTION OF FOREIGN MARKETS.

In the Section of Foreign Markets a radical departure was made in the study of our relations with foreign markets by promptly diverting it to the field opened by the prospect of changes in Hawaii and the West Indies. The advantage of this was demonstrated by the demand for publications in that connection.

REPORTS ON COMMERCE OF HAWAII, SPAIN, AND PUERTO RICO.

A report on the commerce of the Hawaiian Islands was issued during the discussion of annexation. It covered the past ten years and gave special attention to trade with the United States.

When war with Spain was imminent, a rapid investigation of the extent and nature of the commerce of the people of that country was made. By quick and intelligent action information was obtained from Spanish official reports showing the foreign trade of Spain in detail, and the amount and direction of shipping under the Spanish flag. This information was made public at the critical moment, just preceding the declaration of war. It was followed a few days later by a more detailed statement of the trade between Spain and the United States.

The likelihood that Puerto Rico would become a possession of this Government called for a statement of the trade relations of that island, and it was made. Full details were presented of the exports and imports of the island. These furnished a basis for estimating its productive capacity and its requirements from other places. The statistics were from Puerto Rican official sources, and as they were made public for the first time were particularly valuable as well as timely.

REPORTS ON TRADE WITH AUSTRIA-HUNGARY.

Reports were issued during the year on the foreign trade of the United States in agricultural products and on the wheat production of Austria-Hungary. In the first of these the classification of agricultural imports and exports was carefully revised and a comprehensive and instructive presentation of the important facts was made. The demand for the report on foreign trade in agricultural products was so strong that the essential information was embodied in a circular, of which 85,000 copies were distributed.

In compliance with a request from the Secretary of State, much time was devoted to the compilation of information for the use of the special commissioner appointed to negotiate reciprocity treaties.

OFFICE OF ROAD INQUIRY.

EFFORTS FOR GOOD ROADS.

The problem of securing good roads continues to be a very important branch of work. Publications upon the subject of the best methods for road improvement have been distributed freely. Care has been taken to send them where they would be most effective in stimulating activity in the movement. Representatives of the Office have attended many important meetings for the discussion of roads, and in this way valuable information has been both gathered and disseminated.

In localities where construction of roads according to the most approved methods has been in progress a representative of the Department has made a study of the operations and extended such assistance as was possible. The Office of Road Inquiry has also actively cooperated with two of the State agricultural experiment stations in spreading the work of good roads. The road laws of several of the most progressive States have been collected and studied.

These efforts have met with hearty appreciation in every direction, and there has been a steady increase in the demand for assistance. Both country papers and the metropolitan dailies have become interested in the movement and have printed very much upon the subject, in many instances reproducing Department circulars and bulletins in full.

OBJECT-LESSON ROADS.

The object-lesson road at the Rhode Island Agricultural College has been completed, and a report of the details of the work, along with the results of other inquiries, will be presented in the Yearbook for 1898. Owing to lack of funds it has been impossible to comply with calls for similar aid elsewhere, and it has been necessary to discontinue these object lessons in connection with agricultural colleges and experiment stations, although many of these institutions are still calling for aid. They are ready to bear most of the expense, asking of the Department only the payment of freight on machinery and of part of the salaries of experts. The help given from this Department usually proves sufficient to secure the financial support of the towns and farming communities in the vicinity of the experiment. Numerous letters received by the Office of Road Inquiry testify to the great value of these cooperative experiments. Everywhere the plan meets with the highest commendation, but it can not be extended without an additional appropriation.

STEEL ROADS.

The aim of the Office of Road Inquiry is to cooperate with people of the several States in making the best possible use of material within their reach in road making. Large areas in many of the States have no gravel, rock, or other hard material with which to make roads. I have had experiments made during the present year with steel as extensively as our means would permit.

An experiment of this kind is being conducted at Cleveland, Ohio. A section of 500 feet of steel track has been laid on a street in the suburbs where the traffic is heavy, and its value is already generally acknowledged. A sample steel road 510 feet long has been laid upon the grounds of the exposition at Omaha. It is proposed to make traction tests upon this track to show how much less power is required to move a load over such a road.

The steel road is not excessively costly by comparison with other roads and will last much longer with less repair, and is probably the most economic road for localities where material is not obtainable for macadamizing.

SENTIMENT IN FAVOR OF GOOD ROADS.

The growth of sentiment in favor of good roads is shown by the passage of progressive laws in New York, Pennsylvania, and other States, and by the appointment of a highway commission in Maryland, and also by the reports of increased sales of road-making machinery.

DIVISION OF AGROSTOLOGY.

EXPERIMENTS IN THE GRASS GARDENS.

Through the efforts of this Division we are learning the needs of the several sections of the country and the forage problems which they have to meet. We are acquiring a better knowledge of the distribution and value of our native grasses and forage plants, as well as the peculiar conditions of soil and climate best suited to their growth. More than 500 varieties of grasses and forage plants valued for forage have been grown in the grass garden on the grounds of the Department during the past season. Visitors from all parts of the country have been much interested in this exhibition, which has afforded many lessons, not only of interest but of real practical value.

The garden contains plats of grasses suitable for lawns, besides many species from the East and from the South, and especially from the West, all growing together with apparent success, and it is interesting to note the peculiar habits of the grasses of the moist and wooded regions of the East and those of the arid, treeless regions of the West as here displayed. A large number of leguminous plants have been given a place in the garden, and one of the most interesting experiments has been a trial of alfalfa grown from seed obtained from more than twenty different sources. Trial samples of these seeds were sent to a large number of experiment stations who volunteered to undertake comparative experiments in their cultivation. Up to the present time it has not been possible to detect any marked variation in the plants grown. Turkestan alfalfa, the seed of which was introduced last year in large quantities from Russia, has made a remarkable growth in some of the experiments conducted in the West. At North Yakima, Wash., it made a growth of over 3 feet in seventy-nine days, sending up many stems from each root. It is believed that this alfalfa will prove to be more hardy than the ordinary sort, and it may be distinguished by minute hairiness on the under surface of the leaves.

Many varieties of grasses and forage plants have been tested at the grass garden at Knoxville, Tenn., during the year. It has, however,

been thought best to discontinue official connection with this garden and select a station farther south, which shall be more typically Southern in its character, both in soil and climate. The problem in Tennessee is not so much what can be grown as how to grow the largest amount of the best quality with the least expense, problems which the agricultural experiment station at Knoxville is now well prepared to solve.

INVESTIGATIONS FOR THE IMPROVEMENT OF FORAGE RESOURCES.

In connection with the investigations in the Southwest two stations have been established, one at Abilene and one at Channing, the former presenting conditions characteristic of the center of Texas and the latter of the great region of northwest Texas, known as the Panhandle. The experiments carried on at these stations were made with a view of determining how the cattle ranges may be improved by practical methods. At the station at Abilene more special lines of investigations and experiments are being carried on, especially in the way of testing varieties which may be suited to that region.

Comparative work of the Division is being performed by many volunteer experimenters, especially among the more intelligent farmers in Colorado, Texas, Wyoming, Montana, and Idaho. The object of these experiments is the introduction of new or little-known and desirable hay and pasture grasses, as well as soiling crops. A number of the more progressive ranchmen and stockmen of the Northwest have agreed to devote from 1 to 5 acres of cultivated land to the more promising native grasses or those introduced from foreign countries, seed of which we may be able to furnish them.

Seeds of grasses and alfalfa imported from Russian and eastern Asia were sent in amounts sufficient to sow from one-twentieth of an acre to an acre of each variety to 479 parties who had previously agreed to give them careful cultivation and report fully at the close of the season the results obtained. The data thus secured can not fail to be of great interest and value to all interested in the improvement of the forage resources of our country. Eleven hundred packages of seeds of native grasses, salt bushes, wild clovers, wild beans, and lawn grasses, mostly collected by the employees of the Division while in the field, were distributed to our correspondents, who expressed a desire to aid the Division in its investigations.

Field investigations in the States along the Gulf coast have been carried on during the past two seasons and one report upon the work done in this section is now in the hands of the printer. Work, as already indicated, has been carried on in the Southwest, and in the Northwest investigations have been made by special agents, whose reports have already been published.

The field work so far has been confined to the Atlantic slope, but there is being manifested among the farmers and ranchmen of the

Pacific coast a marked interest in grass and forage-plant questions, and a demand for an extension of our work along these lines in the States west of the Divide is now being made.

THE GRASS COLLECTION.

Over 5,000 specimens of American grasses have been identified during the year and nearly 3,000 sheets of herbarium specimens mounted and added to the National Herbarium. The grass collection now in the Department numbers over 30,000 sheets.

DIVISION OF SOILS.

The Division of Soils has continued the investigation of the physical properties of soils and their relation to crop production, and work has now been started upon the mapping of soils on a scale of 4 inches to the mile, to be published probably on a scale of 2 inches to the mile. These maps will show in great detail the soil areas adapted to the different agricultural crops. Considerable advance has also been made in devising methods of investigating soil conditions where crops suffer, or where the soil conditions are not well adapted to crops which the location and markets demand.

RECORDS OF MOISTURE CONTENT OF SOILS.

Records have been continued of the moisture content of some of the principal soil areas in the country with the electrical method of moisture determination. As the soil is the immediate source of the water supply of plants, this record becomes an essential part of climatology, and it seems probable that this work of the Division of Soils, in connection with the present work of the Weather Bureau and of the Division of Statistics, will develop a distinctively new line of agricultural climatology. This work is closely related to the work of the Weather Bureau, but is supplementary to it. It includes the record of evaporation to which the plant is subjected, the water supply maintained by the soil for supplying the loss due to this evaporation, and the intensity of the actinic and heat radiations which influence the physiological activities of the plant. Numerical values can be given to the evaporation and to the soil-moisture conditions, so that it is possible to express numerically the relative conditions of plant growth from day to day so far as these two important factors of evaporation and water supply are concerned. This will add greatly to the practical value of our knowledge of climatology.

INVESTIGATION OF ALKALI SOILS OF YELLOWSTONE VALLEY.

The electrical method of salt determination in soils has been used in the exploration and investigation of the alkali soils of the Yellowstone Valley. An examination was first made of the general conditions

in the valley, and then a very minute study of a section of land which was just being ruined by the rise of alkali. This examination amounted to an underground survey of the field, and maps have been made showing the distribution of alkali at different depths. A great number of borings were made to a depth of 10 or 15 feet, and salt determinations were made in every 6 inches or each foot in depth. Accurate maps have been made showing the amount and distribution of the alkali at several of these depths.

The result of this investigation will be issued in the form of a bulletin. Briefly, it was found that in the original prairie soil above the ditch there is not sufficient alkali to be injurious to vegetation. The amount of alkali was greater in the lower depths of the subsoil. As a rule, water is used in excess on all of these lands under irrigation, and to such an extent that it accumulates in the subsoil. When the depth to standing water is not more than 2 feet from the surface, alfalfa turns yellow and dies out. In all cases the first injury was from the accumulation of water from excessive applications through irrigation. Where this water remains for some time in the subsoil the alkali leaches down through seepage from higher lands, and is brought up from the subsoil and accumulates at the surface in quantities sufficient to prevent the growth of cultivated plants. Other problems of great value to the agriculturist were worked out in the course of this investigation. Such work will be invaluable in the treatment of alkali soils.

This underground survey of the alkali lands has given the most important information in regard to the amount and distribution of the soluble salts and the way in which they accumulate in certain localities through overirrigation.

TOBACCO INVESTIGATIONS.

The tobacco business has become very highly specialized. Each market has its own requirements, each class of users has its own particular style, and each season brings some change of style which must be met by the tobacco grower. There is a great deal of competition in our own country and very serious competition from abroad, especially from Cuba and Sumatra. In several of our tobacco districts the acreage has been reduced one-half in the past ten or fifteen years. Some of the districts have almost completely abandoned the culture of tobacco. On the other hand, several new localities are being opened, with prospects of good prices for the better grades of wrapper leaf both for cigar and manufacturing purposes. The best we can do, however, in the cigar leaf is far below the product of foreign countries. The Cuban filler sells for ten times as much as the Pennsylvania and Ohio filler; the Sumatra wrapper is worth ten or fifteen times as much in the markets as the Connecticut wrapper. To meet this competition it is absolutely necessary that our farmers should

have at their disposal a thorough knowledge of their own conditions and of the conditions of the soil, climate, methods, and labor conditions of competing districts.

SOIL MAPS OF THE TOBACCO DISTRICTS.

One of the first necessities in the development of a new district or in the improvement of an established district is an accurate soil map of the locality, on which the soils adapted to the different types and grades of tobacco are plainly shown. In all of our tobacco districts there are large areas of land sown to this crop which are not adapted to a good grade of tobacco. There are also large areas well adapted to a fine grade of leaf which have never been used for this purpose. Enough is known of the relation of soils to tobacco to warrant the preparation of very accurate maps, indicating the character of the tobacco from each of the soil areas in the district. After these types have been established and the soil areas have been mapped, the experiment stations can take up a study of the cultural methods adapted to each of the types of soil. In this study of the influence of the soil upon the quality of the leaf it is important to extend the study to all localities, and to gather information from Cuba and Sumatra as well as from Kentucky, Virginia, Pennsylvania, and Connecticut. This is work that the experiment stations can not do for themselves.

CURING AND FERMENTATION.

Among the most important lines of work which the Department can take up for the tobacco grower is the study of the diseases in the tobacco bed and the comparatively few diseases in the field, and particularly the study of curing and fermentation. A large amount of research work has been done, particularly in Germany, in the fermentation of tobacco, but very little is yet known of the changes which go on in the process or regarding the specific agents which bring about these changes. So much information and practical benefit have been derived from a study of butter and cheese, in the control of the ferments and bacteria which produce the texture and flavor of the product, that it is very desirable that similar knowledge in the curing and fermentation of tobacco and similar control of the finished product should be secured. This work will require very careful study of the changes in the fermentation pile in the different tobacco districts.

It is important to know exactly to what organisms the peculiar flavor and aroma of the tobacco is due; what influence is exerted by the character of the leaf, by climatic conditions, and by methods of manipulation. This work can only be thoroughly done by systematic working in different tobacco districts in our country with different varieties of tobacco and different climatic conditions. It should certainly

embrace a study of fermentation in the tobacco of Cuba and of Sumatra. If our tobacco growers are to attempt to raise a product equal to that of Cuba and Sumatra, and if this is to be done not by chance, but through systematic, scientific investigations, then the soils and other conditions of growth must be thoroughly understood and the fermentation changes carefully worked out in Cuba and Sumatra. It is necessary, therefore, that a soil expert and a bacteriologist extend their work to these foreign countries.

In view of the great importance of the tobacco industry in this country and of the very important practical results which are likely to accrue from the investigation of the subjects herewith presented, I have submitted in my estimates to Congress a special appropriation for tobacco investigations.

DIVISION OF FORESTRY.

CHANGE IN CHIEF OF DIVISION.

At the end of the fiscal year the creation of the New York State College of Forestry and the election of Mr. B. E. Fernow to the directorship created a vacancy in the position of Chief of the Division, which Mr. Fernow held for twelve years, and Mr. Gifford Pinchot, of New York, was appointed his successor.

TREE PLANTING IN THE TREELESS REGIONS.

Believing that the attention of this Division should be directed rather more to the tree-planting interests of the treeless regions, I directed the discontinuance of the series of investigations which had in view a better knowledge and use of our economic timbers, in order that the funds might become available in the aforesaid direction. The forest-planting experiments in cooperation with the State agricultural experiment stations were, therefore, prosecuted more vigorously and extended to Texas, Oklahoma, and Montana, besides adding another station in Pennsylvania, where the methods of reclothing cut-over lands were to be demonstrated.

By my direction a plan was elaborated for the introduction of species adapted to dry climates, and a competent agent appointed to carry out the plan, which contemplates the establishment of a number of arboreta in our dry regions, in which are to be assembled such trees and shrubs from all parts of the world as might eventually prove adapted to these regions. One of the most useful lines of work has been a canvass of the forest conditions of the State of Wisconsin, in cooperation with the State geological survey, which has brought out the significant fact that, through careless lumbering, followed by destructive fires, over 8,000,000 acres of that State have been rendered practically useless and one-half that area a veritable desert as far as present economic conditions are considered.

TIMBER PHYSICS INVESTIGATIONS.

The accumulated data of the investigations in timber physics have been worked over in part and yielded some most important results, among which the law that the strength of a beam at the elastic limit is equal to the compression strength of the material, which was established by the tests of the Division, will influence the practice in the use of wood for construction most advantageously.

PLANS FOR THE COMING YEAR.

The plans for the Division of Forestry, approved by me, for the coming year cover the following lines of work, all of which are directly related to the welfare of our people:

Practical assistance to farmers, lumbermen, and others in handling private forest lands. Since these lands exceed by far in area those of the Government and the States combined, woodland in farms alone covering more than 200,000,000 acres, this attempt to increase their present as well as their future value, and thus secure their preservation, has before it a field of wide usefulness.

An attempt to find the best trees for planting in the so-called treeless regions of the West, a matter of far-reaching importance to a very large percentage of the farming population of this country.

A study of the history, nature, and ways of action of forest fires in the United States and their effect on the composition and reproduction of forests. The prime object of this work, which covers a field practically untouched until now, is to develop better methods of preventing and extinguishing these fires than have yet been employed.

A study of the effect of lumbering on the forests, in order to devise improved methods advantageous both to the lumberman and to the forest. Combined with this work, detailed investigations of the growth of trees of special commercial importance will be made, with the object of ascertaining whether and how much it will pay to hold timber land for future crops.

Investigation of the timber resources and requirements of Alaska, Cuba, and Puerto Rico, which is needed to meet the numerous requests for information made to this Department.

In addition, a classified series of forest photographs, intended to furnish illustrations of the results of the various lines of work, will be begun during the year.

The extremely practical character of these lines of work is evident. Their popular standing is indicated by the fact that the assistance of the Division has been asked in the handling of nearly a million acres of forest land, under an arrangement by which, in the case of all but farmers' wood lots, the Department is relieved of all expenses except salaries for its agents in the field.

In view of these facts, I have been impelled to lay before Congress the urgent need of a considerable addition to the appropriations at my disposal for the use of the Division of Forestry.

OFFICE OF EXPERIMENT STATIONS.

THE STATE EXPERIMENT STATIONS.

The examination of the work and expenditures of the agricultural experiment stations by the Office of Experiment Stations during the past year has shown that these institutions are, as a rule, working more thoroughly and efficiently than ever before for the benefit of American agriculture. More than six hundred persons are employed in the work of administration and inquiry. About four hundred reports and bulletins were issued by the stations in 1897, which were directly distributed to over half a million addresses, besides being widely reproduced in the agricultural and county papers. The appropriation of $720,000 from the National Treasury for the support of the stations was supplemented by State funds aggregating over $400,000.

The need and value of scientific researches on behalf of agriculture are now very clearly understood, and the number and importance of institutions organized for this work are constantly increasing in all parts of the world. Nowhere has so comprehensive and efficient a system of experiment stations been established as in the United States. In the scope and amount of their operations, and in the thoroughness with which the useful information they obtain is disseminated among the farmers, our stations are unsurpassed. During the ten years which have elapsed since the Hatch Act went into effect a very large amount of accurate information of direct practical benefit to our farmers has been published by the stations. Not only have the numerous bulletins and reports of the stations been freely distributed in all parts of the country, but many valuable books largely based on the work of the stations have been written for the farmers' use, while the agricultural press has busily collated and disseminated a vast mass of information directly relating to the work of the stations or supplementary to it. The contrast between the correct information regarding the principles and practices of his art easily obtainable by the farmer of to-day and that available for his predecessor of a generation ago is very wide and striking.

NEED OF MAKING OUR STATIONS STILL MORE EFFECTIVE.

The general success of our agricultural experiment stations makes it all the more important that they should everywhere be organized and conducted with a view to securing the most economical and efficient service for the benefit of agriculture. It were well if the farmers in every State and Territory were alive to the importance of making each and every experiment station a thoroughly effective institution for agricultural research. There are certain principles which experience

has shown must be followed in the management of stations if they are to be most highly useful. Attention has been called to these from time to time in the reports of the Department, but there is still need to urge upon appointing officers, governing boards, and all the friends of agricultural progress that, in order to make the experiment stations what they ought to be, they must be organized on a permanent basis, and their plans of work must be carefully made and carried out by thoroughly trained experts, who are so circumstanced that they can give time and energy in full measure to the research work.

Political considerations should have no place in the choice and retention of station officers, college duties should not be allowed to encroach on the time set apart for original investigation, and the compilation of old information should always be made secondary to the acquirement of new knowledge. Our farmers are worthy of the best that science and expert skill can win for them out of the realm of the facts and principles which nature will reveal to the diligent student of her mysteries. To divert from their highest and best uses any of the funds which the people have freely given to bring the aid of science to agriculture is most reprehensible. The stations which are held in the highest honor alike by scientists and farmers are those in which there has been most original and thorough work.

The stations are not the only means for the education of the farmer. Agricultural colleges, farmers' institutes, boards of agriculture, and various other agencies have been established to instruct the farmer regarding the present status of agricultural science as applied to his art. It is the business of the experiment stations, on the other hand, to advance knowledge of the facts and principles underlying successful agriculture and to teach the farmer new truths made known by their investigations. The act of Congress creating the stations clearly defines their functions to be the making and publishing of original investigations. Wherever a station has neglected this and merely endeavored to educate the farmer, we find a weak station, and wherever a station has earnestly devoted itself to original investigations, we find a strong station. The station may very properly lend its assistance in strengthening the influence and work of the educational agencies established for the farmers' benefit, but it fails to fulfill its real mission when it resolves itself into a bureau of information or devotes a large share of its energies to the compilation of popular treatises on agriculture. It is gratifying to observe that the original investigations at our stations are increasing in number and improving in quality. In some places, however, there is still need of decided changes in policy and work.

WORK OF THE OFFICE.

In connection with its supervision of the expenditures of the experiment stations, representatives of this Office have visited the stations

in all the States and Territories. During the year the Office issued 43 documents, among which were included the ninth volume of the Experiment Station Record, 12 bulletins, and 7 Farmers' Bulletins. The review of the literature of agricultural science in the Experiment Station Record has been made more complete than heretofore, and embraces all the countries in which agricultural investigations are conducted. No such comprehensive survey of this field of scientific research is made elsewhere. With the aid of the Record our investigators are kept well informed regarding the progress of agricultural science throughout the world.

In accordance with my instructions, the Office has systematically engaged in the preparation of popular résumés of the work of the experiment stations for publication as Farmers' Bulletins. Several of the bulletins have been issued and are grouped together in a subseries denominated Experiment Station Work. Each of these bulletins contains a number of short articles, summarizing the results of recent investigations in different lines, and explanations of the technical terms necessarily employed in describing the results of investigations. As stated in a prefatory note in each number, "the chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side." One of the chief reasons for establishing an Office of Experiment Stations in the Department was that it would be able to collate and disseminate the information obtained by the individual stations for the benefit of farmers throughout the country. It is believed that this new series of popular bulletins makes the work of the Office much more effective in this direction. Now that the purpose of these bulletins is being understood there is a large demand for them.

The Office has somewhat extended its work in collating and publishing information regarding the agricultural colleges, and in promoting the general interests of their work. It has also continued in charge of special agricultural investigations in Alaska and of the researches on the food and nutrition of man which the Department is conducting in cooperation with colleges and experimental stations. Investigations on irrigation, to be carried on in a similar way, have recently been intrusted to this Office.

AGRICULTURAL EDUCATION.

The past year has been marked by considerable progress in the more complete organization of courses of instruction in agriculture in our colleges and universities. The general subject of agriculture is being divided in these courses with a view to securing more efficient teaching in the several branches. Instead of having one professor of agriculture as in the past, a number of our colleges have separate

chairs of plant production, animal husbandry, and dairying. Departments of soil physics with separate laboratories are being established. The buildings, apparatus, and other facilities for agricultural education have been materially improved during the year. The improvement in the equipment and methods of instruction has resulted in bringing more and better students into the agricultural colleges.

The movement for the extension and popularization of agricultural instruction is growing in importance. The short and special courses in the colleges, the farmers' institutes, and the home-reading circles are attracting larger numbers of farmer students. The effort to introduce nature teaching, largely on subjects relating to agriculture, is being actively prosecuted in several States. The time seems ripe for the introduction of outline courses in the theory and practice of agriculture into the secondary schools in or near our rural communities in much the same way that business courses are employed in the city high schools.

There is a growing demand that this Department shall furnish our people with information regarding the progress of agricultural education at home and abroad. The necessity for the more careful study of the problems of education as related to the progress of our country in agriculture, as in the other arts and industries, is being forced home upon us by the closer relations of the United States with the rest of the world which recent events have done so much to promote. The Department of Agriculture, sustaining close relations with the workers on the farms and the educational institutions already established for their benefit, might accomplish much more toward the improvement and wide extension of agricultural education. I have therefore recommended a small increase in the appropriation for the Office of Experiment Stations to enable it to extend its work in this direction.

AGRICULTURAL INVESTIGATIONS IN ALASKA.

The first appropriation "to enable the Secretary of Agriculture to investigate and report to Congress upon the agricultural resources of Alaska, with special reference to the desirability and feasibility of the establishment of agricultural experiment stations in said Territory," became available July 1, 1897. The general supervision of the work under this appropriation was assigned to the Director of the Office of Experiment Stations. Special commissioners were appointed to visit the coast and island region of Alaska, and by the courtesy of the honorable Secretary of the Interior the superintendent of Government schools in Alaska collected information regarding the agricultural capabilities of the Yukon Valley. Collections were made of soils and of native plants, especially those used for food and forage. Data were obtained regarding the general topography, climate, and soils; natural and cultivated products and methods of cultivation; stock

raising; area of arable lands; agricultural difficulties and possibilities; desirability of experiment stations, and the locations suitable for them.

Specimens of vegetables and small fruits, in no way inferior to those grown elsewhere in the United States, were collected in different parts of Alaska, and analyses of the grasses which grew very luxuriantly in many localities in that region showed them to be fully as nutritious as those produced in the most favored agricultural regions of this country. The reports of our agents, prepared under the direction of the Director of the Office of Experiment Stations, were transmitted to Congress last December and were published as Document No. 160 of the House of Representatives, Fifty-fifth Congress, second session, and afterwards as Bulletin No. 48 of the Office of Experiment Stations.

In accordance with my recommendation, Congress continued the appropriation for work in Alaska during the current fiscal year, increasing the amount to $10,000. Prof. C. C. Georgeson, a native of Denmark, and thoroughly familiar with the conditions of agriculture in northern Europe, who had had a long experience as professor of agriculture and an experiment-station officer in Japan and Kansas, was transferred from the Division of Agrostology to the Office of Experiment Stations and made special agent in charge of the Alaska investigations. He has made his headquarters at Sitka, in the vicinity of which place experimental plantings of seed of over 100 varieties of vegetables, grasses, and forage plants have been made.

Seeds have also been distributed to a number of different localities in Alaska, and agreements for cooperative experiments in a number of places have also been made. The building of a silo for the preservation of native grasses and the feeding of the silage to horses and cattle have been arranged for on a farm in the vicinity of Juneau. After careful examination Castle Hill, a lot in Sitka, which a number of years ago was set aside as a site for Government buildings, which were afterwards located elsewhere, has been reserved by an order of the President as a proper place on which to erect a building to serve as headquarters for the experiment station and weather service in Alaska. About 110 acres of partly cleared land have also been reserved in the immediate vicinity of Sitka for experimental purposes. A similar reservation has been made on Kadiak Island, and it is proposed to make a third reservation on the Kenai peninsula.

The botanist of the Office of Experiment Stations has continued the botanical survey of the region in the vicinity of Sitka and Cook Inlet begun last year.

The reports of the officers engaged in the Alaskan investigations during the present season have not yet been prepared, but it is expected that they will be ready for transmission to Congress early in its coming session. Enough has, however, been done to show that it is both desirable and feasible to carry on agricultural investigations

in Alaska. To accomplish results of any value it will, of course, be necessary to plan these investigations to cover a series of years, and comparatively little of practical importance can be expected from them until they have been in progress for some time. The experiments and observations made in the field should be supplemented by work in the laboratory. No provision has thus far been made for the erection of such buildings as will be needed in connection with these experimental investigations. It is also very desirable that experiments with live stock should be undertaken in the near future. The appropriation for these investigations should also be made with reference to the difficult conditions under which the work must be prosecuted. I therefore urge that the recommendation of the Director of the Office of Experiment Stations, that the appropriations for Alaska investigations for the ensuing year be the same in amount as that for experiment stations in other parts of the United States, be adopted in the appropriation bill for the next fiscal year. As it will be very desirable to enlarge our experimental operations in Alaska at the outset of the season of plant growth, commencing with the spring of 1899, I hope that the next appropriation for this work will be made immediately available.

NUTRITION INVESTIGATIONS.

The investigations upon the "nutritive value of various articles and commodities used for human food" have been pursued as hitherto, in cooperation with agricultural colleges and experiment stations and other educational institutions. In this way the Department has secured the services of experts and facilities for its work on very advantageous terms. There have been many indications that public interest in these inquiries is widespread. Special investigations with the respiration calorimeter have been made, in which not only the nutritive value of the food consumed but also its relation to the heat and energy evolved by the human body during periods of rest and work have been measured with a completeness and accuracy hitherto unknown. These investigations are not only of very high scientific importance, but have also already given promise of useful practical application. The results of the careful studies of the dietaries of people of different occupations, made in connection with the nutrition investigations, have been widely republished in this country and abroad.

It is believed that the nutrition investigations of the Department have already done much to establish a scientific basis for the courses of instruction on the food and nutrition of man, which are rapidly increasing in number and importance throughout the country. The amount of information which the Department has published in connection with these investigations has already been relatively large,

and the accumulation of unpublished data will make it possible to publish a number of bulletins on this subject during the present fiscal year.

IRRIGATION INVESTIGATIONS.

The friends of the development of irrigation as applied in agriculture in the vast region west of the Missouri River secured from Congress at its last session an appropriation of $10,000 for the current fiscal year, to be expended under the direction of the Secretary of Agriculture "for the purpose of collecting from agricultural colleges, agricultural experiment stations, and other sources, including the employment of practical agents, valuable information and data on the subject of irrigation, and publishing the same in bulletin form."

With a view to securing economy in the general administration of this fund it was decided not to create a separate division for this work. As by the terms of the act the work was largely to be done in cooperation with the agricultural colleges and experiment stations, its general supervision was intrusted to the Director of the Office of Experiment Stations. Special effort has been made to secure the services of experts who have had not only scientific training but also practical experience in irrigation as conducted in the great West. With a view to formulating plans of work along the most useful lines, a conference of experiment station officers and irrigation engineers was held at Denver last summer under the direction of the Director of the Office of Experiment Stations. The problems of irrigation were earnestly and freely discussed at this conference and the needs of the farmer for information on irrigation subjects were carefully considered. As a result of the expert advice which the Department thus received, it has been determined to confine the work on irrigation at present to two general lines: (1) The collation and publication of information regarding the laws and institutions of the irrigated region in their relation to agriculture, and (2) the publication of available information regarding the use of irrigation waters in agriculture, as determined by actual experience of farmers and experimental investigations, and the encouragement of further investigations in this line by the experiment stations.

Arrangements have already been made for the preparation of several bulletins by competent experts, and it is hoped that during the present fiscal year considerable useful information will be published and distributed by the Department. It is obvious that the present appropriation will enable the Department to go only a little way in the accomplishment of the work which is urgently demanded by the growing agricultural interests of the irrigated region. I heartily concur with the opinion set forth in the report of the Director of the Office of Experiment Stations, that Congress should establish a settled policy regarding the work of this Department on irrigation, and that

if it is deemed wise to continue such work under my direction appropriations should be made which will enable the Department to plan irrigation investigations on a comparatively large scale and continue them through a series of years. Some of the reasons which seem to make it very desirable that investigations on irrigation should be systematically pursued by this Department are set forth in the report above referred to, and I ask that careful consideration be given to the arguments there made in support of this proposition.

It is clear that a crisis has been reached in the life of the communities in which agriculture is dependent upon irrigation for its success. The laws and institutions relating to irrigation, which have grown up in these communities, have in many ways proved so inadequate and unsatisfactory that there is a widespread feeling that radical and immediate action is demanded for their reformation. Unfortunately, the accurate information on which alone intelligent reforms can be based is almost wholly lacking. As the problems which confront these communities are, in a general way, the same, and in many particulars affect the national as well as local interests, it is highly appropriate that the National Government should undertake investigations to aid in the solution of the problems of irrigation. As many of these problems are directly connected with those in other agricultural lines in which this Department and the experiment stations are working, it is my judgment that this Department should be put in a position to efficiently organize and conduct important investigations in this line.

As already stated, the investigations of the Department may properly follow two general lines: First, a careful study should be made of the laws and institutions of the irrigated region with special reference to their improvement. The objects of this work will be (1) to aid courts and administrative officers in the adjudication of claims respecting water rights; (2) to bring out the defects in existing laws and methods of administration, and to furnish impartial and adequate information on which wiser and more equitable legislation and court decisions may be based; and, (3) to assist farmers in the acquirement of water rights and to protect their interests in the appropriation and use of water for irrigation. The other branch of work which the Department should take up is the carrying on of thorough original investigations along a number of different lines. The agricultural experiment stations in the irrigated regions have already shown the way in which such investigations should be conducted. Their means have, however, been too limited to enable them to make more than a beginning of the work in this direction.

One fundamental investigation which should be immediately undertaken relates to the correct determination of the practice of successful farmers in the use of water for irrigation with different soils and crops. At present such information is almost wholly lacking. The

collation of such information in sufficient amount to warrant the conclusions on which agricultural practices, laws, and judicial and administrative proceedings may properly be based is in itself a large task. The data thus obtained would be of great value, not only for practical purposes, but also as a guide to investigations by the experiment stations and other agencies. When once the actual amounts of water used by farmers in the irrigated regions have been determined, investigations should be undertaken to find out what is the minimum of water required by different soils and crops, in order that we may know to what extent the available water supply of the irrigated region may be utilized in the development of its agriculture. There are numerous other irrigation investigations which the Department and the experiment stations might well undertake; such are those which relate to the most economical methods for the application of water to crops, the utilization of the rainfall as affecting the need for irrigation waters, the problems of seepage and drainage, the effect of irrigation water on the growth and productivity of plants of different kinds, the prevention of the accumulation of alkali in the surface soils, and the reclamation of the alkali lands.

I believe that the importance and variety of the work demanded in the interests of irrigation in this country will justify a large increase in the appropriation for irrigation investigations by the Department. I hope that at the coming session of Congress a well-defined policy regarding the work of the Department on this subject will be definitely adopted.

DIVISION OF BOTANY.

SHEEP GRAZING IN THE FOREST RESERVES.

At the request of the Secretary of the Interior, the Botanist of the Department was directed early in July, 1897, to proceed to the Cascade Forest Reserve of Oregon to investigate and report upon the effect of sheep grazing on the forests of that region, an agricultural investigation for which his long experience in Western botanical exploration had well equipped him. The report demonstrates that the old system of unrestricted use of the forest lands as a grazing common is a public evil and is a menace to other branches of agricultural and State prosperity. A feasible way of removing this menace is conclusively pointed out, and fortunately the method proposed not only is not antagonistic to the interests of those engaged in stock grazing, but is distinctly favorable to them. The adoption of the proposed system gives every promise of contributing materially to the solidity of agricultural institutions in the West, more especially to the range-stock industry itself.

CHICORY GROWING, ETC.

In my last Annual Report attention was called to the fact that the United States imports annually at least $8,000,000 worth of minor

agricultural products, nearly all of which could undoubtedly be grown with profit by the farmers of this country. The first of these crops taken up for investigation was chicory. Following the Department's support of the chicory-growing industry, which consisted, first, in indorsing a tariff of 1 cent per pound on imports of the crude root, and secondly, in publishing, after a careful investigation, a full report on the methods of chicory growing, the imports of chicory, which in the fiscal year 1896 amounted to 16,317,888 pounds, and in 1897 to 17,329,170 pounds, dropped in the fiscal year 1898 to the astonishing total of 315,707 (raw) pounds. Making due allowance for the heavy antetariff imports of May and June, 1897, it is clear that a very large percentage of the chicory consumed in the United States during the last fiscal year was grown by American farmers. Not only does this result appear from the import statistics just cited, but the Department has direct information of the establishment and successful operation of chicory farms in Michigan, Nebraska, and other States. In several respects methods of chicory growing as now practiced in the United States are superior to the Belgian methods in the substitution of horsepower for hand cultivation, the use of superior plows, new and much cheaper method of digging the root, and more efficient slicing and evaporating machinery.

Investigations of other miscellaneous agricultural imports of the United States are now under way.

SEED TESTING.

To the Division of Botany has been intrusted the task of testing all the seeds sent out by the Department, not only those of the regular departmental distribution, but those imported through the recently established Section of Seed and Plant Introduction and those procured in other ways for the experimental work of the various Divisions. Never before has the Department distributed seeds of higher purity and germinative capacity than during the past year. Furthermore, an elaborate series of field tests was made to ascertain whether the seeds were really of the varieties stipulated in the contract. It was found that in several cases the varieties were wholly at variance with the contract, seeds of cheaper varieties having been substituted, presumably by the subcontractors. The fact that these varieties were not true to name could not, of course, be ascertained for several months after the seeds were distributed, but a portion of the purchase money was withheld, pending the result of the field tests, and a commensurate reduction was made in the price paid for the seed. The principal beneficial result of this action is expected to lie in its warning to future contractors that they will be paid for no inferior seed, whether this inferiority is due to themselves or to their subcontractors.

The seeds purchased in Russia by Prof. N. E. Hansen, special agent of the Department, for introduction into the United States, upon

their receipt in Washington were found to contain a large amount of weed seed, in many cases of kinds not yet known in the United States. On account of the lack of seed-cleaning machinery in the districts in which the seed was purchased it was impossible to get clean seed. Every package, therefore, was carefully tested in Washington City for purity, and if found to contain weed seeds was carefully cleaned, either by machinery or by hand. Furthermore, the seeds when distributed were accompanied by a memorandum calling attention to the danger from foreign weeds and directing their extermination, should any appear.

GINSENG.

The efforts of the Department in encouraging the cultivation of ginseng have met with gratifying success. An investigation of the subject was begun in 1893 and a report issued in the following year. At that time the Department announced the cultivation of the root as feasible, but could of course give no information as to the manner in which cultivated root would be received in the Chinese market. During the past four years, however, experimentation in ginseng culture has gone steadily on. The cultivated product has been marketed, and the commercial status of cultivated American ginseng established. First-class cultivated roots, dried, have been selling during the past year at $5.50 to $6 per pound, slightly in advance of the best wild root. The Department, therefore, fully indorses the cultivation of American ginseng as an additional resource of the American farmer.

DIVISION OF POMOLOGY.

WORK DURING THE YEAR.

The distribution among experimenters, in different sections of the country, of trees, scions, cuttings, plants, vines, and seeds of fruit-bearing varieties and species amounted to 200 lots, including 185 varieties and 26 species.

In preparing an exhibit of fruit models for the Trans-Mississippi International Exhibition at Omaha a plan was adopted by the Division which would furnish information to observant visitors as to the appearance and varied characteristics of important fruits. The exhibit was divided into groups illustrating the principal commercial apple grown in the trans-Mississippi region, the varieties adapted to dessert and other uses in the same region, Russian and crabs, new and small varieties, and specimens of the leading commercial and dessert fruits of the United States.

A special investigation of the fruit districts of the Pacific slope was made during the year, and the results will be included in the next revision of the Fruit Catalogue, to be issued during the coming fiscal year. For this purpose, I appointed Prof. E. J. Wilson, of the

University of California, a special agent of this Division for a period of six months; also Prof. W. H. Ragan, of Greencastle, Ind., as special agent for three months. Professor Ragan is chairman of the committee on revision of Catalogue of the American Pomological Society, and the appointment was made in recognition of the cooperative work undertaken by this Division with the society in the revision of this catalogue.

Descriptions of 485 fruits were added to the files, 75 wax models were completed, and 200 water colors were made during the year.

WORK IN PROGRESS.

An investigation of the present status of the cultivation of the European grape in the Southeastern section of the United States is being made. This is being done in cooperation with the Section of Seed and Plant Introduction, for the purpose of determining the advisability of renewed efforts in the introduction and cultivation of varieties of *Vitis vinifera* on resistant stocks in that region.

Many of the promising fruit-bearing species of foreign countries referred to in last year's report will soon be introduced into this country for experimental cultivation.

DIVISION OF PUBLICATIONS.

MEDIUM FOR DIFFUSION OF INFORMATION.

The Division of Publications is the medium for the diffusion of the information acquired by the various Bureaus, Offices, and Divisions of the Department. The results of the investigations for the promotion of agriculture and the information acquired by the corps of scientists and experts are made available through various forms of publications, of which 501 were issued during the year, and the total number of printed copies amounted to 6,280,365. These publications comprised technical reports and popular bulletins, and circulars on agricultural and kindred subjects, and they were distributed as promptly as our facilities afforded to the very large proportion of our people interested in or actually engaged in farming pursuits. Notwithstanding the large number of copies of publications distributed, they were not sufficient to meet the demands; and it is evident that only by an increased appropriation will it be possible to place the results of the work of this Department in the hands of all who are justly entitled to the same.

It is extremely gratifying to know that a knowledge of the Department and its usefulness is more widely prevalent than at any time in its history. This is due in a measure to the great increase in the number of small popular pamphlets and the wide distribution of them. At the same time there has been no retrogression in the scientific and technical reports which record the investigations and researches

made by our scientists and experts, and afford a permanent record of our achievements in the various realms of inquiry. These bulletins have been distributed with the greatest possible discretion. As regards all the bulletins and reports, the effort has been to place them in the hands of the persons who actually need them, and to deny the publications to all who apply for them simply to gratify a desire to obtain something because it is free.

THE YEARBOOK.

An interesting feature was added to the Yearbook for 1897, consisting of a series of 19 papers, aggregating 220 printed pages, prepared by the various chiefs of Bureaus, Offices, and Divisions, setting forth the work of each in relation to the farmer. The Yearbook also contained 18 miscellaneous papers on agricultural and kindred subjects, besides my preliminary report and the appendix of useful information, aggregating 786 pages. In this connection, I am constrained to recommend an increase in the quota of this publication allotted to the Department. For several years this allotment has consisted of only 30,000 copies, which is inadequate to supply the correspondents and others who receive no other compensation for the valuable services they render the Department, to say nothing of the demands from miscellaneous applicants, both domestic and foreign. For such purposes there should be at least 20,000 copies, making the entire quota of the Department 50,000, while Congress might order for the exclusive use of its Senators and Members such number as it sees fit, its proportion now being 470,000 copies. It is safe to say that the growing popularity of the Yearbook is due to its improved character and to the increased knowledge in regard to it.

The preparation of the volume for 1898 is already far advanced, and for 1899 I am considering the propriety of making a special effort to prepare a publication which shall contain a résumé of the achievements in the United States in every branch of science as related to agriculture during the nineteenth century for distribution at the Paris Exposition. At least 50,000 copies could be advantageously distributed, and I have no doubt Congress will vote an increased appropriation for such purpose.

FARMERS' BULLETINS.

The amount expended for printing Farmers' Bulletins during the year was $32,756.46, the total number of copies being 2,170,000, of which 1,580,000 were distributed upon the order of Senators, Representatives, and Delegates in Congress, the quota of each being 4,000 copies. Heretofore the quota was 5,000 copies, which was reduced because of the insufficiency of the appropriation for these bulletins. Requests from Members of Congress for additional copies aggregating over 100,000 copies had to be refused, owing to this cause. The

growing demand for these bulletins warrants the recommendation that adequate funds be made available for their preparation, printing, and distribution.

THE DISTRIBUTION OF DOCUMENTS.

The distribution of the publications of the Department has proceeded in accordance with the law of January 12, 1895, occupying the time and energies of the considerable force of employees necessary to mail, including publications and circulars, more than 7,000,000 documents. A special effort has been made to prevent duplication, and this precaution has made it possible to supply many deserving persons who would otherwise have been deprived of the publications.

The documents turned over to the Superintendent of Documents have met with ready sale, outnumbering those of all the other Departments combined, the amount which he realized from such sales being $2,089.15. The sum so realized should be made available for reprinting the publications that become exhausted, thus renewing the supply for the benefit of those who are willing to pay the nominal price affixed.

AN UNJUST RESTRICTION.

I feel constrained to again recommend the repeal or alteration of the provision of the act providing for the public printing and binding and the distribution of public documents, approved January 12, 1895, which restricts to 1,000 copies in any one year all publications exceeding in size 100 octavo pages. Not infrequently a most valuable report is necessarily larger, and the restriction referred to prevents its proper dissemination, withholding from many people, specially interested, valuable information to which they are entitled. It is earnestly hoped that Congress will speedily remove this and every other barrier, so as to allow the widest possible diffusion of the information acquired by the Department.

DIVISION OF STATISTICS.

INVESTIGATIONS OF THE YEAR.

The principal work of the Division of Statistics consists of the collection and publication of information concerning the condition, acreage, and production of the principal products of the soil, and the number, value, and condition of farm animals.

Among the subjects which have been investigated by the experts of this Division are the consumption of commercial fertilizers, the changes in the rate of charge for railway and other transportation services, the cost of raising a bale of cotton, the production of sugar in the United States, the world's production and consumption of wool, and the application of the principle of cooperation to farming or for the farmers' benefit. Reports on the two first mentioned have been published. The others are in progress.

IMPROVEMENT IN CROP REPORTING SYSTEM.

One of the most important duties devolving upon this Division is crop reporting. The Statistician has devoted special attention to the subject of improving these reports and organizing a system which shall be less cumbersome and more efficient. During the year the number of State agents has been increased from twenty to forty-one, and the relative increase in the reports received from voluntary reporters, both county and township, has been very considerable. The Statistician earnestly recommends, as a further step in securing efficient service and adding to the value of the improvements already secured, the appointment of five traveling inspectors, whose duties shall include the periodic visitation of State and county agents, and who shall visit the principal agricultural regions after seedtime and during critical periods of the growing season, and finally, after harvest, reporting the results of their observations to the Statistician. In view of the value of these reports, it is to be regretted that Congress reduced the appropriation for this Division for the current year.

IMPOSSIBILITY OF ANTICIPATING FINAL OFFICIAL FIGURES.

For many years charges have been made that certain operators on the different produce exchanges have had in their possession, several hours in advance of publication, statements relative to the crop reports alleged to have been obtained from official sources. In many cases the figures closely corresponded with the figures subsequently announced by this Department. It was evidently necessary to make such allegations impossible, and without reflecting upon anyone of the employees of the Division, changes have been made in the handling of the returns which make it practically impossible for anyone to anticipate the final official figures. The fact that since these changes were made the discrepancy between the figures claimed to have been prematurely obtained and those actually published by the Department has been marked is a matter of congratulation, and should confirm the falsity of any such allegations in the future.

INVESTIGATION OF THE CONSUMPTION OF WHEAT.

Owing to the uncertainty that prevails as to the annual per capita consumption of wheat and the difficulty of obtaining absolutely reliable information concerning the amount produced from year to year, it is proposed to so extend the work of this Division as shall enable the Department to speak with a greater degree of confidence and authority concerning the much-discussed food problem of the United States and the world at large. To this end it is proposed to establish a record of movement and supply, which will prove a valuable check upon the statistics of production and pave the way for an investigation of the consumption of wheat in certain typical

communities that would be of the highest statistical and economic value.

In connection with this work the five traveling inspectors already recommended could be employed to great advantage.

CROP-REPORTING SYSTEM FOR NEW TERRITORY.

The recent acquisition of territory brings under control of the United States islands the products of whose soils are so large and of such vital importance that adequate provision must be made for the establishment of an efficient system of crop reporting in all these islands.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

IMPROVED BUSINESS METHODS.

The regulations governing financial transactions with the Department have been thoroughly revised during the year and made to conform with new and amended laws, as well as with recent rulings of the Treasury and the Department of Justice. Thus revised, the regulations have been published and supplied to persons interested.

The Accounting Officer of the Department has performed an important service during the year by aiding in the formulation of a more satisfactory method of public advertising and settlement of accounts in that connection, by which uniformity, accuracy, and a permanent record of details have been secured and a great saving of money effected. In the consideration of such questions he acted in connection with a committee of representatives from the Executive Departments, with the Chief Clerk of the Treasury as chairman. A better form for requests for transportation for persons traveling on Government business was adopted at the same time. Another step in the direction of improvement of business methods was the assignment of a well-qualified official to the duties of law clerk.

RECEIPTS AND EXPENDITURES.

During the year there were received, audited, and paid by the Department 15,576 accounts, including supplemental accounts for 1896 and 1897, as follows: Divisional, 4,658, amounting to $847,621.64; Bureau of Animal Industry, 3,606, amounting to $733,901.66; Weather Bureau, 7,312, amounting to $830,437.55; and the settlement of these accounts required the issuance of 25,593 checks.

From the appropriations for 1898 the total disbursement through the Department prior to July 1, 1898, was $2,245,334.08. There remained at that date unpaid bills for that year aggregating $170,000. When these shall have been paid there will be a final balance to return to the Treasury of nearly $50,000.

The total amount paid out during the year was $2,411,960.85, which includes supplementary payments for 1896 and 1897. The accounts for 1896 were finally closed and $488,833.58 was covered into the Treasury as an unexpended balance.

During the year $8,071.06 was received from sales of Government property and for services, and will go into the Treasury as part of the surplus for the year. Of this amount, $4,220.19 is made up of receipts from the seacoast telegraph lines and $3,464.61 is from sales of condemned property.

A perusal of the foregoing review of the operations of the Department during the past fiscal year justifies the statement that the record of the year has been one of the most satisfactory growth and development. There has been manifested in many ways a widespread interest in the work of the Department and an appreciation of the value of its investigations to the producers of this country. The demand for information from the Department has been unprecedented, and covers the greatest variety of agricultural problems. Day by day the fact is more and more fully acknowledged that the services of the Department to the producer are of the first importance, and such as can be rendered to him through no other agency.

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 23, 1898.*

SOME TYPES OF AMERICAN AGRICULTURAL COLLEGES.

By A. C. True, Ph. D.,

Director of the Office of Experiment Stations.

In papers in the Yearbooks of the Department for 1894 and 1897 the history and general organization of the institutions for agricultural education in the United States were outlined, and the general features of the various agencies for the more elementary education of the farmer were described. It is now proposed to set forth more definitely the chief characteristics of different kinds of institutions in which agricultural instruction of college grade is provided. To do this in any satisfactory way is by no means a simple matter. The colleges of agriculture in the several States and Territories have been so fashioned by the conditions of their local environment that each of them has developed individual peculiarities of form and life to such an extent that classification of them is more or less open to objections. It will not do at all, for example, to classify these institutions according to the names which they bear. Some which are denominated simply agricultural colleges are really institutions of quite complex structure, while others in whose title the term "agricultural" does not appear have thoroughly organized and well-attended courses in that branch of learning.

CLASSIFICATION OF THE AGRICULTURAL COLLEGES.

With this caution we will, however, proceed to do what for the purposes of this paper seems quite essential, namely, to divide the agricultural colleges according to the general differences in their organization into three classes: (1) Colleges having only courses in agriculture; (2) colleges having courses in agriculture along with those in a variety of subjects, including, especially, mechanic arts; and, (3) colleges (or schools or departments) of agriculture forming a part of universities. Or, more briefly and conveniently, the institutions having collegiate courses in agriculture may be designated as (1) agricultural colleges; (2) agricultural and mechanical colleges; and, (3) universities. The only institution in this country which is simply an agricultural college is the Massachusetts Agricultural College.

Agricultural and mechanical colleges have been organized in Alabama, Colorado, Connecticut, Delaware, Florida, Iowa, Kansas, Kentucky, Maryland, Michigan, Mississippi, Montana, New Hampshire,

New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Texas, Utah, Virginia, and Washington. Separate institutions of this class for colored students are maintained under the Morrill Act of 1890 in Alabama, Delaware, Florida, Mississippi, North Carolina, South Carolina, and Virginia. The instruction in these institutions has, however, very wisely been confined for the most part to courses below the college grade. A similar institution, maintained by private funds, is the well-known Tuskegee Industrial Institute, in Alabama.

Colleges of agriculture (or equivalent schools or departments) in universities are maintained with the aid of national funds in Arizona, Arkansas, California, Georgia, Idaho, Illinois, Indiana, Louisiana, Maine, Minnesota, Missouri, Nebraska, Nevada, New York, Ohio, Tennessee, Vermont, West Virginia, Wisconsin, and Wyoming. In Massachusetts, Harvard University has a school of agriculture known as Bussey Institution.

To bring out the main features of each of the three groups of agricultural colleges, it seems best to describe briefly a few institutions, which may thus serve as types of the rest, and for this purpose institutions are selected which are relatively well equipped for agricultural instruction.

THE MASSACHUSETTS AGRICULTURAL COLLEGE.

The Massachusetts Agricultural College, which, as has been stated, is the only exclusively agricultural college in the United States, is located on a farm of about 400 acres at Amherst, Mass., in one of the most beautiful localities in the picturesque valley of the Connecticut River. It is in a region where public and private schools of all grades are numerous and thoroughly organized. The neighboring colleges are Amherst and Williams for men and Smith and Mount Holyoke for women. The mechanical and other branches of industrial education, exclusive of agriculture, are provided for in the State by the Massachusetts Institute of Technology at Boston and the Worcester Polytechnic Institute, both strong and high-grade institutions. The Massachusetts Agricultural College has an annual income of about $45,000, one-half of which is derived from the United States and the other from the State. In addition to this the college receives about $30,000 annually for the maintenance of an agricultural experiment station, nearly equally divided between national and State funds. Two-thirds of the land-grant fund of 1862 and of the annual appropriation made to Massachusetts by Congress under the Morrill Act of 1890 are given to this college, the remaining third going to the Massachusetts Institute of Technology. In 1897 the college had permanent endowment funds aggregating $360,000, and its buildings, farms, and equipment were valued at about $315,000. The college buildings include combined dormitory and class-room building, chapel

FIG. 1.—LIBRARY AND CHAPEL BUILDING, MASSACHUSETTS AGRICULTURAL COLLEGE.

FIG. 2.—COLLEGE BARN, MASSACHUSETTS AGRICULTURAL COLLEGE.

FIG. 1.—MACHINE SHOP, MICHIGAN STATE AGRICULTURAL COLLEGE.

FIG. 2.—PRINTING OFFICE, KANSAS STATE AGRICULTURAL COLLEGE.

FIG. 1.—MAIN BUILDING AND MORRILL HALL, IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

FIG. 2.—ENGINEERING BUILDING PENNSYLVANIA STATE COLLEGE.

and library (Pl. I, fig. 1), laboratory for chemistry and physics, entomological laboratory with insectary, botanic laboratory and museum, drill hall, dormitory, president's house, several residences for professors, farm house, boarding house, horticultural plant houses, and barn, including creamery and dairy laboratory. Two buildings for the use of the veterinary department are being erected. The experiment station also has a chemical laboratory, botanical laboratory with plant house, and barns. On the farm 150 acres are under cultivation with a variety of field crops, and the extensive college barn (Pl. I, fig. 2) is stocked with 100 head of cattle and equipped with the most improved agricultural implements and machinery. The horticultural grounds cover 100 acres, with orchards, vineyards, small fruit and vegetable plantations, and groves of forest trees. Much attention is given to floriculture and landscape gardening, and the ample plant houses are well stocked with numerous varieties of exotics. Some 80 acres are devoted to the work of the experiment station, including numerous plat experiments with varieties of field and horticultural plants, fertilizers, methods of culture, etc.; feeding experiments with animals; soil investigations, etc. The laboratories of the different scientific departments are well equipped with apparatus for experimentation and demonstration and with illustrative material, such as specimens of plants, insects, animals, and machines, particularly those of importance in their relation to agriculture. The library of 18,000 volumes has been carefully collected with reference to the needs of an agricultural college, and is thoroughly catalogued and managed with a view to providing the students every facility for obtaining the information they desire to gather from books. It is one of the most extensive and valuable collections of books on the science and practice of agriculture to be found in this country. The instruction is given by a corps of 18 professors and assistants. The chairs include chemistry, botany, agriculture, horticulture, zoology, veterinary science, mental and political science, English and Latin, modern languages, mathematics and civil engineering, and military science and tactics. There is also a lecturer on farm law. In 1897 there were 132 students in attendance, of whom 8 were in post-graduate courses. During the thirty years of its active life the college has given instruction to about 1,100 men, of whom almost one-half have graduated. Of the living graduates, some 350 are engaged in agricultural pursuits. The student is required to follow a definitely prescribed curriculum during three years, and in the fourth and last year of the course he is allowed wide latitude of choice among numerous specialties, English and military science being the only required studies. In freshman year the following subjects are included in the course: Agriculture, botany, chemistry, algebra, geometry, bookkeeping, English, French, military tactics, and mechanical drawing; in sophomore year, agriculture,

horticulture, botany, chemistry, anatomy and physiology, trigonometry, surveying, English, and mechanical drawing; in junior year, agriculture, horticulture, chemistry, zoology, entomology, physics, English (including rhetoric and literature); in senior year, together with the required English and military science, at least three elective studies must be taken, which may be selected from the following: Agriculture, botany, chemistry, entomology, veterinary science, civil engineering, analytical geometry, calculus, English, German, Latin, political economy, history, and farm law. Eleven short winter courses are also offered, the instruction in which is elementary and practical. The college has hitherto been open to men only, but women may now attend special elective courses in such branches as botany, entomology, floriculture, fruit culture, market gardening, and dairying.

On the completion of the four years' course students receive the degree of Bachelor of Science, "the diploma being signed by the governor of Massachusetts, who is president of the corporation." The college is so affiliated with Boston University that upon graduation the students may also receive the diploma of that institution. Post-graduate courses leading to the degree of Master of Science are also offered.

Candidates for admission must be at least 16 years old, and are required to pass examinations in English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books), and civil government.

The students, as a rule, room in the college dormitories and are boarded in clubs or private families. The expenses for room rent, board, fuel, washing, and military suit for the college year are estimated to range from $150 to $300. For residents of Massachusetts, scholarships covering tuition have been established for each of the thirteen Congressional districts of the State, together with 80 scholarships divided among the State senatorial districts and awarded on the basis of competitive examinations. Five thousand dollars are provided by the State to pay students performing labor at the college, and there are small endowment funds for the assistance of needy students. Small money prizes are also given for excellence in declamation, oratory, agriculture, botany, and military science and tactics. The undergraduates conduct a 16-page biweekly journal, known as Aggie Life, and publish a college annual called the Index. They also maintain a natural history society, reading room association, "Kollege Kemical Klub," and four secret societies. There are glee and banjo clubs, a general athletic association, and special associations for football, baseball, polo, and tennis. The moral and religious interests of the students are cared for by a requirement to attend prayers every week day and public worship every Sunday in

the college chapel, and by the work of a Young Men's Christian Association.

The college is under the general management of a board of 14 trustees appointed by the governor in such a way that their terms of office expire in different years, together with 4 ex-officio members, the governor (president of the board), the president of the college, the secretary of the State board of education, and the secretary of the State board of agriculture. The board of agriculture also acts as a board of overseers for the college.

THE AGRICULTURAL AND MECHANICAL COLLEGES.

The agricultural and mechanical colleges have such different organizations that no one institution will serve as a type of them all. In many respects their facilities for instruction in agriculture are similar to those already described as belonging to the Massachusetts Agricultural College. In speaking of these colleges we shall therefore omit some of the details given for that institution, and state only the chief distinguishing features of several of the colleges of the second class, in which there are considerable numbers of students pursuing agricultural courses.

MICHIGAN STATE AGRICULTURAL COLLEGE.

The Michigan State Agricultural College is the oldest agricultural college in this country, having been established by an act of the State legislature passed February 12, 1855, and opened for students May 13, 1857. For more than thirty years it was like the Massachusetts college in having only an agricultural course, but after the passage by Congress of the Morrill Act of 1890, which gave the college a materially increased income, a mechanical course was added, and later a woman's course. The laws of the State under which the college is organized prescribe that it shall be a "high seminary of learning in which the graduate of the common school can commence, pursue, and finish a course of study terminating in thorough theoretic and practical instruction in those sciences and arts which bear directly upon agriculture and kindred industrial pursuits." Students are admitted at 15 years of age, and are examined in reading, spelling, penmanship, grammar, geography, arithmetic, and history of the United States. They may also be admitted on a certificate from approved graded schools or on a teacher's certificate. There are preparatory classes for students unable to meet these requirements. The regular college courses cover four years, and lead to the degree of Bachelor of Science. The course in agriculture is arranged as follows: Freshman year, algebra, English, military drill, botany, agriculture, blacksmithing, carpenter work, drawing, physics, chemistry, geometry; sophomore year, chemistry, anatomy, military science and drill, English, geometry, physics, agriculture, physiology, botany, veterinary

science, entomology, horticulture, trigonometry, and surveying; junior year, military drill, English history, agriculture, horticulture, fungous diseases of plants, rhetoric, agricultural chemistry, English literature, civics, forestry, botany, together with special elective courses in agriculture or horticulture; senior year, bacteriology, constitutional history, economic zoology, meteorology, physics, veterinary science, engineering, English literature, geology, psychology, entomology, logic, political economy, together with special electives in agriculture or horticulture, and in some other branches, including French and German. There are also short winter courses of six weeks in dairy husbandry, live-stock husbandry, fruit culture and floriculture, and winter vegetable gardening. A farm home reading circle is conducted by the college. Provision is made for post-graduate studies leading to the degrees of Master of Science, Mechanical Engineer, and Master of Agriculture. The Michigan college has well-equipped laboratories in botany, physics, chemistry, agriculture, horticulture, and zoology, which are very largely used in connection with the course in agriculture. There are in addition laboratories and shops for the courses in civil engineering and mechanic arts. (See Pl. II, fig. 1.) The library contains over 20,000 volumes.

The college land, comprising 676 acres, is divided into the farm of 230 acres, devoted to field crops grown under a system of rotation, 45 acres of woodland pasture, 114 acres of very attractive lawns, gardens, and orchards, 240 acres of forest, and 47 acres of experimental fields and plats. The farm is equipped with cattle, sheep, and swine of the principal breeds. There is an arboretum of 150 species of trees, a botanic garden containing some 1,200 species of native and foreign hardy herbaceous plants with some shrubs, a grass garden of 200 species of grasses and clovers, and a weed garden of 100 or more species of the most troublesome weeds. The students in agriculture are required to work two and one-half hours a day on the farm or garden.

The students for the most part room in dormitories and board in clubs. The average annual expenses of students for board, room rent, heat, light, books, laboratory, and other fees are estimated at about $125. These expenses are oftentimes reduced by receipts from labor performed on the farm or elsewhere about the college.

The college is under the management of the State board of agriculture of which the governor and the president of the college are members ex officio. There are somewhat over 30 professors and assistants in the faculty. In addition to the chairs provided by the Massachusetts college, there are in the Michigan college professors of mechanical engineering and domestic economy and household science. In 1897 the Michigan college reported 211 students in agricultural courses out of a total attendance of 425.

MISSISSIPPI AGRICULTURAL AND MECHANICAL COLLEGE.

The Mississippi Agricultural and Mechanical College is similar to the Michigan Agricultural College in providing separate courses in agriculture and mechanic arts, in having the same general requirements for the admission of students, and in offering preparatory courses. It differs from the Michigan college in not admitting women or persons of the negro race. The State, however, has made provision for colored students in the Alcorn Agricultural and Mechanical College. The courses in agriculture give especial attention to the crops and methods of farming peculiar to the Southern States. As is common in the South, the college has a more strictly military organization and discipline than pertain to institutions of this class in the North and West. The expenses of the students average about the same as at the Michigan college. Student labor in the field or garden is paid for at the rate of 8 cents per hour, and in this way students may reduce their expenses to $100 per annum. The college is under the general management of a board of 9 trustees, and the governor of the State is a member ex officio. The faculty comprises 22 members. In 1897, 316 students out of a total of 368 were reported as pursuing courses in agriculture.

KANSAS STATE AGRICULTURAL COLLEGE.

The Kansas State Agricultural College was first established in 1863, and has been maintained in its present location at Manhattan, Kans., since 1875. The State has generously supplemented the United States grants by the erection of substantial buildings, including a main building, chemical laboratory, mechanics hall, horticultural hall, armory and entomological hall, library and agricultural science hall, domestic science hall, horticultural laboratory with six propagating houses, farm and horticultural barns, and other buildings, valued at over $350,000. The college farm comprises over 300 acres, and is well equipped with live stock. The faculty includes 45 professors and assistants, and over 800 students were in attendance last year. Students of both sexes are admitted at 14 years of age after passing an examination in reading, spelling, writing, arithmetic, geography, English grammar, and United States history. Candidates are also admitted without examination on presenting satisfactory diplomas or certificates from county or city superintendents. Preparatory classes are provided "for those over 18 years of age who have not been able to make their preparation in the common schools." Four-year courses are offered as follows: Agricultural, engineering, general and household economics. "Closely adjusted to the course of study is industrial training in several of the arts, to which each student is required to devote at least one hour a day throughout almost his entire course. Among the lines of training each student may select, with the approval of the faculty, except in terms when special industrials

are required. Young men may have farming, gardening, fruit growing, woodwork, ironwork, or printing. Young women may take cooking, sewing, printing, floriculture, or music. The training in these departments is designed to be systematic and complete in each, so that a student following a single line diligently through the four years' course gains the essentials of a trade and a reasonable degree of skill. Those who wish only a general training in the arts can take shorter courses in several of them."

There is also a dairy course of twelve weeks, and apprentice courses in blacksmithing, foundry and machine-shop practice, printing (see Pl. II, fig. 2), and sewing, which run from forty to eighty weeks. Opportunities are offered for graduate study, and original investigations in a number of agricultural lines are carried on at the experiment station connected with the college. Tuition is free, and the annual expenses of students range from $100 to $200. Considerable work is furnished to students at 10 cents per hour. Besides a weekly paper edited by the students, the college publishes a journal called the Industrialist, which is edited by the faculty. Both these publications are printed at the college.

IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

The Iowa State College of Agriculture and Mechanic Arts was established under an act of the State legislature passed in 1858, but was not opened to students until March 17, 1869. The college has in recent years enjoyed a large measure of prosperity and has been broadened and made stronger in a number of ways. It has fifteen college buildings erected by the State at a cost of about $500,000, including a main dormitory and class-room building (with botanical laboratory), two smaller dormitories, Margaret Hall for women (including a dining room for all the students), chemical and physical hall, veterinary hospital, sanitary hall, engineering hall, wood shops, power house (with facilities for mechanical and electrical engineering), music hall, administration building, Morrill Hall (containing chapel, library, museum, lecture rooms, and laboratories of natural history and geology, Pl. III, fig. 1), agricultural hall, and greenhouse. There are also ten dwelling houses for professors and other employees, a creamery, barns, stables, seed houses, etc. The college lands comprise about 900 acres, of which 120 acres are set apart for college grounds, and with their gardens, trees, and shrubs constitute a large and beautiful park. "The farm consists of rolling prairies, bottom, and woodland, and is stocked with good representatives of five breeds of horses, six breeds of cattle, seven breeds of sheep, and six breeds of hogs. These animals are used in class illustrations and for the various experiments in breeding and feeding for milk, meat, wool, growth, and maintenance, conducted by the experiment station as a department of the college. All the crops of the farm are grown for

some educational purpose; all the animals are fed by rule and system and the results of their management reported upon and used in class work. (See Pl. IV, fig. 1.) Labor is not compulsory, but students in the agricultural courses are given work that is educational and parallel with their studies. Some students pay for their board by work in the mornings and evenings." Especial emphasis is at present laid on instruction in dairying. (Pl. IV, fig. 2.) There is a practical working creamery and cheese factory in operation throughout the year. "During the summer season from 15,000 to 25,000 pounds of milk are taken in daily and manufactured into butter and cheese; during the winter somewhat less." Experiments in dairying are always in progress and different kinds of improved machinery are tested in practical operations. In 1897 the number of professors and assistants in the faculty was reported as 55, and the number of students (men and women) as 573. Eight courses of study leading to a bachelor's degree are offered, as follows: Agriculture, veterinary science, mechanical engineering, civil engineering, electrical engineering, mining engineering, science, woman's course. These cover four years, except the course in veterinary science, which is of three years' duration. There is also a two-year course in agriculture, a one-year course in dairying, and summer and winter schools in dairying. The subjects taught in the four years' agricultural course correspond in a general way with those in similar courses in Michigan and Massachusetts. During freshman and sophomore years the student pursues a prescribed curriculum, but during junior and senior years he is offered a considerable number of electives. In senior year the subjects of instruction are so grouped that the student may give much attention to general agriculture or he may specialize in animal husbandry, dairying, or horticulture.

Students are admitted to the college courses at 16 years of age, after passing an examination in spelling, English grammar, geography, arithmetic, United States history, physiology, and (except in veterinary and agricultural courses) algebra through simple equations. The requirements for admission will be somewhat increased after the present year. Students are also admitted on certificate from a select number of high schools and academies. Preparatory classes are conducted during the last half of each college year.

The Iowa college represents those institutions whose development has been along broad lines and in which the agricultural course, maintained side by side with a number of courses in the arts and sciences, is being more thoroughly organized and specialized in accordance with the general advance movement in education along industrial lines.

PENNSYLVANIA STATE COLLEGE.

The Pennsylvania State College was begun as a "Farmers' High School" in 1859, became "The Agricultural College of Pennsylvania"

in 1862, and with the broadening of its scope has been known by its present name since 1874. It now offers thirteen four-year courses, grouped as follows: (1) Classical course; (2) general courses, including general science, Latin-scientific, philosophy; (3) technical courses, including agriculture, biology, chemistry, civil engineering, electrical engineering, mathematics, mechanical engineering, mining engineering, and physics. The classical course leads to the degree of Bachelor of Arts, the other courses to the degree of Bachelor of Science. The requirements for admission to scientific and industrial courses differ from those of the Latin-scientific and classical courses, and include arithmetic (with the metric system), English classics, United States history, algebra (through quadratics and progression), plane geometry (five books), and physics (elements). It will be seen that these requirements are higher than those of the institutions thus far mentioned. In fact, the Pennsylvania college is being developed into a high-grade technical, scientific, and classical college. It is well equipped with buildings, laboratories, workshops, apparatus, farm and live stock, and other facilities for its work. (See Pl. III, fig. 2.) Its faculty numbers 50 professors and assistants, and the number of students, increasing with the strengthening of its courses of instruction and its equipment, has reached 350. Both sexes are admitted. While devoting its main attention to the work of the regular college classes, the Pennsylvania college reaches down and up in its efforts to meet the special needs of students desiring to avail themselves of its facilities for education. For those who are so situated that they can not gain the necessary qualification for admission in the public schools of the State, the college provides preparatory classes. In agriculture, besides the thorough four years' course, there is a special course of one year and short winter courses in agriculture, creamery work, cheese making, and private dairying. Much attention has been given to the organization of correspondence courses in agricultural subjects, and five distinct courses of this character are now offered, as follows: Crop production, live-stock production, horticulture, dairying, and domestic economy. Provision is made for advanced courses leading to the degrees of Civil Engineer, Mechanical Engineer, Engineer of Mines, Electrical Engineer, and Master of Science. Original investigations in agriculture are being systematically pursued by the agricultural experiment station, which here, as in the other institutions of this class, is organized as a department of the college.

ALABAMA POLYTECHNIC INSTITUTE.

An institution organized in much the same way as the Pennsylvania State College is the State Agricultural and Mechanical College of Alabama, or, as it has more recently been denominated, the Alabama Polytechnic Institute. This institution offers four-year courses in

chemistry (Pl. V, fig. 1) and agriculture, civil engineering, electrical and mechanical engineering, and pharmacy, together with a "general course," the scope of which would be more definitely indicated by the term Latin-scientific. The requirements for admission for men are not so high as in Pennsylvania, including only geography, English, arithmetic, algebra to quadratics, and United States history. While men are admitted at 15 years of age, women are excluded until they are 17 years old, and are required to pass examinations in English grammar and rhetoric, United States and general history, arithmetic, algebra, geometry, trigonometry, and Latin. There are preparatory classes and two-year courses in agriculture and mechanic arts. Post-graduate courses lead to the degrees of Master of Science, Mining Engineer, Civil Engineer, Electrical and Mechanical Engineer, and Pharmaceutical Chemist. In 1897 the faculty of this institution numbered 31 professors and assistants, and the number of students was 361, of whom 112 were in agricultural courses.

COMMON FEATURES OF AGRICULTURAL AND MECHANICAL COLLEGES.

The general conditions of student life in the agricultural and mechanical colleges are much alike. For general culture and recreation there are literary societies, student periodicals or annuals, music clubs, and athletic organizations. The moral and religious life is promoted through services on week days and Sundays in the college chapel and through the work of voluntary organizations, especially the Young Men's Christian Association. In many ways the students keep in close touch with the common life of the communities in which the colleges are located. The general atmosphere of these institutions tends to keep the students in sympathy with whatever promotes the advancement of American arts and industries. Agriculture has an honorable place in these colleges, and the strengthening of the agricultural courses tends to bring into them a more earnest and successful class of students. Through their experiment stations, short courses, home reading circles, and lectures at farmers' meetings these institutions are also doing much to diffuse useful information among the farmers. In their organization it will be seen that they vary considerably, ranging from institutions in which agriculture and one or two branches of the mechanic arts receive almost exclusive attention to those which approximate the State universities in the variety of subjects in which courses are offered. In general, it may be said that the present tendency is to make these colleges schools of technology (or polytechnic institutes) in which there shall be a great variety of technical and scientific subjects taught in direct relation to their application to many arts and industries and with special reference to the betterment of our industrial organization and life. This is in accordance with the general trend of educational movements in our day, which, in

harmony with the expansion in variety and the concentration in effort of our industrial and social life, are seeking to adapt courses of instruction to the varied needs of the modern man and at the same time to secure economy in equipment and teaching force by combining related courses of instruction in single institutions.

STATE UNIVERSITIES HAVING COURSES IN AGRICULTURE.

Another phase of this movement is presented by the third class of institutions in which college courses in agriculture are maintained, and the remainder of this paper will be devoted to a brief consideration of the State universities having agricultural schools or departments.

CORNELL UNIVERSITY.

In this class of institutions Cornell University, in the State of New York, is preeminent as regards the resources at its command for education and research. This institution was incorporated by the State legislature April 27, 1865, and opened to students October 7, 1868. "The existence of the university is due to the combined wisdom and bounty of the United States, the State of New York, and Ezra Cornell." The oft-quoted words of the founder of this great university have done much to inspire the establishment of similar institutions in many of our States: "I would found an institution where any person can find instruction in any study." In 1897 Cornell University reported that its endowment funds, buildings, and equipment were valued at more than $9,500,000, of which $688,572 belonged to the land-grant funds of 1862, and that its income for that year was $576,154.82, of which $70,087.24 was derived from the United States. There were 220 professors and assistants in the faculty, and the number of students was 1,868, of whom 127 were pursuing courses in agriculture. The university is divided into graduate and academic departments, and colleges of law, civil engineering, mechanical engineering, and mechanic arts, architecture, agriculture, veterinary medicine, and forestry. All of these are amply equipped with buildings, laboratories, apparatus, and museum collections, and the students enjoy the privileges of the university library of 200,000 volumes.

The college of agriculture comprises the departments of general agriculture, animal industry and dairy husbandry, horticulture and pomology, agricultural chemistry, general and economic entomology, the agricultural experiment station, and university extension work in agriculture. One hundred and twenty-five acres of arable land are used as the college farm, which is well stocked with dairy cows, sheep, horses, pigs, and poultry. The dairy building (Pl. V, fig. 2), erected in 1893, is fully equipped with modern machinery and appliances for butter and cheese making. Ten acres are devoted to the gardens, orchards, and nurseries of the horticultural department, which also

has eight forcing houses, covering about 6,000 square feet of ground, and a museum containing a large garden herbarium and an extensive collection of photographs.

Candidates for admission must be at least 16 years old, and pass examinations in English, geography, physiology and hygiene, history of the United States and England, Greece or Rome, plain geometry, elementary algebra, and at least two of the following subjects: Greek, Latin, French, German, and advanced mathematics. The four years' course in agriculture "is designed to afford an education as broad and liberal as that given by other departments of the university, and leads to the degree of Bachelor of Science in Agriculture." A large number of electives are open to the students in agriculture, especially during junior and senior years. Besides those of the college of agriculture, the following departments give instruction to students in this course: Botany, free-hand drawing, physics, political economy, physiology, vertebrate zoology, hygiene, mathematics, French, German, military drill and gymnasium, geology, veterinary science, civil engineering, and mechanical engineering. There are special courses and winter courses in agriculture and dairy husbandry for those who can not take the four years' course. The college of agriculture is also actively engaged in introducing nature studies into the public schools of the State, as described in the Yearbook for 1897 (p. 286). The university affords many opportunities for graduate study in agriculture, horticulture, and allied sciences. Tuition is free to students pursuing agricultural courses. The yearly expenses of students are estimated to be from $300 to $500.

OHIO STATE UNIVERSITY.

West of the Alleghenies the idea that the State is the proper agency for the maintenance of broad institutions for higher education, which shall thus be the crown of the public-school system, has taken a strong hold upon the public mind during recent years. There has, therefore, been a rapid increase in the number of students attending the State universities, and the equipment of these institutions has been greatly enlarged. A representative university of this kind in the eastern part of this region is the Ohio State University at Columbus, Ohio, which in 1897 reported a total attendance of 1,019 students; 78 professors and assistants in its faculties; endowment funds, buildings and equipment aggregating nearly $3,000,000 in value, and an income of $349,000.

The university is briefly described in its publications as "simply the thirteenth, fourteenth, fifteenth, and sixteenth grades of the State system of public, free education. It is related to the high schools just as they are related to the grades, and it ought to be quite as natural for a pupil to look forward from the high school to the university as from the eighth grade to the high school." Its aim is

"to give to the young men and young women of Ohio the largest possible opportunity for both general and special training, to prepare them for life, and to touch in a practical and helpful way every interest of this State." The university is divided into six colleges, agriculture and domestic science; arts, philosophy, and science; engineering; law; pharmacy, and veterinary medicine.

In the college of agriculture and domestic science four-year courses are offered in agriculture, horticulture and forestry, and domestic science; two-year courses in agriculture and domestic science, and a short course in dairying. There are also opportunities for graduate study. Candidates for admission to the four-year courses must be 16 years old and pass examination in arithmetic, elementary algebra, English grammar and rhetoric, plane geometry, geography, United States history, physics, botany, and either civil government or general history. Graduates of accredited high schools are, however, admitted without examination. Tuition is free. The average annual expenses are estimated to be $250. "Students room and board where they please."

The university has a well-stocked farm of 200 acres and is otherwise well equipped for agricultural instruction. The State has recently added several fine buildings to the equipment of the university. Among these is Townshend Hall, erected at a cost of about $100,000, for the use of the department of agriculture. A brief description of this building may serve to show something of the latest stage of the development of facilities for agricultural instruction in a State university.

Townshend Hall (Pl. VI, fig. 1) is built of cut stone and gray pressed brick, with terra cotta trimmings, tile roof, interior brick walls, expressed beams, maple floors, and hard-pine finish. In the dairy department, which has about 6,000 square feet of floor space, the floors are of tile and the walls wainscoted with enameled brick. The building is 260 feet long and varies in width from 64 to 78 feet. It has two stories and a basement.

"On the left of the entrance, which is 28 feet wide, is the office of the department of agriculture and a private office, a stenographer's room, and fireproof vault. Connected with the office on the south is an assistant's room, opening into a laboratory for advanced students. At the extreme south end of this floor is a large laboratory for student work in soils and farm crops. Connected with this laboratory is a balance room, a storeroom, and an instructor's laboratory. On the west side of the main corridor and connected with the instructor's room, is a large class room opening into a preparation room with a dark room. This class room is fitted with all appliances for showing lantern slides of live stock, buildings, machinery, etc. On the same side of the corridor and on the right of the stairway leading to the basement and second floor are the class room and instructor's room

for dairying. On the right of the main entrance is the department reading room. The north end of this floor is occupied by the museum (which is 54 by 67 feet), with an attendant's room. The north end of the high basement is occupied by the dairy department. This consists of receiving room, pasteurizing room, storeroom, refrigerator room, lavatory, butter-making room, cheese-making room, two cheese-curing rooms, and instructor's room.

"In the south end of this floor is a live-stock room about 40 feet square. One-third of this room is occupied by raised seats, the remaining floor space being used for exhibiting and judging live stock. Connected with this is a room fitted with stalls for the temporary accommodation of live stock when needed for class exercises. The basement also contains soil-storage room, bath room, toilet rooms, repair shop, locker rooms, bicycle room, and janitor's room. A small detached building will furnish steam and power for the dairy department. Detached from the main building, but connected with the soil-storage room by a tramway, is a glass house 30 by 40 feet for the study of soils and the experimental growth of plants.

"The north end of the second story contains a large student laboratory for the department of agricultural chemistry, connected with an organic analysis laboratory, a balance room, a storeroom, and a private laboratory. The lecture room of this department, with a preparation room adjoining, is at the south end of this floor and will seat 160 students on raised seats.

"There is also on this floor a class room connected with preparation room, storeroom, and instructor's room which will be used temporarily by the department of veterinary medicine. There is also an extra class room, ladies' toilet and locker rooms, and a hall for the use of the Townshend Society, designed to seat about 200 persons."

UNIVERSITY OF WISCONSIN.

The University of Wisconsin is "picturesquely situated at Madison," the State capital, on the shore of Lake Mendota, and is supported "partly by the income of Federal grants, partly by taxation of the people of the State, and partly by private gifts." It has received the benefit of no less than five Federal grants and six permanent grants from the State in addition to appropriations for buildings and other specific purposes. In 1897 the total value of its endowment funds, buildings, and equipment was reported to be $2,057,000, the faculties included 130 professors and assistants, and the number of students was 1,767. The university is divided into four colleges, letters and science, mechanics and engineering, agriculture, and law, and two schools, pharmacy and music. The college of agriculture embraces (1) the experiment station; (2) the graduate course; (3) the long (four-year) agricultural course; (4) the short agricultural course; (5) the dairy course; and, (6) the farmers' institutes. In this

institution the division of the subject of agriculture into special subjects with different teachers has been pushed to a considerable extent. There are professors of agriculture, animal husbandry, and dairy husbandry, and instructors in cheese making, milk testing, butter working, separating of milk, pasteurizing, farm dairying, greenhouse practice, and stock judging. There are also separate chairs of agricultural physics and bacteriology. Especial attention has been given to providing facilities for research and instruction in agricultural physics and dairying.

The horticulture-physics building (Pl. VI, fig. 2), completed in 1896, is three stories in height and has a frontage of 78 feet by 60 feet in depth. "At the rear are glass houses covering a space of 88 by 75 feet. The right wing of the building, with its greenhouses, is devoted to plant life and horticulture. The left wing, with its large glass house, is devoted to instruction and investigation in the physics and mechanics of the farm." The course in agricultural physics includes meteorology, drainage, irrigation (Pl. VII, fig. 1), road building, construction of farm buildings, soil physics, and original investigations in the physical laboratory and field.

Hiram Smith Hall, a building with a frontage of 95 feet by 48 feet in depth and three stories in height is devoted entirely to dairying. "It contains an office, lecture room, reading room, dairy laboratory, and rooms devoted to creamery practice, cheese making, farm dairying, pasteurizing, cheese curing, etc." The student here has an opportunity to observe and take part in all the operations of farm and commercial dairying conducted with the most approved machinery and by the methods which have been found most successful in recent years. The course in dairying includes (1) lectures and class-room work under eight different professors and specialists, embracing the chemistry and bacteriology of milk and its products, breeding, selection, feeding, and management of dairy stock, heating, ventilation, and other physical problems connected with dairy practice, care and management of the boiler and engine, creamery management, and accounts; (2) milk testing or the estimation of the fat in milk, butter, and cheese by methods adapted to the factory and factory operatives; (3) butter making on the creamery plan, including the use of power centrifugal separators, the ripening of the cream, churning and packing butter, and, in general, practical work in all the operations of a modern creamery; (4) cheese making, including instruction in all the regular factory operations involved in the manufacture of Cheddar cheese. There are also opportunities for advanced studies in the chemistry and bacteriology of dairying and experimental investigations in butter and cheese making.

In Wisconsin the farmers' institutes are organized and conducted as a part of the university courses in agriculture. They are under the immediate charge of a superintendent who is an officer of the

college of agriculture. Members of the agricultural faculty assist in the institutes as far as their other duties will permit. Experts in different branches of agricultural science and practice from Wisconsin and other States are employed to give instruction on special topics. Above sixty institutes are held annually, and a selected portion of the material presented at the institutes is published each year in bulletin form in an edition of 60,000 copies, 8,000 of which are placed in the school district libraries of the State.

UNIVERSITY OF CALIFORNIA.

On the Pacific coast the University of California has played an important part in the agricultural development of that great region. This work has been very largely accomplished through the extensive and varied researches of the agricultural experiment station, which for more than a score of years has pursued its labors as a department of the university. In recent years it has become in a large way the policy of the State to concentrate the management of its agencies for the improvement of agriculture, horticulture, and forestry in the State university. Naturally in a State whose agriculture is so young and so flourishing comparatively few students have been found to pursue regular college courses in agriculture. The university has, however, provided ample facilities and thorough instruction for such students as have been qualified to undertake college work in this department. The requirements for admission to the four years' course in agriculture are English, algebra, geometry, civil government, physics, Latin or French or German, and two of the following subjects: Advanced mathematics, chemistry, botany, and zoology. "In the college of agriculture (Pl. VII, fig. 2) about two-thirds of the course is prescribed in preliminary, liberal, and technical studies. The remainder is distributed among free electives and electives consisting of agriculture and cognate studies." The university comprises the following departments of instruction: (1) At Berkeley, colleges of letters, social sciences, natural sciences, agriculture, mechanics, mining, civil engineering, and chemistry; (2) at Mount Hamilton, the Lick Observatory; (3) at San Francisco, the institute of art, college of law, two medical departments, colleges of dentistry and of pharmacy, and veterinary department. In 1897 the colleges at Berkeley reported faculties numbering 149 professors and assistants, and students numbering 1,498 men and women. The permanent endowments, buildings, and equipment were valued at $4,879,857 and the annual income was $326,212.

GENERAL STATUS OF AGRICULTURE IN STATE UNIVERSITIES.

In the universities in which courses in agriculture are maintained, it may be said in general that the tendency is to make the regular college courses in agriculture correspond in scope and thoroughness with those given in the other departments, to divide the instruction

in agriculture among an increasing number of specialists, and to provide buildings, apparatus, and illustrative material on a scale commensurate with those in other branches. At the same time there is increased effort to bring the university into close touch with the masses of farmers through special schools, farmers' institutes, nature teaching, and other forms of university extension work. Along with this is the deepening and strengthening of the scientific and practical researches carried on with a view to widening our knowledge of the facts, laws, and processes required for the improvement of agriculture. In a word, each year the universities are seeing more clearly that agriculture is an important human interest, rightfully claiming the best efforts of the most thoroughly trained minds for its advancement, and that on the basis of agriculture may be built a system of instruction in language, literature, mathematics, science, and technology which shall be well adapted to produce scholars, investigators, and leaders in industrial progress.

SOME FEATURES OF STUDENT LIFE IN STATE UNIVERSITIES.

The limits of this paper forbid more than a brief reference to the more general features of student life in the State universities. These do not differ materially, however, from what are found throughout the length and breadth of our land wherever college students are congregated. There is the same enthusiastic, and, in some respects, extravagant, devotion to athletics; there are the musical, literary, and social societies with more or less of clannishness and secrecy; there are the college papers and annuals in which some serious journalistic work is done, and in which humor and wit are more frequently attempted than realized. As these institutions are under the patronage of the State, there is less formal attention to the externals of religion, but in all of them there are stated religious observances and flourishing voluntary religious organizations. More and more the students are made subject to the moral and religious influences which pervade our best American communities, and in their college life are judged by the same moral standards as are men and women throughout the country.

In general, it may be said that the 30,000 young men and women pursuing courses of instruction in the land-grant institutions of the United States are, as a rule, leading earnest and serious lives, doing much severe mental work, enjoying the sports and social recreations of college life to the full, and preparing for careers of usefulness and leadership in the multitudinous occupations of our complex civilization. Our agriculture is every year feeling more fully the influence of the trained mind, and it is not easy to measure the benefits which may come to this branch of human activity when instruction and research shall have reached their full development in the institutions which have so rapidly been put in working order during the past quarter of a century.

FIG. 1.—CLASS SCORING PIGS, IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

FIG. 2.—DAIRY BACTERIOLOGY ROOM, IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

FIG. 1.—CHEMICAL LABORATORY, ALABAMA POLYTECHNIC INSTITUTE.

FIG. 2.—DAIRY BUILDING, CORNELL UNIVERSITY, NEW YORK.

FIG. 1.—TOWNSHEND HALL, OHIO STATE UNIVERSITY.

FIG. 2.—HORTICULTURAL-PHYSICS BUILDING, UNIVERSITY OF WISCONSIN.

FIG. 1.—A LESSON IN IRRIGATION IN HORTICULTURAL-PHYSICS BUILDING, UNIVERSITY OF WISCONSIN.

FIG. 2.—AGRICULTURAL HALL, UNIVERSITY OF CALIFORNIA.

NEW WORK IN THE WEATHER BUREAU.

By Willis L. Moore,
Chief of Weather Bureau.

During the past year the work of the Weather Bureau of the Department of Agriculture has been considerably expanded. The most important new lines of work have been as follows:

(1) Additional stations of observation in the arid and subarid West and in the principal cotton-producing regions of the South.

(2) The establishing of seventeen aerial meteorological stations.

(3) The inauguration of a tentative West Indian daily cablegraphic meteorological service.

THE ADDITIONAL STATIONS IN THE WEST AND SOUTH.

For several years it has been apparent that there was a lack of meteorological stations in the Rocky Mountain region; that the places of observation were so widely scattered as to render it possible to secure only an imperfect survey of the distribution of temperature and pressure, which conditions are so essential to the making of accurate forecasts, not only for that region, but for the extensive area lying farther east. Therefore, under an appropriation specifically made on the recommendation of the Secretary of Agriculture, stations have been established at Kalispell, Mont.; Boise, Idaho; Mount Tamalpais, Cal.; Flagstaff, Ariz., and Cedar City, Utah. Additional stations have also been established at Fort Worth, Tex.; Meridian, Miss.; Macon, Ga.; Lexington, Ky.; Elkins, W. Va.; Evansville, Ind., and Escanaba, Mich., and a climate and crop service is being established in the Territory of Alaska, with headquarters at Sitka.

It is known that the cold waves which cause frost in the fruit districts of California are due to high-pressure areas drifting southward from the Canadian Northwest Territories along the Rocky Mountain plateau, and that when these large masses of dry, clear air become central over Utah or Nevada, notwithstanding the fact that the whole eddy-like system is slowly moving southeastward, they push out from their centers a low layer of frosty air, which flows westward over the Sierra Nevada range into the interior basin of California. The extensive fruit industry of California will materially profit by the establishment of the first few of the additional stations above named, as these will enable the Bureau more accurately to measure the development and drift of the air conditions which at times become so destructive in California. Already the frost and rain warnings of the Bureau have, in the judgment of the raisin and other fruit growers themselves, been worth millions of dollars annually.

The stations recently established will not only assist in the development of the agricultural and industrial interests of the States in which they are respectively located, but they will be of material benefit in improving the weather warnings and forecasts for the regions lying both east and west of the Rocky Mountain plateau.

The section director of the climate and crop service of Wyoming, in cooperation with a special agent of the Office of Experiment Stations of the Department of Agriculture, has been directed to make a careful study of the precipitation at voluntary stations in mountain regions, with a view to determining the amount of snowfall at high levels. He has been directed to secure as many additional voluntary observers as possible, and, wherever the reports are especially desirable, to arrange for paid observers. It is desired to know if a uniform ratio exists between precipitation at moderate levels and precipitation on high mountain ranges. It is true that the amount of snowfall determines in a great measure the volume of water available for the purpose of irrigation during the crop-growing season. If the ratio between mountain snowfall and the precipitation at lower levels be always the same, it will, of course, be possible to determine the amount of snow by the precipitation measured at our many stations on low levels; but if the ratio be not constant, it is apparent that accurate measurements of precipitation should be made along the elevated zone that supplies the streams in summer. From this and similar investigations, it may be possible to make a fairly accurate estimate of the volume of water to be expected during each growing season. The subject is one that requires careful investigation, so that faulty conclusions be not reached.

Recently a tentative station was established on top of Mount Tamalpais, California. This peak rises abruptly to a height of 2,600 feet above sea level, at the entrance of San Francisco harbor. Observations at this level are, in most cases, above the fog common to this vicinity during a considerable portion of each year. They show some surprising results. Out of the fifteen cases in which rain fell in the interior valley of California, fourteen were preceded twelve to twenty-four hours by strong westerly gales at the mountain station, and as a rule marked changes of temperature east of the coastal and Sierra Nevada ranges were preceded many hours by changes at the top of the mountain; hence, it is deemed advisable to establish a permanent meteorological station on Mount Tamalpais. An observatory is now being erected which will be continuously occupied by trained observers. It is hoped that, as a result of these observations, the Bureau will be able to materially improve the character of its service in the region contiguous to San Francisco.

THE NEW AERIAL STATIONS.

About three years ago the development of the kite along mechanical lines was undertaken by the Weather Bureau. An artisan and a skilled mechanical engineer were assigned to this important duty.

They were also charged with the construction of an automatic meteorological instrument which would register pressure, temperature, wind velocity, and humidity, and yet not be too heavy to be carried by kites. They have succeeded fairly well in these undertakings, and to-day the Bureau constructs kites which, with favorable wind movement, will fly to a height of from 1 to 2 miles. The automatic meteorograph, for securing a registration of the air conditions at high levels, weighs but 2 pounds and 2 ounces.

During the past summer aerial stations have been established at the following cities: Washington, D. C.; Knoxville, Tenn.; Memphis, Tenn.; Cincinnati, Ohio; Lansing, Mich.; Saulte Ste. Marie, Mich.; Duluth, Minn.; Dubuque, Iowa; Omaha, Nebr.; North Platte, Nebr.; Pierre, S. Dak.; Dodge City, Kans.; Topeka, Kans.; Fort Smith, Ark.; Cairo, Ill.; Springfield, Ill., and Cleveland, Ohio.

At these stations daily observations at heights ranging from 1,000 to 7,000 feet are regularly secured, and a considerable amount of meteorological data collected which will be used in the study of important meteorological problems. This is the first time in the history of meteorological science that such an extensive system of observations has been maintained at great altitudes in free air. It is hoped that a considerable addition to our knowledge of storms and weather will result. By these observations we shall, among other things, arrive at a more correct knowledge of the vertical distribution of temperature during the passage of rain storms and cold waves. This knowledge is especially important in our efforts to secure a more accurate system of reducing barometric readings to sea level.

The vertical distribution of pressure and temperature and the horizontal gradients of pressure and temperature at some considerable elevation above the surface of the earth are important information for the use of our forecasters in making accurate storm warnings. It is yet to be determined whether or not a sufficient number of flights to high levels can be secured simultaneously at many stations to justify the use of the kite in taking observations to be used in making daily maps and forecasts. This can not be determined until a thorough test is made during actual atmospheric conditions in the late fall, winter, and early spring.

THE INAUGURATION OF A TENTATIVE WEST INDIAN CABLEGRAPHIC SERVICE.

A study of a long series of international observations and of observations taken on shipboard has rendered it possible to accurately determine the region of formation of the storms known in this country as West Indian hurricanes. These are the most destructive storms that approach our continent. The successful warning of one storm may be worth several millions of dollars to the marine interests of the United States. At the time when our Navy was maneuvering in the West Indies, it became especially important that every advantage

known to meteorological science be made use of for the purpose of forewarning our fleet against disaster from storms. This was the motive that induced Congress to place at the disposal of the President of the United States $75,000, to be expended in initiating and maintaining a complete West Indian weather service. However, the great commerce of this region is alone sufficient to justify this country in maintaining such a service permanently for the benefit of our ocean navigators.

Some years ago Mr. Maxwell Hall, of Kingston, Jamaica, an energetic English scientist, journeyed to England for the purpose of inducing his Government to assist him in establishing such a service as the United States now has in operation.

For several years past the Weather Bureau has received meteorological reports during a part of the year from native observers at Havana, Kingston, St. Thomas, and Santiago. These observations, although so widely scattered as to give but an imperfect survey of the atmospheric conditions, were often sufficient to enable the Weather Bureau to detect the early approach of hurricanes and to warn the commerce of our South Atlantic coast; but the information received from these stations was insufficient to enable the Bureau to give warnings to the ports of the West Indies.

Acting under the President's directions, the Secretary of Agriculture instructed the Chief of the Weather Bureau to install complete meteorological stations at such places in Cuba, Jamaica, Santo Domingo, St. Thomas, St. Kitts, the Windward Islands, and the north coast of South America as would enable the Bureau to fully forewarn the commerce of this extensive region of the coming of hurricanes. The Secretary's order was that the vessels of all nations should receive the benefit of the information precisely as they have in our own ports for many years past.

In accordance with the foregoing directions the Weather Bureau inaugurated such a service. Early in July, for the first time in the history of practical meteorology, a daily synoptic chart of the West Indies was constructed. Since that time such a chart has been compiled twice daily. The area covered by these observations is equal to that of the United States, although the greater part of the region is covered by water, and the stations are not, therefore, placed as close together as might be desired.

In the benefits derived from extending the Weather Bureau system to the West Indies the commerce of all countries shares equally with that of the United States. While others have stood back and waited for a more progressive nation and a more feasible opportunity, the United States, spurred on by the necessities of war, extended to this vast region one of the most beneficent services that science is able to render the mariner.

The new service soon had opportunity to demonstrate its utility.

The approach of the hurricane which created such destruction in the Windward Islands on Sunday night, September 11, 1898, was discerned on the previous day. At 8 a. m. on Saturday morning observations on the islands of Martinique and Trinidad gave slight indications of a disturbance southeast of the Windward Islands. At 12.40 p. m. a special observation taken at Barbados indicated a fall of nearly one-tenth of an inch in the barometer during the preceding two hours. This movement of the barometer at Barbados, taken in connection with the atmospheric survey of the whole West Indies, made four hours previous, satisfied the forecast officer that a hurricane would soon develop over the Windward Islands, although to the nonexpert there were no indications of a coming storm.

Hurricane warnings were immediately dispatched to all ports in the islands of Barbados, Martinique, St. Thomas, and St. Kitts, and they were advised to prepare for a destructive storm. They were informed that the hurricane would move from a point south of Barbados, and that it would travel slowly northwesterly, with wind increasing to a hurricane velocity. Cable communication was perfect, and the warnings were promptly received. Advisory messages were sent to Colon, Curaçao, Santo Domingo, Trinidad, and Santiago. A message was also sent to Admiral Watson's fleet, lying in the harbor of Caimanera, Cuba.

How completely these warnings were verified by the coming of the storm twenty-four hours hence was shown by the press dispatches a few days later. While the destruction of life and property was great, there is no question but that hundreds, if not thousands, of lives and millions of property were saved by reason of the complete warnings given by the United States. These warnings were of benefit to the commerce of all nations. Aside from the saving in human life, they have, from a financial and commercial standpoint, fully justified the President in asking for the necessary appropriation and in personally directing the inauguration of a complete and efficient meteorological service.

LOSS OF FARM PROPERTY BY LIGHTNING.

In order to determine the frequency of lightning stroke and the amount of property that is destroyed annually by that agency, the Weather Bureau has undertaken to collect, through the cooperation of agents and adjusters of farmers' mutual insurance associations and many private persons, statistics of loss to farm property, including live stock in the fields. The data so collected will, in the course of time, afford means of determining an equitable rate on lightning risks.

The impression that there has been a perceptible increase in the number of storms and of fatalities by lightning stroke within a comparatively short period is more or less prevalent in some States, and

this view is also held by insurance companies which include lightning risks in their business. The statistics that have been adduced thus far in support of the hypothetical increase are far from convincing. It might easily happen that a short term of years taken at random would show a much greater number of cases of lightning stroke than a corresponding number of years at some other time. In order to arrive at a satisfactory conclusion as to the relative frequency of lightning stroke in the various States and Territories it will be necessary to collect observations for at least twenty years. It will also be necessary to secure accurate returns of the number of insured buildings in the several States and Territories for each year covered by the statistics of damage by lightning stroke.

There is undoubtedly a very great variation in the number of destructive lightning strokes from one year to another. A single illustration is given in the subjoined table, the values of which have been compiled from the annual reports of the commissioner of insurance for Michigan. The number of lightning strokes given in the table does not by any means represent the total number of cases of damage that occurred in that State during the years mentioned. There must have been many cases of damage by lightning not covered by insurance, all of which are necessarily omitted from the table.

Property loss in Michigan by lightning.

Year.	Number of cases.	Loss.	Year.	Number of cases.	Loss.
1883	348	$38,466	1890	540	$58,086
1884	No record.		1891	No record.	
1885	332	43,916	1892	No record.	
1886	305	42,745	1893	No record.	
1887	208	22,201	1894	697	76,423
1888	255	23,129	1895	316	37,593
1889	102	21,745	1896	1,509	143,841

THE DANGER OF INTRODUCING NOXIOUS ANIMALS AND BIRDS.

By T. S. Palmer,
Assistant Chief of Biological Survey.

INTRODUCTION.

Acclimatization of plants and animals has attracted attention in all parts of the world. Useful or curious species have been introduced from one country to another with varying degrees of success; some have failed while others have become acclimated, and occasionally have increased to such an extent as to usurp the places of native species. In comparing the results of the introduction of plants and of animals, the important difference between these two classes of experiments should not be lost sight of. Plants, on the one hand, are introduced almost without exception for purposes of cultivation, and are therefore kept somewhat under control. Occasionally, under favorable conditions, they "escape" and increase so rapidly that they become troublesome weeds. Chicory and wild garlic of the Eastern States and the water hyacinth of Florida are familiar examples of weeds originally introduced as useful or ornamental plants. Animals, on the contrary, unless intended for pets or for exhibition in menageries or zoological gardens, are seldom kept in captivity, but are liberated and allowed to live as nearly as possible under natural conditions. Only the strongest and hardiest species survive, and in adapting themselves to new surroundings necessarily cause some change in the existing fauna. If prolific, they are likely to become abundant in a short time; if they crowd out indigenous species, they are regarded as nuisances. Hence, it is sometimes said that acclimatization of animals has produced far less satisfactory results than that of plants, but the comparison is made between the relatively small number of animals, birds, and insects purposely imported and allowed to run wild and a long list of useful and ornamental plants carefully kept under cultivation.

MEANS OF DISPERSAL.

Animals are transported from one country to another or to distant islands either by accident or by the direct agency of man. Horses, cattle, sheep, goats, pigs, dogs, and cats are now almost cosmopolitan, but they owe their wide distribution entirely to man, who has carried them with him to all parts of the earth. Accidental distribution is

much less common in the case of mammals and birds than among the smaller plants and insects, and species which have gained a foothold in distant lands have almost always been intentionally introduced.

Certain small mammals have, however, accidentally found their way in vessels from one port to another. Two or three species of rats and the house mouse of Europe have thus become widely dispersed over the globe. Fruit vessels plying between ports of the United States and Central or South America occasionally bring snakes, small mammals, and insects in bunches of bananas. In November, 1895, a Central American mouse, of the genus *Oryzomys*, concealed in a bunch of bananas shipped from Puerto Limon, Costa Rica, was captured alive in a commission house in Washington, D. C. A young murine opossum from tropical America was discovered in a bunch of bananas at Ames, Iowa, during the summer of 1882, and was kept alive for some time. If such cases were frequent, it can be readily seen how a species might gain a foothold in new regions, provided the conditions were favorable for its increase.

During the last fifteen or twenty years Bering Island, one of the Commander group in Bering Sea, has been overrun with the common Siberian red-backed mouse (*Evotomys rutilus*). This species was formerly unknown on the islands, but has been introduced since 1870, probably in firewood brought from Kamchatka. Within ten years it spread all over the island from the beaches to the mountains in the interior. It occurs both in the swamps and on the sand dunes, and has become a pest in the huts of the natives. In 1889 it was still confined to Bering Island, but will probably reach Copper Island in time.

DOMESTICATED SPECIES MAY BECOME NOXIOUS.

Domesticated animals, like cultivated plants, may run wild and become so abundant as to be extremely injurious. Wild horses are said to have become so numerous in some parts of Australia that they consume the feed needed for sheep and other animals, and hunters are employed to shoot them. In some of the Western States they have also become a nuisance, and in Nevada a law was passed in 1897 permitting wild horses to be shot. Recent reports from Washington indicate that cayuses are considered of so little value that they are killed and used for bait in poisoning wolves and coyotes.

Pigs have run wild in some of the Southern States and also on certain islands, where, as on the Galapagos, they were originally introduced to furnish food for crews of vessels in need of fresh meat. According to Dr. Finsch,[1] they were introduced into New Zealand by Captain Cook about 1770, and soon becoming wild, increased to a remarkable degree. A century later wild pigs were so abundant in the flax thickets of the province of Taranaki, on the North Island,

[1] Globus, LXIX, 1896, Nr. 2.

that a hunter could shoot fifty in a single day. Dr. Finsch also cites a case mentioned by Hochstetter in which 25,000 wild pigs were said to have been killed by three hunters in less than two years.

Sheep and goats when numerous are likely to cause widespread injury, particularly in forested regions. An instructive example of the damage done by goats is that on St. Helena, described by Wallace.[1] St. Helena is a mountainous island scarcely 50 square miles in extent, and its highest summits reach an elevation of 2,700 feet. At the time of its discovery, about the beginning of the sixteenth century, it is said to have been covered by a dense forest; to-day it is described as a comparatively barren rocky desert. This change has been largely brought about by goats first introduced by the Portuguese in 1513, and which multiplied so fast that in seventy-five years they existed by thousands. Browsing on the young trees and shrubs, they rapidly brought about the destruction of the vegetation which protected the steep slopes. With the disappearance of the undergrowth, began the washing of the soil by tropical rains and the destruction of the forests. In 1709 the governor reported that the timber was rapidly disappearing and that the goats should be destroyed if the forests were to be preserved. This advice was not heeded, and only a century later, in 1810, another governor reported the total destruction of the forests by the goats, and in consequence an expense of $13,600 (£2,729) in one year for the importation of fuel for Government use.

The Santa Barbara Islands, off the coast of southern California, and the island of Guadalupe, off the Lower California coast, are utilized as ranges for goats. All these islands are dry and more or less covered with brush, but arborescent vegetation is comparatively scarce. The goats practically run wild, and already exist in considerable numbers. On Santa Catalina, one of the Santa Barbara group, wild-goat hunting is one of the diversions afforded tourists, and is considered one of the principal attractions of this popular summer resort. As yet the goats have not been on the islands long enough to cause any serious effects on the vegetation, and they may never bring about the ruin which has been wrought on St. Helena. But it is scarcely possible for the islands to be grazed by goats for an indefinite length of time without suffering serious damage.

House cats are often greater pests than commonly supposed. When numerous about the suburbs of cities and towns, they are apt to forage for a living either from necessity or choice, and their food is by no means confined to rats and mice. They are constantly on the watch for birds, but it is impossible even to estimate how many they destroy. It is certain, however, that in some places the decrease in native birds is largely due to their presence. Where cats have run wild on isolated islands, their work can be more readily appreciated. On Sable Island, off the coast of Nova Scotia, they were

[1] Island Life, 1880, pp. 283–286.

introduced about 1880 and rapidly exterminated the rabbits, which had been in possession of the island for half a century. In one of the harbors of Kerguelen Island, southeast of the Cape of Good Hope, cats were allowed to run wild upon a little islet known as Cat Island, which has been used as a wintering place for sealers for many years. Here they live in holes in the ground, preying upon sea birds and their young, and are said to have developed such extraordinary ferocity that it is almost impossible to tame them even when captured young. Dr. W. L. Abbott states that on Aldabra, about 200 miles northwest of Madagascar, cats are common on the main island, and have completely exterminated the flightless rail (*Rougelius aldabranus*), an interesting bird, peculiar to this group of islands. They are also numerous on Glorioso Island, 120 miles to the southeast, and in consequence birds are less common even than on Aldabra.[1]

The Chatham Islands, 500 miles east of New Zealand, were colonized about fifty years ago; cats, dogs, and pigs were introduced, and the native birds, represented by fifty-five species, including thirteen not found elsewhere, have since greatly decreased in numbers. Two of the most interesting birds are land rails of the genus *Cabalus*. Dr. Dieffenbach, naturalist of the New Zealand Company, who visited the islands in 1840, states that one of these rails (*Cabalus dieffenbachi*), called by the natives "meriki," was formerly common, but since the introduction of cats and dogs it has become very scarce. It is now probably extinct, and the closely related species *C. modestus* will doubtless soon suffer a similar fate, since the islet of Mangare, to which it is confined, has recently been invaded by cats.[2]

SOURCES OF DANGER FROM NOXIOUS SPECIES.

The animals and birds which have thus far become most troublesome when introduced into foreign lands are nearly all natives of the Old World. The mammals belong to three orders: (1) Rodents, including rats of two or three species, the house mouse, and rabbit of western Asia or southern Europe; (2) Carnivores, represented by the stoat, weasel, and common house cat of Europe, and the mongoose of India; (3) Cheiroptera, represented by large fruit-eating bats or flying foxes of Australia and the Malay Archipelago. Flying foxes have not yet been actually introduced, but are likely to be carried to different islands in the Pacific, and are dangerous because of their depredations on fruit. The birds comprise the house sparrow and starling of Europe, and the mina of India. Other species, usually regarded as beneficial in their native homes, such as the European skylark, green linnet, black thrush or blackbird, and the great titmouse or kohlmeise, are likely to prove injurious in new surroundings. Most of these species have extended their range from the east

[1] Proc. U. S. Nat. Mus., XVI, 1891, pp. 762, 764.

[2] Forbes, Ibis, 6th ser., V, 1893, pp. 523, 531–533.

toward the west, although the minas have been carried in the opposite direction to New Zealand and the Hawaiian Islands, and flying foxes are likely to extend northward and eastward. The main danger for the United States lies in species native to central and southern Europe and western Asia, but tropical species, particularly of India, might become acclimated in the Southern States. In order to show how these animals and birds have already spread, and the damage they have done, it will be necessary to refer briefly to the history of each species.

RATS AND MICE.

Rats and mice are among the greatest pests with which man has to contend, and the annoyance and damage which they occasion are beyond computation. They are ubiquitous, abundant alike in the largest cities and on the most distant islands of the sea. They have not been intentionally introduced anywhere, but have found their way by means of vessels to all parts of the earth. Small islands, populated with rats from wrecks, or otherwise, are occasionally overrun by these animals. On the island of Aldabra, already mentioned, rats fairly swarm, and are very destructive to the gigantic native land tortoise, eating the young as soon as they are hatched. Sable Island, off the coast of Nova Scotia, has suffered from several plagues of rats, and it is said that the first superintendent of the light station and his men were at one time threatened with starvation owing to the inroads made on their stores by rats.

The common brown rat.—The common brown rat, known also as the wharf rat and Norway rat (*Mus decumanus*), was originally a native of western China,[1] and until two hundred years ago was unknown in Europe or America. It is very prolific, producing from four to twelve young at a birth several times a year, and has spread so rapidly that at the present time it is nearly cosmopolitan. In the autumn of 1727 large numbers of brown rats entered Europe by swimming across the Volga, and, gaining a foothold in the province of Astrakan in eastern Russia, spread westward over central Europe. Five years later (1732) they reached England by vessels from western India. The brown rat appeared in east Prussia about 1750, and in Denmark and Switzerland in 1809. It reached the eastern coast of the United States about 1775, and in 1825, according to Sir John Richardson, had extended as far west in Canada as Kingston, Ontario. By 1855 it was abundant at several points on the Pacific coast, including San Francisco, Cal.; Astoria, Oreg., and Steilacoom, Wash., and its range on the west coast now extends as far north as Alaska, at Sitka, Kadiak, and even Unalaska.

[1] Blanford (Mammals of India, 1888–1891, p. 409), who gives Chinese Mongolia as its probable original habitat, states that it is not indigenous to India, and is unknown in Persia and Afghanistan, but suggests that it will probably be introduced into the two latter countries as soon as wheeled vehicles take the place of pack animals.

At the present time it is probably abundant in all the larger cities of the United States except in the South, where it is replaced by another species.

The black, or house, rat.—The black rat, or house rat (*Mus rattus*), was in all probability originally a native of Asia. The time of its introduction into Europe is uncertain, but in the middle ages it was the common house rat of central Europe. The date of its introduction into the New World is placed as early as 1544, or more than two hundred years previous to that of the brown rat. It evidently became very generally distributed along the coasts and in the principal seaports, and by the middle of the present century was known as far north as Halifax and Montreal, Canada, and on the Pacific coast at San Diego and Humboldt Bay, California. Since the introduction of the brown rat, the black rat has become comparatively rare in most places where the former is abundant. In the Laccadive Islands, in the Indian Ocean, the black rat seems to have modified its habits and become arboreal. It is said to live in the crowns of the cocoanut trees without descending to the ground, and to do great damage by biting off the nuts, upon which it feeds, before they are ripe.

The roof, or white-bellied, rat.—The roof rat, or white-bellied rat (*Mus alexandrinus*), is a native of Egypt, Nubia, and northern Africa, and evidently found its way to America by way of Italy and Spain at an early date. It probably reached this continent long before the brown rat, but the exact date of its arrival is uncertain. It is common in Brazil, in some parts of Mexico, and in the southern United States, and is known to occur at least as far north as the Dismal Swamp, in southern Virginia.

The house mouse.—The well-known house mouse (*Mus musculus*) is readily distinguished from the native white-bellied mice of North America by its nearly uniform brownish color above and below. It is a native of Europe and central Asia, but now occurs all over the world. In the United States it is found from Florida to Maine, and from San Diego to the Pribilof Islands. It is not restricted to the seaports, as it made its way inland at an early date. Sir John Richardson, in 1829, mentions having seen a dead mouse in the storehouse of the Hudson Bay Company, at York Factory, among packages of goods brought over from England, and states that the house mouse was introduced at Engineer Cantonment, on the Missouri River, near Council Bluffs, Iowa, by Long's Expedition in 1819–20. By 1855 it was found at many points in the interior, such as Prairie Mer Rouge, La.; Fort Riley, Kans.; Fort Pierre, S. Dak.; Fort Redding, Cal., and Parras, Coahuila, Mexico. It has even penetrated to such points as the Huachuca Mountains in Arizona, where it was introduced about 1891 in a wagonload of seed grain. It reached Bering Island, one of the Commander group off Kamchatka, in 1870, in a cargo of flour shipped from San Francisco in the schooner *Justus*. In the southern

MONGOOSE (HERPESTES MUNGO).

hemisphere it occurs at Punta Arenas, Patagonia, and is common in such out-of-the-way places as Gough Island, in the middle of the South Atlantic, and Kerguelen Island, southeast of the Cape of Good Hope. In short, its distribution is apparently limited only by the Arctic and Antarctic circles.

RABBITS.

The common rabbit of Europe (*Lepus cuniculus*) was originally introduced into Australia for purposes of sport, and the results of the experiment are so well known that anything more than a brief reference to them is unnecessary. Suffice it to say that the rabbits were liberated near Melbourne about 1864, and by 1878 had extended westward over Victoria and beyond the Murray River. They were also introduced into Tasmania and New Zealand, and spread over the country like a scourge. So rapidly did they multiply that in 1879 legislative action for their destruction was begun in South Australia, and the example was soon followed by New South Wales, New Zealand, Queensland, and Tasmania. At the present time their range in Australia is probably equal in area to that of our three largest States—Texas, California, and Montana. Millions of dollars have been spent for bounties, poisons, and various other methods of destruction; thousands of miles of rabbit-proof fences have been built, and hundreds of schemes for destroying the animals have been suggested, but nothing has yet been found that will effectually exterminate the pest. Natural enemies, such as cats and other carnivorous animals, have been introduced, and in certain parts of New Zealand at least have become almost as much a pest as the rabbits they were intended to kill. In 1887 no less than 19,182,539 rabbits were destroyed in New South Wales alone, but despite the efforts of the Government and private landowners the rabbits seem to be still increasing. In the meantime, a great industry has grown up in the export of rabbit skins. For the last five years New Zealand has been shipping an average of about 15,000,000 per annum, and since 1873 has exported more than 200,000,000. Recently, canning rabbit meat for export to European markets is assuming larger proportions and gives promise of developing into an important industry.

THE MONGOOSE.

The common mongoose of India (*Herpestes mungo* or *H. griseus*, Pl. VIII) is a well-known destroyer of rats, lizards, and snakes, and has been introduced into Jamaica and other tropical islands for the purpose of ridding cane fields of rats. The annual loss which the island of Jamaica formerly suffered on account of the ravages of the introduced black rats (*Mus rattus*) and brown rats (*M. decumanus*), and the so-called "cane-piece rat," including the expense of destroying these pests, was estimated at £100,000, or $500,000. Various remedies were

tried, but apparently with little success, until in February, 1872, Mr. W. Bancroft Espeut introduced nine individuals of the mongoose, four males and five females, from India. These animals increased with remarkable rapidity, and soon spread to all parts of the island, even to the tops of the highest mountains. A decrease in the number of rats was soon noticeable, and in 1882, ten years after the first introduction, the saving to the sugar planters was said to be £45,000, or $225,000, per annum.

Still the mongoose increased, and its omnivorous habits became more and more apparent as the rats diminished. It destroyed young pigs, kids, lambs, kittens, puppies, the native "coney," or capromys, poultry, game, birds which nested on or near the ground, eggs, snakes, ground lizards, frogs, turtles' eggs, and land crabs. It was also known to eat ripe bananas, pineapples, young corn, avocado pears, sweet potatoes, cocoanuts, and other fruits. Toward the close of the second decade the mongoose, originally considered very beneficial, came to be regarded as the greatest pest ever introduced into the island. Poultry and domesticated animals suffered from its depredations, and the short-tailed capromys (*Capromys brachyurus*), which was formerly numerous, became almost extinct except in some of the mountainous districts. The ground dove (*Columbigallina passerina*) and the quail dove (*Geotrygon montana*) became rare, and the introduced bobwhite, or quail, was almost exterminated. The peculiar Jamaica petrel (*Æstrelata caribbæa*), which nested in the mountains of the island, likewise became almost exterminated. Snakes, represented by at least five species, all harmless, and lizards, including about twenty species, were greatly diminished in numbers. The same thing was true of the land and fresh-water tortoises and the marine turtle (*Chelone viridis*), which formerly laid its eggs in abundance in the loose sand on the north coast. The destruction of insectivorous birds, snakes, and lizards was followed by an increase in several injurious insects, particularly ticks, which became a serious pest, and a Coccid moth, the larvæ of which bore into the pimento trees. In 1890 a commission was appointed by the Government to consider whether measures should be taken to reduce the number of the animals, and the evidence collected showed conclusively that the evil results of the introduction of the mongoose far outweighed the benefits rendered to the sugar and coffee plantations.

Recently there has been a change in the situation, and the mongoose is now reported as decreasing, while certain birds and reptiles, particularly the ground lizard, are increasing. Quail and pigeons are reported as more numerous, and there is less complaint concerning the destruction of poultry. Thus, Jamaica seems to have passed the high-water mark of loss occasioned by rats and by the mongoose, and while its fauna has been modified by the presence of the intruders, both native and introduced species are gradually accommodating

themselves to the changed conditions, and a new balance of nature is being established.[1]

According to Mr. Espeut,[2] who originally introduced the mongoose into Jamaica, large numbers of the animals have been sent to Cuba, Puerto Rico, Grenada, Barbados, Santa Cruz, and elsewhere, but the fate of these shipments, made at least sixteen years ago, is now unknown. It is now established on Haiti, as shown by the capture of a specimen at Santo Domingo City in the winter of 1895,[3] and is generally distributed over the island of Puerto Rico. It is also present on the island of Vieques, east of Puerto Rico, and is abundant on St. Thomas. During a recent visit Mr. A. B. Baker found it along the coast of Puerto Rico at Arecibo, San Juan, Fajardo, Arroyo, Ponce, and Mayaguez, and in the interior at Utuado and Adjuntas. It was introduced at San Juan about 1877–79, and although now becoming a nuisance, is considered beneficial by the sugar planters who claim that the rats, which were formerly very destructive to cane, now do little damage. These rats often live in the tops of the royal and cocoa palms and destroy cocoanuts as well as sugar cane.

The first efforts to introduce the mongoose into the Hawaiian Islands were made about 1881, when a few individuals of a large species were brought from the East Indies and liberated on a sugar plantation in the district of Hamakua on Hawaii. These animals did not breed and soon disappeared. A few months later a few pairs of a smaller species were imported from Calcutta, but nearly all were accidentally drowned while being landed near Hilo. Soon afterwards 75 individuals were imported from Jamaica by the planters of Hilo, and later 215 more were imported for Hamakua. Here the mongoose is aiding in the rapid extermination of some of the native birds, particularly the Hawaiian goose (*Nesochen sandvicensis*), which is found only on those islands above an altitude of 4,000 feet, and the Hawaiian duck (*Anas wyvilliana*), also a peculiar species. According to Mr. H. W. Henshaw this duck was common about Hilo four years ago, but in 1898 none were left anywhere in this region. As in Jamaica, the depredations of rats in the cane fields diminished with the increase of the mongoose, but the latter soon became so abundant that measures became necessary to keep it under control. In 1892 a law was passed forbidding the introduction, breeding, or keeping of the mongoose in the islands, and the sum of $1,000 was appropriated for the payment of bounties on animals killed on the island of Oahu. These rewards, not to exceed 25 cents per head, were to be paid by the Minister of the Interior, but apparently no applications were made for them, the animals being regarded as a necessary evil in the sugar-cane districts.

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[1] See Duerden, Journ. Inst. Jamaica, II, 1896, pp. 273–275.

[2] Proc. Zool. Soc., London, 1882, p. 714.

[3] Elliott, Field Columbian Mus., Zool. Ser., I, 1896, p. 82.

Attempts at introduction in other countries have not succeeded so well. The mongoose was introduced into the Fiji Islands, probably about 1870, but apparently has not increased to the extent to which it has in Hawaii. Early in the eighties several experiments were made in Australia, which resulted in failure. More than a hundred individuals were liberated near the Murray River, and others in New South Wales. An experiment was also made in New Zealand, but apparently without much success.[1] In February, 1892, it was erroneously reported that the Department of Agriculture was about to introduce the mongoose into the United States for the purpose of destroying gophers in the West. Although founded on a mistake, and speedily corrected, the rumor was so well heralded by the press that it attracted widespread attention. Persons who were familiar with the situation in Jamaica and Hawaii protested vigorously against the supposed experiment. Others, ignorant of the animal's past record and anxious to try some new method of exterminating gophers, prepared to obtain specimens from Honolulu. By the most strenuous efforts these importations were prevented, and as yet the mongoose is not known to have gained a foothold on this continent.

FERRETS, STOATS, AND WEASELS.

In the attempt to check the rabbit pest in New Zealand, recourse has been had to the importation of natural enemies, such as ferrets, stoats (*Putorius ermineus*), and weasels (*P. nivalis*). In the Wairarapa district some 600 ferrets, 300 stoats and weasels, and 300 cats had been turned out previous to 1887. Between January, 1887, and June, 1888, contracts were made by the Government for nearly 22,000 ferrets, and several thousand had previously been liberated on Crown and private lands. Large numbers of stoats and weasels have also been liberated during the last fifteen years. This host of predatory animals speedily brought about a decrease in the number of rabbits, but its work was not confined to rabbits, and soon game birds and other species were found to be diminishing. The stoat and the weasel are much more bloodthirsty than the ferret, and the widespread destruction is attributed to them rather than to the latter animal. Now that some of the native birds are threatened with extermination, it has been suggested to set aside an island along the New Zealand coast where the more interesting indigenous species can be kept safe from their enemies and saved from complete extinction.

FLYING FOXES, OR FRUIT BATS.

On August 4, 1893, the steamer *Monowai* from Australia arrived at San Francisco, having on board a fruit-eating bat, or flying fox. The animal had taken refuge on the steamer off the coast of Australia,

[1] Final Rept. Royal Comm. Inquiry Exterm. Rabbits Australasia, 1890, p. 9.

and was captured and kept as a pet by one of the passengers. It was promptly killed by the quarantine officer at San Francisco, and four more, which arrived in captivity two months later from China, on the steamer *Rio de Janeiro*, met the same fate. Attention was called to the danger of the new pest, and one of the regulations adopted by the State board of horticulture in the following year prohibited the importation of these animals into California.

Flying foxes belong to the genus *Pteropus* (fig. 1), one of the best-known groups of fruit-eating bats. The genus includes some fifty species which are found in the tropics of the Old World, from Madagascar and the Comoro Islands east to Australia, and the Samoan Islands, and north to India, Malay Archipelago, and southern Japan. Five species occur in Australia, two of them as far south as New South Wales (lat. 35° S.), but none are found in New Zealand or in the Hawaiian Islands. The largest species is the Kalong or Malay fruit bat (*Pteropus edulis*), which measures more than 5 feet across the tips of the wings.

FIG. 1.—Flying fox (*Pteropus* sp., redrawn from Proceedings Zoological Society, London, 1874).

In Australia these bats are described as living in immense communities or "camps" in the most inaccessible parts of the dense scrub of gullies and swamps. Here they may be seen by thousands, frequently crowded so thickly on the trees that large branches are broken by their weight. They fly considerable distances in search of food, sallying forth in flocks about sunset and returning to their camps before dawn. In New South Wales, and more especially in Queensland, flying foxes are one of the worst pests of the fruit grower, and are described as a plague which threatens the fruit-growing industry in a large part of Australia. They are particularly injurious to figs, bananas, peaches, and other soft fruit, and it is estimated that the damage done to orchards in the coast district of New South Wales amounts to many thousands of pounds annually. Various expedients have been suggested to protect orchards from their depredations. Rags dipped in melted sulphur and hung among the branches, netting placed over the trees, and wires suspended around the trees, and even stretched close together from poles and covering the whole orchard have been tried, but apparently without much success. The most practical method is to destroy the bats in their camps. A few years ago the Minister for Mines and Agriculture for New South Wales supplied

ammunition for this purpose and, after considerable expenditure of powder and shot, about 100,000 foxes were destroyed at a cost of about 30 cents apiece. Wholesale destruction with dynamite was suggested and experiments with high explosives were made by the department of agriculture. Charges of roburite (1 to 4 pounds) and gun cotton (2¼ pounds), connected with wires so that they could be fired by an electric current, were placed in the branches of trees where the bats were accustomed to roost. The bats carefully avoided the trees in which explosives were hung, and when the charges were fired none were killed, even among those roosting in neighboring trees.[1]

Since nearly all the species of flying foxes are natives of the Tropics, it is hardly likely that they could gain a foothold in the United States, except in the South, but there is a serious danger of their introduction into the Hawaiian Islands by means of vessels plying between Honolulu and the Orient, the South Sea Islands, and Australia.

THE ENGLISH SPARROW.

The house sparrow, better known in America as the English sparrow (*Passer domesticus*), is a common bird of north central Eurasia. It is said to range as far north as latitude 67° in Europe and to latitude 61° in Asia. The damage which it does in destroying fruit and grain, in disfiguring buildings in cities and towns, and in driving away other birds, makes it one of the worst of feathered pests. The rapidity with which it increases in a new locality is scarcely more remarkable than the persistency and care which have been displayed in introducing it into foreign lands, in spite of the warnings of persons familiar with its habits. It has gained a foothold on all of the continents, and has been transported to some of the most distant islands in the Indian and Pacific oceans. In North America it has not increased very rapidly north of the Transition zone nor in the Lower Austral, but wherever it has become at all abundant efforts to exterminate it have been practically futile.

The English sparrow was first introduced into the United States by a gentleman of Brooklyn, N. Y., who brought over eight pairs from Europe in the fall of 1850 and liberated them in the following spring. These birds did not thrive, and in 1852 a second importation was made. In 1854 and 1858 the sparrow was introduced at Portland, Me., and in the latter year at Peacedale, R. I., and a few birds escaped at Boston, Mass. During the next decade it was imported direct from Europe to eight other cities, and in one case 1,000 birds were sent to Philadelphia in a single lot; birds were also distributed from the colonies already started in this country. By 1870 it had become established as far south as Columbia, S. C., Louisville, Ky., and Galveston, Tex.; as far west as St. Louis, Mo., and Davenport, Iowa, and as far north as Montreal, Canada, thus gaining a

[1] Agr. Gazette, New South Wales, 1, 1890, p. 105.

foothold in twenty States, the District of Columbia, and two provinces in Canada.

Between 1870 and 1880 it was estimated that its range had been extended by nearly 16,000 square miles, and isolated colonies were established at San Francisco (1871–72) and Salt Lake City, Utah (1873). During the next five years it spread over more than 500,000 square miles, and in 1886 had become established in thirty-five States and five Territories, occupying practically all of the region east of the Mississippi River (except portions of Florida, Alabama, and Mississippi), as well as parts of eight States in the West. Its range was estimated to cover 1,033,000 square miles, including 148,000 square miles in Canada.

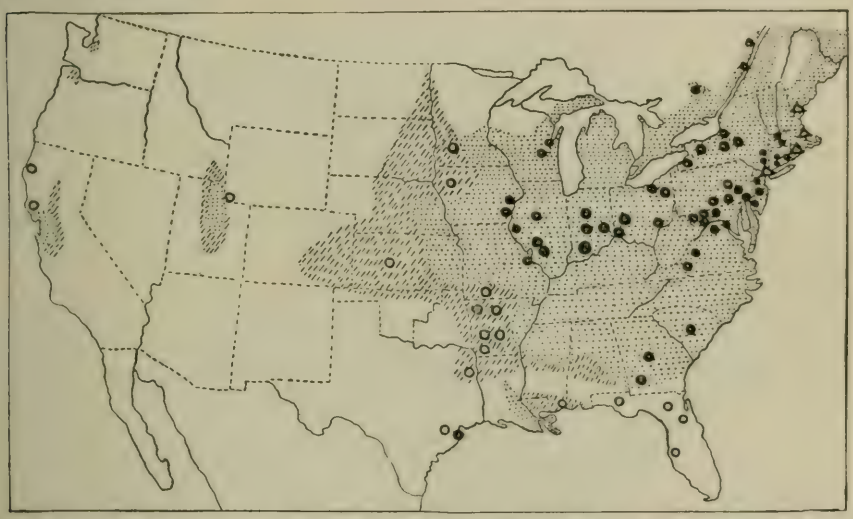

FIG. 2.—Map showing spread of English sparrow in the United States: The entire shaded area represents approximately the present distribution of the sparrow; triangles indicate colonies in 1860; black spots, colonies in 1870; circles, isolated colonies in 1886; dotted area, range in 1886; lined area, extension of range up to end of 1898.

At the present time (1898) only three States (Montana, Nevada, and Wyoming) and three Territories (Alaska, Arizona, and New Mexico) are apparently free from the sparrow. Its range extends westward to the Great Plains and in Colorado to the Rocky Mountains, and also occupies considerable areas in Utah and central California. (See fig 2.)

The true character of the bird is now so well known that it is unnecessary to dwell on its injuries to fruit and grain, the nuisance it has become in large cities, and the extent to which it has replaced native birds. The ill-directed care and energy expended on introducing and fostering it thirty years ago are largely responsible for the marvelous rapidity of its distribution. Now, when too late, efforts at extermination have been begun, and four States (Illinois, Michigan, Ohio, and Utah) have offered bounties for its destruction, the expenditures in Illinois (1891–1895) and Michigan (1887–1895) amounting to about $117,500.

Besides the United States, New Zealand and Australia have suffered considerably from the English sparrow, and in some of the colonies of Australia it is considered second only to the rabbit as a pest. It seems to have been introduced on the North Island of New Zealand in 1866, by the Wanganui Acclimatization Society.[1] By 1870 it began to be numerous, and twelve years later threatened to spread over the whole island, becoming established in the most inaccessible regions, in spite of its usual partiality for cities and towns. In Victoria the sparrow was introduced about 1865, and probably appeared soon after in Queensland, New South Wales, South Australia, and Tasmania, but data are lacking as to the date of its first appearance in these colonies. It has increased so rapidly that, in order to hold it in check, "Sparrow-destruction" bills have been passed in several of the colonies during the last ten years.

Thus far the sparrow has not gained a foothold in Western Australia, and radical measures have been adopted to prevent its introduction. Its importation was prohibited by the "Destructive birds and animals act," passed in 1893, and when a few birds were discovered in Perth in January, 1898, prompt measures for their extermination were taken by the bureau of agriculture. All that could be found were shot, and attention was called to the necessity of stamping out the pest before it spread beyond control.

The English sparrow has also found its way into many other distant corners of the earth. It is gaining a foothold in Argentina, and has been carried to remote islands. In the Indian Ocean it is present on Mauritius, about 400 miles east of Madagascar, and on the Comoro Islands, off the southeast coast of Africa and 350 miles northwest of Madagascar. It was first reported from Grand Comoro in 1879. In the Pacific Ocean it has been introduced on the Chatham Islands, some 500 miles east of New Zealand,[2] probably on New Caledonia, and on the Hawaiian Islands. In the latter group it is reasonable to suppose that it was introduced by way of San Francisco in the early seventies, since it was reported to be numerous at Honolulu in 1879. In the Atlantic Ocean it is present on Bermuda, the Bahamas, and Cuba. It was sent to Bermuda from New York about 1874, and two years later was given the same protection accorded to other birds, its destruction being punished by a fine of 5 to 20 shillings. Ten years after its introduction it had increased so enormously that a bounty was offered for its destruction, and between 1884 and 1886 about £530 ($2,650) were expended, without causing any appreciable decrease in its numbers, notwithstanding the short time the bird had been present and the fact that the islands have an area of less than 20 square miles. It is said to have been imported into Cuba, and in

[1] Rept. New Zealand Dept. Agriculture, 1897, Div. Biology, p. 8.
[2] Ibis, 1893, p. 543.

1877 was reported to have been introduced on New Providence, Bahamas, "within the last few years." It has not, however, increased rapidly on either island, for in 1891 it was reported as still not abundant, and apparently had not extended its range to any of the neighboring islands.

THE STARLING.

The starling (*Sturnus vulgaris*, fig. 3) of Europe and western Asia is one of the best known birds of the Old World, and during late years has been increasing in numbers in the British Isles. It is sometimes accused of stealing fruit and destroying nests and eggs of other birds, but in its native home it seems to be beneficial rather than otherwise. Comparatively little accurate information concerning its

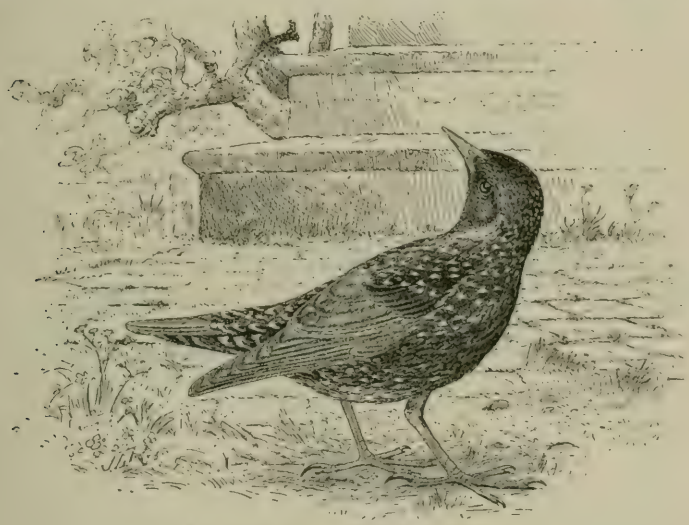

FIG. 3.—Starling (*Sturnus vulgaris*).

food habits is available, except the results of an examination of 175 stomachs recently made in Scotland by Mr. John Gilmour.[1] According to this examination the food consists of 75 per cent insects, 20 per cent grain (mainly waste grain), and 5 per cent miscellaneous substances. Some useful insects were eaten, but the greater proportion were classed as injurious. The charge of destroying eggs of larks, and occasionally young nestlings, was not substantiated, as no eggshells were found in these stomachs. Mr. Gilmour calls attention to the rapid increase of starlings in Fifeshire, thousands now existing where fifty or sixty years ago they were considered rare, and mentions the serious damage sometimes done to shrubs and young plantations when occupied as roosting places, but concludes that on the whole the bird is beneficial and worthy of protection.

[1] Trans. Highland and Agr. Soc., Scotland, 1896.

Several attempts have been made to introduce this species into the United States, but as yet it has hardly obtained a foothold. One of the first importations was made by the Acclimatization Society of Cincinnati, Ohio, in the winter of 1872–73. About 1877 a number of starlings were liberated in Central Park, New York, by the American Acclimatization Society, and several similar experiments have since been made, but only the last seems to have met with success. About 60 birds were released in 1890. Some of them have bred for several years, and, leaving the park, have established themselves in favorable places in the neighborhood. In 1893 and 1894 flocks of as many as 50 individuals were reported to have been seen in the suburbs about the northern end of the city, and late in 1898 a flock of about 30 took up residence at Sing Sing. During the last two or three years a few have been seen on Long Island, about Brooklyn. Thirty-five pairs were liberated at Portland, Oregon, in 1889 and 1892, where they are said to have done remarkably well, and as recently as June, 1898, a few were seen about the suburbs. In the autumn of 1897 it was reported that starlings were to be imported for the city park at Allegheny, Pa., but as yet only a dozen or fifteen seem to have been introduced, and these have been carefully kept in captivity for breeding, with the intention of ultimately stocking the park.

Much has been said concerning the advantages of introducing the starling into this country, but in spite of the many arguments brought forward, the bird's character is not above suspicion, and its usefulness is still open to question. The fact seems to have been overlooked that in other countries the starling has signally failed to fulfill the expectations concerning its usefulness. Certainly the experience of Australia and New Zealand offers little encouragement. It was introduced in New Zealand in 1867, and as early as 1870 was reported as "becoming very numerous." It seems to have increased very rapidly, and in spite of its natural preference for insects, in its new home it has adopted a fruit diet to such an extent as to become a great pest.[1] In South Australia it was reported to be common in certain localities in 1894, and measures for its extermination were considered. In Victoria, on the other hand, steps were taken in 1895 to promote its increase in fruit and grain growing districts, and this fact was used as an argument in its favor by persons who were endeavoring to introduce it into some of the other colonies. Western Australia has taken a firm stand on the question, and Mr. R. Helms, biologist of the bureau of agriculture of that colony, who opposed the proposed importation, gives his reasons as follows:

Had I been asked fifteen or twenty years ago what I had to say, I would probably have recommended their introduction. But not so now. My experience has

[1] It is also interesting to note that nearly twenty years ago an eminent English ornithologist predicted that in foreign countries the starling would undoubtedly aid in destroying native birds. (Newton in Yarrell's British Birds, 4th ed., II, 1876–1882.)

taught me better. The birds were introduced more than fifteen years ago into New Zealand, and now, like the thrushes, they have become a pest to fruit growers. They have changed their habit from being principally insectivorous to having become omnivorous.[1]

After due deliberation, the Government issued a proclamation on January 22, 1896, declaring the starling a destructive bird and absolutely prohibiting its importation into Western Australia. Still more recently it has been condemned in Tasmania, where it is charged with committing depredations on small fruits, cherries, and wheat.

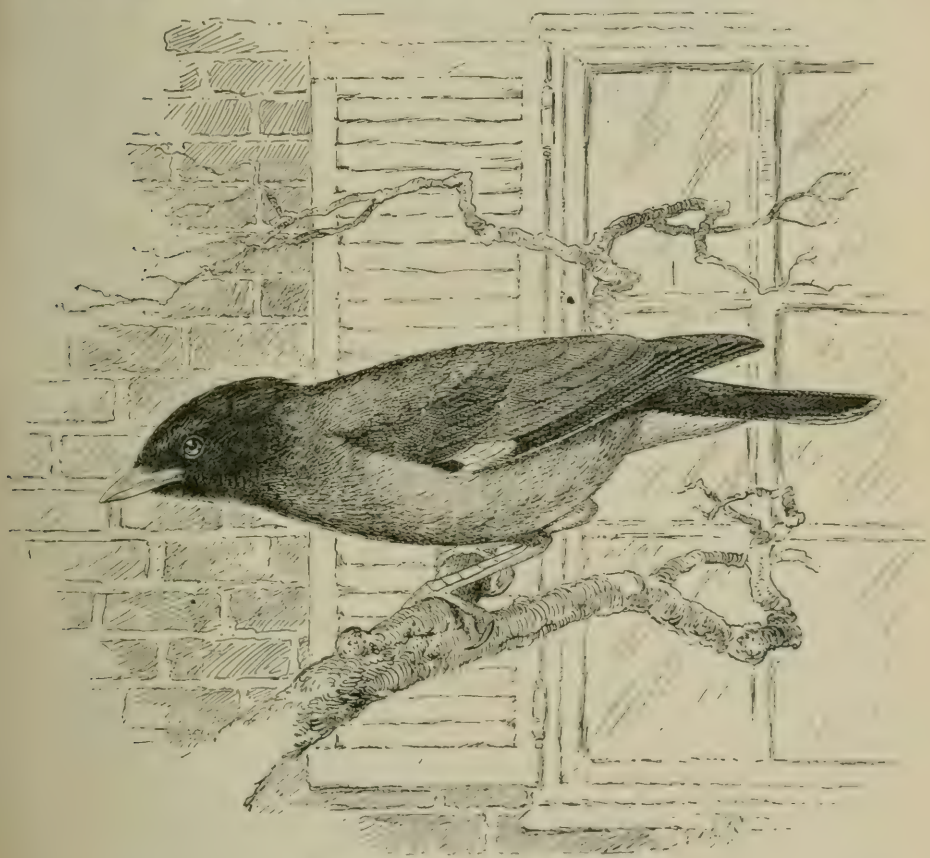

FIG. 4.—Mina (*Acridotheres tristis*).

Its further distribution has been discouraged, and when the question of introducing several species of birds was under discussion at an agricultural conference at Scottsdale on December 6, 1897, the starling was promptly rejected.[2]

THE MINA.

The mina, or mynah (*Acridotheres tristis*, fig. 4), is common throughout most of India, except Kashmir and Tenasserim. In its habits it

[1] Producers' Gazette, Western Australia, V, January, 1898, p. 29.

[2] Agr. Gazette, Tasmania, V, November, 1897, p. 66; January, 1898, p. 103.

is somewhat like our native grackles or crow blackbirds, but seems to resemble the sparrow in its familiarity and partiality for human habitations. It was introduced more than thirty-five years ago into Mauritius to destroy grasshoppers, and is said to have become perfectly naturalized there.[1] It has also been introduced into the Andaman Islands (some time prior to 1873), the Hawaiian Islands, New Zealand, and possibly Australia.

FIG. 5.—Kohlmeise (*Parus major*).

It is said to have reached the Hawaiian Islands by way of China. Dr. Finsch, an eminent ornithologist, who visited Honolulu in 1879, found it very abundant, and describes its habits as follows:

> The mainas are a great nuisance to the inhabitants, as they drive away the pigeons and fowls, and are said to destroy the nests and eggs of the domestic birds. That they do drive out the pigeons from their houses, I observed many times myself. * * * In Mr. Barning's garden, where the finest trees, chiefly palm, abound, hundreds and thousands come to roost, and their inharmonious concert lasts from 6 in the evening for an hour or more. The same is the case at daybreak, a little after 5 o'clock.[2]

THE KOHLMEISE, OR GREAT TITMOUSE.

"Kohlmeise" is the German name of the great titmouse of Europe (*Parus major*), and this designation is used to some extent in the United States. The kohlmeise (fig. 5) is common over the whole of Europe as far north as the Arctic Circle and also in Siberia. It is a handsome species, about the size of the common eastern chickadee (*Parus atricapillus*, fig. 6), but may be readily distinguished from any American titmouse by the dull yellow on the sides of the body and the broad black stripe

FIG. 6.—Chickadee (*Parus atricapillus*).

[1] Jerdon, Birds of India, II, 1863, p. 326.

[2] Ibis, 1880, pp. 77, 78.

extending down the center of its breast (see fig. 5). Like other species of the genus, it is mainly insectivorous, but in winter is said to eat nuts and hard seeds. The kohlmeise has recently attracted attention on account of its alleged value as a destroyer of the codling moth (*Carpocapsa pomonella*), particularly in Germany, where it is reported to protect apple trees in large measure from the attacks of this destructive insect. But although several German authors regard it as a most useful species, there seems to be no satisfactory evidence that it is partial to the codling moth, or in fact that it ever feeds on the moth to any great extent. In Great Britain where the kohlmeise is also a resident and generally distributed, its presence has not been sufficient to exterminate the codling moth or even to hold this pest in check. On the other hand, it is said to attack small and weakly birds, splitting open their skulls with its beak to get at the brains, and doing more or less damage to fruit, particularly pears. One English observer reported that all the pears in his garden had to be inclosed in muslin bags to protect them from the birds, which would otherwise eat a considerable part of the fruit before it was ripe. Another reported that the great titmouse spoiled most of a limited crop of apples, and then began on the pears, boring a small hole near the stem, and passing from one pear to another until every one of forty or fifty trees had been damaged. It also attacked figs, scooping them out before they were ripe.

In the autumn of 1897 an article appeared in a paper in Idaho setting forth the great value of the bird to the fruit grower, and strongly advocating its importation into this country. The article attracted the attention of horticulturists throughout the Northwest, and gave rise to considerable discussion concerning the merits of the bird and the desirability of its introduction. While the kohlmeise might not develop its fruit-eating propensities in America, it should not be introduced until more definite information is available concerning its habits and until it has been shown beyond question that it will do no serious harm. Moreover, since there are already several titmice of the same genus in the United States, it seems entirely unnecessary to add another to the list, for it is hardly probable that the European bird would confine itself to the codling moth or be of more value to the horticulturist than the native species. It may be added that recent investigations seem to show that the common eastern chickadee feeds to some extent on the codling moth, as a few larvæ, believed to be those of this insect, have been found in chickadee stomachs collected in New Hampshire during February and March.[1] It may be of interest also to recall the fact that the kohlmeise was actually introduced in 1874 at Cincinnati, Ohio, but the experiment failed, as neither this nor any of the other exotic species imported at the same time became naturalized.

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[1] Weed, Bul. 54, N. H. Coll. Agr. Expt. Station, 1898, pp. 87, 94.

THE SKYLARK, GREEN LINNET, AND BLACK THRUSH.

The skylark (*Alauda arvensis*), the green linnet (*Ligurinus chloris*), and black thrush, or black bird (*Turdus merula*), are all natives of Europe. They are chiefly of interest in this connection, because in their native home they are almost universally considered beneficial, but in New Zealand they have developed traits which render them far from desirable additions to the fauna of that island. They were introduced into New Zealand in 1867; in 1870 they had begun to breed in a wild state in the province of Auckland on the North Island, and the green linnet was reported as already becoming common.[1] At the present time they are common all over the colony and troublesome in certain districts. The skylark confines its injuries mainly to turnips, eating the seed soon after it is planted, and thus causing no small damage to the future crop. The green linnet is similarly injurious to grain, while the black thrush is accused of taking strawberries, currants, raspberries, and other small fruits. As a fruit destroyer the black thrush is said to be worse than the English sparrow, and the proposal to introduce it into Western Australia elicited a strenuous protest.

The skylark has been introduced several times into the United States, especially in the vicinity of New York, and recently all three birds have been liberated in Oregon, but as yet they have not increased to any extent. Both the skylark and the black thrush are noted singers, but the charms of their song hardly compensate for damage to crops.

NEED OF LEGISLATION.

The examples already cited show the danger of introducing exotic species on large islands, particularly on those far distant from continents, where the fauna is necessarily limited and predatory species practically absent. In such places introduced species are almost sure to increase very rapidly. The experience of New Zealand indicates the necessity of exercising unusual care in introducing birds and mammals into the islands recently acquired by the United States. Much remains to be learned about the fauna of these new possessions. Puerto Rico is less known than any of the larger islands of the West Indies, but it probably has no indigenous mammals except bats. About 150 species of birds have been recorded from the island,[2] of which 20 are not found elsewhere. The fauna of the Hawaiian Islands is still more limited; indigenous mammals, except one bat (*Lasiurus*), are entirely wanting, but many of the birds are of great interest. Although no complete list of them has yet been published, about 100 species are known to occur on the islands. The fauna of

[1] The green linnet has found its way to the Kermadec Islands, 600 miles to the northeast, and all three species are said to be now present on the Chatham Islands, nearly 500 miles east of the South Island of New Zealand.

[2] Gundlach, J. F. O., XXVI, 1878, p. 163.

the Philippines is much richer. The mammals are comparatively unknown, and until recently were supposed to be poorly represented, but at present the list includes some 50 species, of which about half are bats. The birds have received much more attention, and nearly 600 species have been recorded from the archipelago,[1] 286 occurring on Luzon alone.

All of the islands have probably suffered more or less from the introduction of noxious species, especially rats and mice. In Hawaii rats have done so much damage that the sugar planters have imported the mongoose to destroy them, and this animal is now becoming a pest. The mina of India is also present in considerable numbers, and the house finch (*Carpodacus mexicanus frontalis*) has been introduced, notwithstanding the fact that it is usually considered a great pest by fruit growers in California.

During the last fifty years a number of acclimatization societies have been organized for the purpose of introducing animals and plants from foreign countries. Private individuals, too, have devoted both time and money to importing birds or mammals which they consider necessary or desirable additions to the native fauna. Four or five societies exist in New Zealand, and several have been formed in the United States. During the years 1872–1874 the Acclimatization Society of Cincinnati, Ohio, expended about $9,000 in the purchase and importation of European birds, and introduced some 4,000, belonging to about 20 species, at an average cost of about $4.50 a pair. These included several birds of doubtful value, such as the starling, skylark, and great titmouse or kohlmeise.[2] This experiment proved a failure.

In 1888 the Society for the Introduction of European Song Birds was organized at Portland, Oregon, and imported two lots of birds in 1889 and 1892, at a cost of about $2,000. Among the number were 50 pairs of skylarks, 35 pairs of black thrushes, 35 pairs of starlings, 15 pairs of green linnets, and a number of others, representing in all some 20 species. Recently the introduction of the kohlmeise into the Northwest has been seriously considered, and the spasmodic attempts to acclimatize the skylark and starling have been renewed.

Whatever may be the difference of opinion concerning the desirability of introducing exotic species, it will be generally admitted that some restriction should be placed on the importation of birds and mammals which may become injurious. Since it has been found necessary to restrict immigration and to have laws preventing the introduction of diseases dangerous to man or domesticated animals, is it not also important to prevent the introduction of any species

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[1] This number includes the species found on Palawan. Worcester and Bourns class Palawan with Borneo on zoological grounds, giving for the Philippines proper 526 species; of these, 323 are confined to the group. (Proc. U. S. Nat. Museum, XX, 1898, pp. 564, 575.)

[2] Journ. Cincinnati Soc. Nat. Hist., IV, 1881, p. 342.

which may cause incalculable harm? Experience with the English sparrow, the work of rabbits in Australia and of the mongoose in Jamaica, all these have abundantly shown the necessity of preventing the repetition of similar costly blunders in the future.

Twelve years ago Dr. C. Hart Merriam, Chief of the Biological Survey, urged the necessity of restricting the importation of exotic species, as follows:[1]

> It seems desirable that a law be enacted conferring upon the Commissioner [Secretary] of Agriculture the power of granting or withholding permits for the importation of birds and mammals, except in the case of domesticated species, certain song and cage birds (to be specifically enumerated), and species intended for exhibition in zoological gardens, menageries, and museums, which may be brought in without special permits. The question of the desirability of importing species of known beneficial qualities in other lands is one which sooner or later must force itself upon our notice; and it is highly important that when such experiments are made they should be conducted by or under the control of the Department of Agriculture.

Ten years later Mr. Alexander Craw, quarantine officer of the California State board of horticulture, again called attention to the need of legislation, and in his annual report for 1896 recommended the passage by Congress of a stringent law preventing the introduction of noxious animals.

At present there is no Federal statute on the subject, and apparently California is the only State which has given the matter serious attention or has taken steps to prevent thoughtless or intentional importation of injurious species. In the act creating the State board of horticulture, approved March 13, 1883, and amended March 8, 1889, authority was conferred on the board to make regulations for the purpose of preventing the spread of fruit pests. In accordance with this act, certain quarantine regulations were adopted on August 15, 1894, one of which, Rule XII, provides that "animals known as flying fox, Australian or English wild rabbit, or other animals or birds detrimental to fruit or fruit trees, plants, etc., are prohibited from being brought or landed in this State, and if brought, they shall be destroyed."[2] This law has resulted in the destruction of several flying foxes and, so far as known, every mongoose thus far brought to the port of San Francisco. It is, perhaps, not too much to say that to this regulation and to the vigilance of the quarantine officer at San Francisco the State owes its present freedom from the mongoose.

The action of Cape Colony and Western Australia on this question stands out in marked contrast to the apathy of other countries. Cape Colony, in 1890, made it unlawful to introduce rabbits, either by land or sea, or to turn them loose within the colony;[3] required the rabbits

[1] Annual Report Department of Agriculture for 1886, p. 258.

[2] Fifth Biennial Report State Board of Horticulture, 1896, p. 8.

[3] Under a penalty not exceeding 5 pounds for first offense or 10 pounds for second offense. (See Agr. Journ., Cape Town, III, January 8, 1891, p. 119.)

already in the colony to be confined in hutches or boxes constructed according to certain prescribed regulations, and authorized anyone to destroy rabbits found on his premises, on Crown lands, or along public roads. Western Australia, profiting by the experience of her sister colonies on the eastern side of the continent, has taken measures to secure protection from the evils of indiscriminate and ill-advised acclimatization by the passage of the so-called "Destructive birds and animals act" (57 Vic., No. 22). This law, passed in 1893, prohibits the introduction of all birds or animals which, in the opinion of the governor-in-council, are destructive to vineyards, orchards, fruit trees, or any agricultural produce. The act also prohibits the keeping of such birds or animals on private premises, authorizes the destruction of those already in the colony, prohibits the liberation of any destructive bird or animal, and permits duly authorized officers to enter premises for the purpose of seizing or destroying such birds or animals. The term "destructive" is interpreted to mean any species to which the governor-in-council may from time to time extend the provisions of the act by proclamation, and the selection of species is based mainly upon the recommendations of the bureau of agriculture.[1] The law is therefore elastic and may be easily modified when necessary. Sparrows and rabbits were originally included in 1893, flying foxes were added in December, 1895, and starlings, blackbirds, and thrushes in January, 1896.

SUMMARY.

(1) Acclimatization of plants differs from that of animals since plants are introduced for cultivation and thus kept to a certain extent within control, while animals are liberated and controlled only by natural enemies or unfavorable conditions.

(2) Animals and birds are distributed from one continent to another, and to islands, either by accidental means or by the direct agency of man. Most animals are intentionally introduced into new regions, cases of accidental dispersion being comparatively rare except among rats and mice.

(3) Domesticated animals, like plants, may run wild and become injurious, especially in regions where food is abundant and natural enemies are absent. Goats and cats on isolated islands are well-known examples.

(4) The animals and birds which have thus far proved most injurious are the rabbit, mongoose, stoat, weasel, flying fox, English sparrow, starling, and mina. The skylark, green linnet, black thrush, and great titmouse, or kohlmeise, are of doubtful value and likely to prove injurious. These species are all natives of the Old World, and with the exception of the mongoose, mina, and flying foxes, are inhabitants of the temperate regions of Europe and western Asia.

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[1] See Journ. Bureau Agr. Western Australia, II, December 10, 1895, pp. 630-631; III, 1896, p. 676.

(5) Notwithstanding the object lessons afforded by the English sparrow in our own country, the rabbit in Australia, and the mongoose in Jamaica, no steps have been taken to prevent the repetition of similar costly mistakes in the future, and at present no restriction is placed on the indiscriminate importation of exotic species into the United States.

(6) Recent events have given new importance to this subject. The gradual increase of the starling and the efforts to introduce the kohlmeise require prompt measures to prevent species of such doubtful value from gaining a foothold in this country. The acquisition of new territory has also brought us face to face with new problems. Not only should the mongoose be prevented from reaching the United States from Hawaii and Puerto Rico, but the native fauna of these islands should be preserved and all our island possessions protected from ill-advised acclimatization, which has caused so much loss in Australia and New Zealand.

(7) The introduction of exotic birds and mammals should be restricted by law and should be under the control of the United States Department of Agriculture. Western Australia has already adopted this course, and under the "Destructive birds and animals act" of 1893, prohibits the importation, liberation, or keeping of animals and birds which the colonial bureau of agriculture considers injurious to vineyards, orchards, or crops.

THE PREPARATION AND USE OF TUBERCULIN.

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INTRODUCTION.

Tuberculin is a solution in glycerin and water of the products of the growth of the tubercle bacilli upon artificial media and the contents of their cells. Although it has been manufactured in quantity and used upon a large scale for some years, it may at the present time be of interest to give a brief sketch of the methods of manufacture of this material as followed in the Biochemic Division, and to note the advantages or objections to its use as a diagnostic agent for tuberculosis in animals and men.

METHOD OF PREPARING TUBERCULIN.

In the preparation of large quantities of tuberculin in the biochemic laboratory of the Bureau of Animal Industry during past years, the following method of procedure has been found to give the most satisfactory results: The fluid upon which the tubercle bacilli are allowed to grow is an extract made with distilled water from perfectly fresh meat which has been finely chopped. One pound of meat is used to a liter of water, to which is added 1 per cent of peptone, one-fourth of 1 per cent of salt, and 7 per cent of glycerin. The solution is heated to boiling, filtered, and placed in perfectly sterilized flasks. The medium is then sterilized for three successive days in a steam bath. After the cotton plugs of the flasks have become dry, they are removed, dipped in paraffin, and replaced in the flasks so as to make tight stoppers. When the culture medium so prepared is found to be thoroughly sterile, it is inoculated. The thorough sterilization of the media can be proved by allowing the flask to stand for some days in a warm place, during which time they should remain perfectly clear if there is no contamination with ordinary bacteria from the air.

INOCULATING THE MEDIA.

The inoculation of the media in the flasks is accomplished by taking up on the end of a platinum wire a small mass of tubercle bacilli obtained originally from an animal that has died of tuberculosis. The first cultures are made from dead animals, by transferring to a jelly made of glycerin and agar, or blood serum, or potato, pieces of the diseased organ, lung or spleen, of a guinea pig that has been

infected by inoculation with tuberculosis. The germs, after four to six weeks, are found to have developed very readily, and to form a thick, spongy layer on the surface of the jelly or potato. It is a very easy matter to detach a small bit of this spongy growth from the surface of the jelly and transfer it to the flask containing the liquid media prepared in the manner already indicated.

In order that the tubercle bacilli may grow readily, it is necessary that they shall have a free supply of oxygen; hence, the mass of bacteria that are transferred to the flask should be caused to float on the surface of the liquid. This can be readily accomplished by detaching a piece of the culture mass from the platinum needle and floating it upon the surface of the liquid without immersing it (Pl. IX, fig. 1). If the inoculating piece is allowed to become wet with the culture media, it will sink to the bottom of the flask and the bacteria will not develop. The inoculated flasks are then placed in the incubator, which is a double-walled copper box. The space between the copper walls of the incubator is filled with water. The incubator is kept at a constant temperature of about 98° F. After a week to ten days the tubercle bacilli will be seen spreading out in all directions from the particle with which the flask was inoculated, and finally the surface of the liquid will be covered with a layer of tubercle bacilli (Pl. IX, fig. 2). When this is noted, the flask should be carefully shaken, so as to cause most of the growth upon the surface to be immersed in the culture liquid and to sink to the bottom of the flask. A small particle, however, should be left on the surface to serve as seed for a new surface growth. This shaking down of the surface growth can be readily accomplished by rotating the flask two or three times very gently, and after a little practice it will be found to be an easy matter to preserve the desired particle upon the surface. From this particle a new surface growth is developed, which should be shaken down as in the first instance, and a third growth allowed to form. This process will require six weeks to two months or more from the time that the flasks were first inoculated, and their contents are then in a condition to be further used for the preparation of tuberculin.

When first obtained from the animal body, the tubercle bacillus grows best upon blood serum, or potato, or a liquid, such as has been already indicated, that has a faint alkaline reaction to litmus or is perfectly neutral. After a time, however, when the tubercle germ has become accustomed to its new food, just as a plant must adapt itself to a new soil, it can be caused to grow upon medium that has a slight acid reaction. When liquid cultures of the tubercle bacilli have been once inoculated and are growing well, it is very much easier to inoculate fresh culture media from liquid cultures rather than from the jelly cultures, with which it is always necessary to start. The transference of a particle containing large numbers of the germs

FIG. 1. TUBERCLE CULTURE JUST INOCULATED. MANNER OF TRANSFERRING.

FIG. 2. FIRST GROWTH TUBERCLE CULTURE.

FIG. 3. MATURE GROWTH TUBERCLE CULTURE.

from the surface of one flask to serve as seed upon the surface of another flask will give what is commonly called a new generation. As these transfers are usually made every month or six weeks, it is possible, in the course of a few years, to obtain a germ which is a direct descendant of the one originally used, but removed from it by many generations. This continued transference of the bacteria from one nutrient flask to another has the effect in many cases of changing some of the properties of the germ. In the laboratory of the Biochemic Division it has been found, in connection with the tubercle germ, that this fact can be utilized to great advantage. There are in the laboratory now, and have been for a number of years, the descendants of a tubercle germ which originally caused the death of guinea pigs in from four to five weeks after they had been inoculated. This germ, which is now perfectly harmless, was originally obtained from a specimen of tuberculous sputum. The guinea pigs inoculated with this sputum died in due time from tuberculosis, and the cultures made from the diseased organs served as a starting point for a large and prolific family. By accustoming this germ gradually to liquid food which had a slight acid reaction, we eventually succeeded in eliminating its ability to produce tuberculosis when it was inoculated into animals. The germs, however, did not lose the property of producing or secreting their active poisons—those poisons which form the active principle of tuberculin. Cultures of this sort, which have been caused to lose their virulence or pathogenic properties, are called attenuated, and we have used these attenuated cultures to great advantage since 1893, both in preparing tuberculin and in treating animals, or injecting animals for the purpose of protecting them against an inoculation with virulent tuberculosis or producing in them a serum which may have curative properties. Virulent cultures are also used in preparing the tuberculin, and there are always a number of different generations of varying virulence of tubercle bacilli on hand in the laboratory.

STERILIZING THE CULTURES.

When the tubercle cultures have grown sufficiently (Pl. IX, fig. 3), which requires from one month to three months, depending upon the readiness with which the growth begins (and this is always influenced by the reaction of the media and the condition of the culture from which the inoculations are made), the flasks with their contents are removed from the incubator and placed immediately in the sterilizing oven, which is kept at a temperature of about 125° C. The cultures are left in this oven until they begin to boil. In this way the germs are killed, and the plugs in the mouth of the flasks may be removed and the material filtered without any danger of infecting the workers. Of course, in handling tubercle cultures in such large quantities there is always some danger of infection for the people who

are doing the work. When proper care is used this danger is of practically no importance; but as accidents may occur (flasks be broken and their contents spilled upon tables or floor or in other places), it is a matter of impossibility to avoid all danger. But the discovery that the attenuated germs can be used to advantage for the preparation of tuberculin materially reduces the possibility of danger to the workers in handling this material. After heating the flasks in the sterilizer the cotton plugs are removed and the contents of the flask heated over a flame to boiling and immediately filtered. The germs, which are packed close together, remain upon the filter paper and are washed once or twice with a small amount of water. The filtrate, including the washings, is then evaporated, and may be concentrated to any desired volume. As a rule, one-fifth of the quantity of the original culture is the most convenient point to be reached in the evaporation. Instead of filtering off the germs and then evaporating the filtrate, the entire contents of the flask may be concentrated by evaporation and the solution filtered after it has been concentrated. The results are the same, but the writer's preference is for the first method.

DILUTION OF TUBERCULIN.

Instead of sending out concentrated tuberculin, it has been found advisable to dilute it to such a strength that 2 cubic centimeters will be a suitable dose for the purpose of diagnosing tuberculosis in cattle. To accomplish this dilution, there is added to the concentrated tuberculin glycerin equal to one-fourth the original bulk of the culture liquid. This is then diluted with one-fourth of 1 per cent carbolic acid, so that the volume of the tuberculin usually obtained is one-fourth more than the original quantity of culture media used. In other words, 1,000 cubic centimeters of culture media, after the germ has been allowed to grow sufficiently long, diluted with the proper amount of glycerin and carbolic acid, should give 1,250 cubic centimeters of tuberculin of such a strength that 2 cubic centimeters would be a satisfactory dose for testing an animal of 1,000 pounds in weight.

METHODS OF STANDARDIZING TUBERCULIN.

Several methods of standardization of the tuberculin are adopted. The amount of the tuberculin required to produce a rise of 4° or 5° in temperature in tuberculous guinea pigs of 1 pound in weight is noted, or the quantity of tuberculin found necessary to kill a tuberculous guinea pig; or, again, a standard upon a chemical basis, depending upon the amount of acid which is produced by the growth of the bacilli, is used. All tubercle cultures after they are well grown show a decided acid reaction. If the reaction of the media is carefully noted before inoculation, and again after the growth of the germ, it is found that the amount of acid reaction is increased proportionately to the quantity of the growth. By practice, it is also found that this

is approximately constant. If the value of a tuberculin made from a culture in which the acid reaction has been carefully tested is once noted it serves as a guide for future work.

In practice, it has been found that healthy animals do not give reactions with large doses of tuberculin, and that as a rule tuberculous animals do not show an appreciably higher reaction with large doses of tuberculin than with medium doses; hence, while the above methods of standardization are not so accurate as those which would have to be used in weighing out a very poisonous alkaloid, experience has shown that they are sufficiently accurate for ordinary work.

If the tuberculin is intended for use upon man, it should, in addition to the filtration through a fine filter paper, be filtered through porous porcelain, so as to remove the last possible germ. In the preparation of tuberculin, however, for use upon animals, especially when attenuated cultures are used as the source for the material, this filtration through porcelain is not necessary.

LOSS IN PREPARING AND COST OF TUBERCULIN.

In handling large amounts of culture media for the preparation of tuberculin there is always a certain amount of unavoidable loss. Sometimes in the process of inoculation, even with the utmost care, the flasks will become contaminated by some foreign germ. Sometimes the contamination may not take place until the culture is pretty well grown. Then it is often due to an imperfect plug or unavoidable handling of the culture. The quantity of cultures lost depends, of course, upon the care of the individual in handling them, the care in inoculation, and the locality in which this work is conducted. All inoculations of tubercle flasks, as well as other culture media, should be made in an air that is free from dust, and consequently free from dangers of contamination. When proper care is used, possibly one-fourth of 1 per cent of the flasks are lost, but the writer has found that in the hands of inexperienced individuals 20, 30, and even 50 per cent of culture flasks may be contaminated. Frequently, as in the case of tubercle cultures, this contamination can be very readily detected. So long as the cultures are pure the germs will be found floating upon the surface of the liquid or at the bottom of the flask, while the rest of the media will be perfectly clear. The slightest contamination causes the media to become cloudy; and as soon as this is noted the flasks should be discarded, as tuberculin should be prepared only from perfectly pure cultures. In experienced hands the cost of the preparation of tuberculin is not great. It should be made and sold, giving a fair profit for the trouble connected with its manufacture, at not over 5 cents a dose.

THE METHOD OF USING TUBERCULIN.

The regulations prescribed for many years by the Bureau of Animal Industry for the use of tuberculin in testing cattle are as follows:

DIRECTIONS FOR USING TUBERCULIN AS PREPARED IN THE BIOCHEMIC LABORATORY OF THE BUREAU OF ANIMAL INDUSTRY FOR THE DIAGNOSIS OF TUBERCULOSIS IN CATTLE.

The febrile reaction in tuberculous cattle following the subcutaneous injection of tuberculin begins from six to ten hours after the injection, reaches the maximum nine to fifteen hours after the injection, and returns to normal eighteen to twenty-six hours after the injection.

In conducting the test the following course is recommended to those who wish to obtain the most accurate results:

(1) Begin to take the rectal temperature at 6 a. m., and take it every hour thereafter until midnight.

(2) Make the injection at midnight.

(3) Begin to take the temperature next morning at 6 o'clock, and continue as on preceding day.

To those who have large herds to examine or who are unable to give the time required by the above directions, the following shortened course is recommended:

(1) Begin to take the temperature at 8 a. m., and continue every two hours until 10 p. m. (omitting at 8 p. m. if more convenient).

(2) Make the injection at 10 p. m.

(3) Take the temperature next morning at 6 or 8 o'clock, and every two hours thereafter until 6 or 8 p. m.

Each adult animal should receive 2 cubic centimeters (about 30 minims) of the undiluted tuberculin as it is sent from the laboratory. Yearlings and two-year-olds should receive 1 to 1½ cubic centimeters, according to size. Bulls and very large animals may receive 3 cubic centimeters. The injection is made beneath the skin of the neck or shoulders.

There is usually no marked local swelling at the seat of injection.

There is, now and then, uneasiness, trembling, and the more frequent passage of softened dung. There may also be slight acceleration of the pulse and of the breathing.

A rise in the temperature on the day following the injection of two or more degrees F. above the maximum observed on the previous day should be regarded as an indication of tuberculosis. For any rise less than this a repetition of the injection after three to six weeks is highly desirable.

In rare cases the temperature may rise in the absence of any disease, or it may fail to rise when tuberculosis is present.

It is hardly necessary to suggest that, for the convenience of the one making the test, the animals should not be turned out, but fed and watered in the stable. It is desirable to make note of the time of feeding and watering.

Charts for reporting to the Bureau of Animal Industry results of tests are always forwarded with the material. It is not necessary that the temperature should be taken at the exact hour indicated upon these charts, but the hours selected have been considered the most convenient for the test. If the animal is diseased, from six to eight hours after the injection of the tuberculin the temperature begins to rise from the normal, which in cattle varies from 101° to 102° F., and should continue to rise until it has reached 105° to 107°. A reaction

of 2° F. above the normal may be considered as good evidence that the animal is infected with tuberculosis.

When tuberculin is to be used upon dairy cattle, a test of the same herd should be made at least once every six months. Dairy cows should be carefully tested by means of tuberculin, and this is required at present by some of the States. Dairy herds once found free from disease should not be subjected to the danger of infection by the introduction of new animals that have not been previously tested and found perfectly sound. The health of animals and of men is very largely dependent upon the use of sanitary precautions and the enforcement of sanitary regulations, such as can be adopted by the aid of a definite diagnostic material like tuberculin.

ABSENCE OF DANGER IN THE USE OF TUBERCULIN.

As will readily be seen from the manner of preparation described, there is not the slightest possible danger of infecting animals or men with tuberculosis from the use of tuberculin. The cultures are heated several times to a temperature a great deal above that necessary to kill the tubercle bacillus, and, in addition, the tuberculin is diluted with carbolic acid, which is an excellent disinfectant and germicide. Again, there is no danger of injuring healthy animals even with quite large doses of tuberculin, as the tuberculin is apparently very readily eliminated in the feces and urine.

When tuberculin is to be used for diagnosing disease in man, very much smaller doses are necessary than in the case of animals. From 1 to 3 milligrams are found sufficient in most cases.

The method of injecting tuberculin upon man for diagnosis, as prescribed by Dr. Trudeau, one who has had a great deal of experience in its use, is as follows:

In applying the tuberculin test, I take the temperature for several days beforehand, at 8 a. m., 3 p. m., and 8 p. m. For the first injection, I usually take 1 milligram of Koch's original tuberculin [5 milligrams Bureau tuberculin], injected as late as possible at bedtime; then note the temperature every two hours the next day. If no reaction follows, after an interval of two days I usually inject 3 milligrams [15 milligrams Bureau tuberculin]. In suspected visceral tuberculosis I usually stop here, but if it is a surgical tuberculosis, where the amount of disease may be very slight, it is well, perhaps, to try another dose of 5 or 6 milligrams after another interval. The reaction usually begins from eight to twelve hours after the injection.

THE DIAGNOSTIC VALUE OF TUBERCULIN.

One of the objections that has often been brought forward against the use of tuberculin upon cattle is that it is entirely too delicate; that by its aid disease is detected in animals which might not have been dangerous for very many years. It is, however, utterly impossible to tell how soon a very slight case of tuberculosis may develop into a very dangerous one, and during this time the animal is the best possible source of infection for other animals. The contagiousness

of tuberculosis both among animals and men is well established, and, this being known, animals which are found infected with tuberculosis in the slightest degree should either be slaughtered and the healthy portion of the animal used as food, if thoroughly cooked, or better still, such animals may be isolated and quarantined and used for breeding purposes, and the calves isolated and fed upon sterilized milk. By adopting a method of this sort, which is both economical and practical, the objection so often made that tuberculin does not give an indication of the character of disease is easily dispensed with. The moment that the disease is found present, that moment the individual becomes dangerous to the rest of the cattle in the herd, and the necessary precautions should be taken.

In Denmark and in several places in this country the method of isolating animals infected with tuberculosis and using them for breeding purposes has been pursued with excellent results, and there is no reason why the same thing may not be done generally in this country. In some localities this method could not be carried out satisfactorily, and then, of course, it becomes necessary to destroy the animals that are infected with tuberculosis. Occasionally this may be a hardship for the owner of the animal, unless the city or State is willing to pay for the animal a price which would, at any rate, partially reimburse him for his loss. It is quite as legitimate for this to be done as for the adoption of any other sanitary regulations which are of importance for the health of the community.

It occasionally happens that animals badly diseased or in an excited condition from various causes have a high temperature at the time of injection and will not give a satisfactory reaction to tuberculin. In these cases, however, the disease is usually so far advanced that it can be detected very readily upon physical examination. These exceptions can not be used as objections to the utility of tuberculin, and do not depreciate its value in the slightest degree. It also occasionally happens that some animals but slightly affected with disease will not react or animals which upon post-mortem appear perfectly healthy have shown reaction. The eminent veterinarian Nocard and others, however, claim that, in all cases in which very careful post-mortem examinations have been made upon animals which had reacted to the tuberculin test but did not show marked post-mortem lesions, they have demonstrated that the germ of the disease was present in the system and had just begun its development. To prove this the most careful bacteriological examination and inoculation tests are necessary. The tuberculin test, it is true, is not infallible, but the mistakes that may occur from its use are so few and it is so much more nearly perfect than any other method that we have at hand that for practical purposes it may be considered sure. While it may be many years before tuberculosis can be practically eradicated from herds, and while it would require many stringent State and national regulations to succeed in stamping it out, nevertheless by the use of

tuberculin and proper methods of disinfection of stables and other localities which have been infected by diseased animals it will be possible in a comparatively short time to greatly reduce the number of cases of this disease. Dr. Pearson's report to the Pennsylvania board of health indicates a reduction of 33 per cent in cases of tuberculosis in that State.

As tuberculosis in animals is reduced so will the disease in man be proportionately decreased. There is every evidence to prove conclusively that man may be infected with tuberculosis by drinking the milk from tuberculous animals. Recent work, combined with many experiments that have been conducted in past years, has shown that the tubercle germ of human origin or the tubercle germ of animal origin can adapt itself very readily to its surroundings and grow upon different varieties of media and at different temperatures without its pathogenic or disease-producing properties being destroyed.

It was claimed for a long time that the human tubercle bacillus was not pathogenic for birds. Very recently, however, Nocard has shown that if a culture of the human bacillus be placed in a collodion sack and this sack introduced into the peritoneal cavity of a chicken, after four weeks or more the germ will have assumed the appearance of the avian bacillus and will have become pathogenic for chickens. Again, the tubercle germ has been recently isolated from carp. It was demonstrated very conclusively that these carp were infected from the sputum of a badly tuberculous individual, which sputum was thrown regularly into the pond occupied by the carp. The germ isolated from the carp grew at a very much lower temperature than the human germ, but its origin was undoubtedly human. All this work has proven very conclusively that the tubercle bacillus found in different animals may adapt itself very readily to different surroundings, may be accustomed to grow at lower or higher temperatures, and may eventually grow under conditions that would have been originally entirely destructive to it. This latter point has been very practically demonstrated in this laboratory, the experiments showing that the tubercle bacillus can be gradually accustomed to a nutrient liquid containing glycerin, sodium and potassium phosphate, and ammonium phosphate. When obtained directly from the animal the germ will not grow on this solution, but by cultivating it first upon a medium which more nearly produces the conditions that the germ finds in the animal body it can then be transferred to the solution of mineral salts and caused to grow rapidly and in great abundance. If such conditions can be produced artificially outside of the body there is certainly every reason to believe that the germ can very readily adapt itself to changes in temperature and nutrient conditions that are found in the bodies of different animals and still cause tuberculosis.

During the seven years that tuberculin has been prepared in this laboratory for distribution by the Bureau of Animal Industry to

various State officials and experiment stations, the results have been very generally satisfactory. Thousands of reports have been received, from nearly every State in the Union, from Canada and the West Indies, and from many different sources, and with one or two exceptions (exceptions arising very probably from the fact that the users of the material were not experienced in handling it) all have realized the importance and usefulness of tuberculin.

There have been one or two cases in which it was claimed that the tuberculin gave misleading results. One may be noted especially. A supply of tuberculin had been sent from this laboratory in the spring of the year to a certain State veterinarian who distributed it to some of his assistants. One of these assistants kept the bottles standing in his office for several months in the hot sun. He then used some of their contents to test an animal, which, according to report, passed the test, and was sold. Subsequently, with another lot of tuberculin, the animal showed the tuberculin reaction, which diagnosis was proved upon post-mortem examination. The doctor to whom this tuberculin had been sent was requested to forward the bottle from which the material had been used to this laboratory. He said that he could not get this, but sent another bottle from the same lot which had not been opened but kept under the same conditions. This latter bottle was kept for some six or eight months, until an opportunity occurred to have the veterinarian of the District of Columbia use some of it. He was told that it was old tuberculin, and that nothing was known about its reliability, but that he could use it upon animals which showed signs of tuberculosis. This he did, and reported a very characteristic reaction. The writer feels sure that the failure reported in the first instance was due to a personal error and not to the tuberculin.

Contrary to the generally accepted statement, the diluted bottled tuberculin has often been kept in this laboratory for two or three years or more without its losing its active properties. In order, however, to avoid all trouble, the usual recommendation is that the tuberculin sent out shall not be used more than six weeks after the date upon the bottle, which indicates the time when it was diluted in the laboratory. This may be an unnecessary precaution, but one which seems advisable when the material is placed with such a large number of people.

CONCLUSIONS.

In conclusion, it would seem that the preparation of tuberculin should always be conducted under experienced direction. It should be distributed through some central authority, so that the results from its use can be collected and tabulated and serve as a source of general information. It is an invaluable test, and by its use, as has been demonstrated by several of the States, especially Vermont, it is certainly possible to reduce very materially tuberculosis among cattle, and it may be possible to eventually exterminate it.

THE PRINCIPAL INSECTS AFFECTING THE TOBACCO PLANT.

By L. O. Howard, Ph. D.,
Entomologist.

INTRODUCTION.

The tobacco plant, although indigenous to America, does not suffer so greatly from the attacks of insects in the United States as do others of our crop plants. It has no insect enemies peculiar to itself, but every season a certain amount of damage is done by insects, and in some years favorable to insect increase this damage may mean a serious loss to the planter.

The most comprehensive work upon tobacco insects which has been published is in the Italian language, and includes a consideration of all species which affect this crop, both in the field and in the factory. But this work treats largely of European insects, being a special report of the entomological agricultural experiment station at Florence, entitled "Animals and insects of growing and dried tobacco," by Prof. A. Targioni-Tozzetti. In this country there have been occasional accounts of specific insects in the different agricultural reports and in the bulletins of the State experiment stations. Prof. H. Garman, of the Kentucky experiment station, in particular, has given the subject much attention, and has done admirable work in the important direction of proving the possibility of the practical use of arsenical mixtures on the tobacco plant. The most comprehensive article which has yet been prepared in this country is, at the time of this writing, being printed by the Florida Agricultural Experiment Station as Bulletin No. 48, with the title "A preliminary report upon the insect enemies of tobacco in Florida," by A. L. Quaintance.

The present paper contains accounts of several tobacco insects not included in the bulletin by the Florida author, who, as the title indicates, treats only of the species occurring in Florida, but the writer defers to Professor Quaintance in matters of actual field experience concerning several of the species, and wishes here to express his thanks for advance proof sheets of the bulletin in question, which have enabled him to make this paper more complete than it would otherwise have been.

From the time when the seed is sown in the seed bed to the time when the tobacco field is plowed under to some late fall crop, the

tobacco plant is subject to the attacks of several species of insects. Throughout the tobacco-growing regions of the United States there is probably no one insect which does more damage to the marketed product than the tobacco flea-beetle, or "flea bug," as it is commonly known to growers (*Epitrix parvula*). The large horn worms or "horn-blowers," also insects of wide distribution, tobacco growers must always fight. The bud worm, which may be either the larva of *Heliothis rhexia* or of the cotton boll worm or tomato fruit worm or corn-ear worm, as it is called according as it affects different plants (larva of *Heliothis armiger*), attacks and bores into the central leaf roll or "bud" early in the summer, or later in the season into the seed pods or into the terminal flower stalk, and even feeds to a certain extent upon the leaves. Several species of cutworms are liable to occasion replanting in soil which has not been properly treated, and one or two of them rag the leaves late in the season. Certain wireworms also are liable to affect the young plant shortly after it is set out. Two or more species of plant bugs occasionally damage the leaves by inserting their beaks and sucking the juices, causing a drying and shriveling of the leaf in much the same way as the harlequin cabbage bug injures the leaves of cabbage. One of these plant bugs, a small species, insignificant in appearance, has recently proved to be a serious enemy to tobacco culture in Florida. Another new insect, and one which may prove to be a very important factor in tobacco culture, is the so-called tobacco leaf-miner, or "split worm," an insect which although first found in North Carolina only two years ago has since made its appearance in Florida, South Carolina, and southern Virginia. These comprise the principal species damaging growing tobacco at the present time. There is always a chance, however, that new insect enemies may make their appearance just as two of those above mentioned have done in very recent times, and it is safe to say that many of the species which affect solanaceous plants, and especially the tomato, are liable to transfer their attentions to the tobacco crop under favorable conditions.

After the tobacco has reached the factory, an insect enemy of importance, and which is always to be feared, is the cigarette beetle (*Lasioderma serricorne*), a species which riddles the tobacco leaf, which bores into or out of manufactured cigarettes and cigars, and which, when once introduced into a not over cleanly factory, is very difficult to eradicate. Two or three other little beetles have been found in dried tobacco, namely, the drug-store beetle (*Sitodrepa panicea*) and the rice weevil (*Calandra oryza*), but they are not as important as the cigarette beetle.

It is proposed to give in this paper a short account of these insects and other species of less importance, with some indication of the proper remedies under each, and a concluding paragraph on remedial work as a whole.

THE TOBACCO FLEA-BEETLE.

(*Epitrix parvula* Fabr.)

This active little insect (fig. 7) may be found in almost any tobacco field from Arkansas to Florida and north to Connecticut. It is a minute, oval, reddish-brown species, which occurs upon many solanaceous plants, feeding upon tomato, potato, horse nettle, and jimson weed (*Datura stramonium*). The beetles make their appearance in July, attacking first the lower and then the upper leaves. After they have fed for awhile the leaf becomes full of small, dry spots and then of holes about the size of a pin point, which later may become considerably enlarged (fig. 8). When the crop is cured it is poor and thin, and frequently full of small holes. While the main damage is done in the beetle condition, the insect feeds also, in its early stages, upon the tobacco. Its eggs being laid at the roots, hatch into minute, whitish larvæ, which feed upon the roots, and, in the course of about a month, as ascertained by Mr. Chittenden, reach full growth, transform to pupæ, and again to adult beetles. The damage done to the roots in this way must affect the health of the plant to a certain extent, but it is not appreciable in comparison with the damage which the adult beetles do to the leaves. The insect, in its early stages, is not confined to tobacco, but feeds also upon the nightshade and the jimson weed, as also ascertained by Mr. Chittenden.

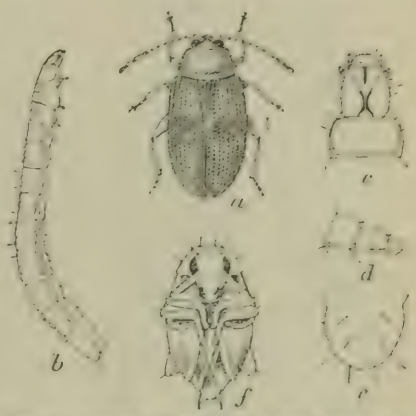

FIG. 7.—*Epitrix parvula*: *a*, adult beetle; *b*, larva, lateral view; *c*, head of larva; *d*, posterior leg of same; *e*, anal segment, dorsal view; *f*, pupa—*a*, *b*, *f* enlarged about fifteen times, *c*, *d*, *e* more enlarged (after Chittenden).

It is not alone in the actual damage to the leaves done by the jaws of the beetle that this insect is injurious to the foliage of tobacco, but through the further fact that these little holes, even when the puncture is not through the entire thickness of the leaf, become the entrance points of fungous spores or bacteria, which start a disease of the leaf which frequently damages it much more than the insects themselves. In moist weather this disease, started by the flea-beetles, may do considerable damage when the flea-beetles themselves are comparatively scarce.

By some writers the round white spots in the leaves, which are illustrated in fig. 9, have been considered to result from the initial work of the tobacco flea-beetle; but, as reported by several workers upon fungous diseases, these spots have been shown to be invaded by

a species of fungus belonging to the genus Cercospora, members of which actually cause leaf diseases upon other plants, and which are certainly capable of damaging leaves in this way without the preliminary insect work. The commonest form of this damage seems to be caused by *Cercospora nicotinæ*, and is known as "frog eye" or "white speck." Another similar disease known by the same names occurs in Florida, and another in Europe, where it is known as "smallpox." The "white speck" of the North Carolina planters is said by Ellis and Everhart to be caused by a fungus known as *Macrosporium tabacinum*. Although not proved, it is quite possible that the tobacco flea-beetle is more or less responsible for, if not the occurrence, at least the spread of these diseases. There is a fad for cigar wrappers spotted in this way. A patent on an artificial method of imitating these disease spots has lately been issued.

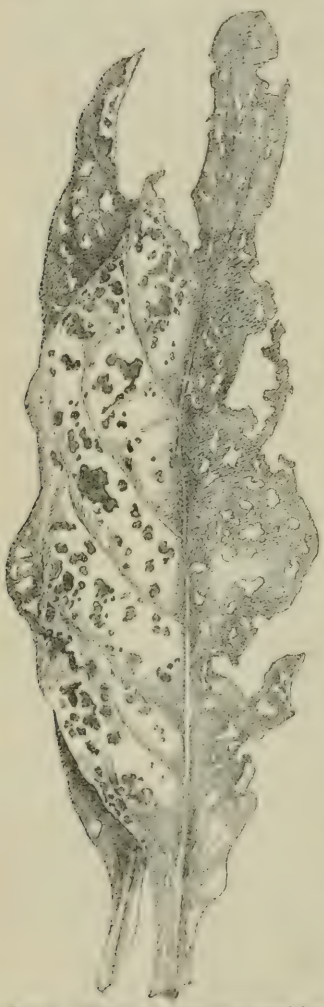

FIG. 8.—Tobacco leaves damaged by *Epitrix parvula* (original).

The writer has visited tobacco fields in Virginia in which almost every plant was more or less affected by the tobacco flea-beetle. The upper leaves were spotted by their work, particularly near the edges, and the lower leaves were riddled with holes and almost covered with the white fungous spots.

REMEDIES.

Reference will be made later in this paper to the advantage of clean cultivation in the tobacco fields. The destruction of weeds, particularly solanaceous weeds, along the margins of the field, will be of positive benefit in reducing the numbers of this insect, as well as other tobacco insects, unless (and this suggestion we make as one of much possible value) it shall be found feasible to grow a few clumps of nightshade or jimson weed as trap crops for the beetles, the plants to be thoroughly poisoned in the early summer before the tobacco has been set out. The tobacco crop is one of a few which are peculiarly adapted to this kind of remedial treatment. In the ordinary course of tobacco culture the weeds are allowed to grow freely about the margins of the fields. Before the tobacco plants are set out, those

weeds which are secondary food plants of tobacco insects, such as *Solanum nigrum*, *Solanum carolinense*, and *Datura stramonium*, act simply as concentrators and multipliers of the tobacco insects, so that the insects are already in force about the margins of the fields, ready to transfer their attentions to the young and succulent tobacco plants after they have been planted. From this it is plain that, if the margins of the fields are kept free from such plants, the insects will not have as good a start, and will not be present in such great numbers. It also follows that, if a few attractive weeds are left in clumps, the flea-beetles and other tobacco insects of the immediate vicinity will concentrate upon these few weeds, where they can readily be killed, either by the application of an arsenical poison, if they are gnawing insects, or of a kerosene emulsion, if they are sucking insects.

FIG. 9.—Leaf spots of old tobacco leaf—slightly reduced (original).

Where preliminary work of this nature has been neglected, and it becomes necessary to treat the tobacco flea-beetle in the tobacco field, we are prepared to heartily recommend the use of arsenical poisons. Small as the insect is, and much as its initial work looks like the puncture of a beak rather than the nibbling of a pair of jaws, it is a true biting or gnawing insect; therefore, if the leaves be treated, even with a minute quantity of an arsenical poison, the insect will be reached by it in the act of eating the leaf, and will be destroyed. This is not as satisfactory a means of killing the insect as the preventive mentioned above, for the reason that, in order to get its dose of the poison, the insect must damage the leaf to a certain extent, and as there is a constant succession of new beetles, the leaves will become damaged more or less, even though the insects be destroyed;

still, it prevents any great damage, and insects thus poisoned are out of the way for good, both as regards future damage by the individual and by its otherwise possible offspring.

When the idea of poisoning the tobacco leaf was first suggested it met with considerable opposition. It was feared that the persistence of the poison might render the tobacco dangerous to the human consumer. This fear still exists in many quarters; in fact, the average smoker, and, still more, the average chewer, would hardly fancy the

FIG. 10.—Northern tobacco worm, or "horn worm" (*Protoparcœceleus*): *a*, adult moth; *b*, full-grown larva; *c*, pupa—natural size (original).

idea that his tobacco had, at any time, been treated with arsenic. The same feeling, however, existed when Paris green was first used on the potato crop for the Colorado potato beetle. It was expressed when fruit growers began to spray apple trees for the codling moth, and it still remains in regard to the use of arsenicals upon cabbages, in spite of the fact that most cabbage growers are using them, and that it has been repeatedly shown that the quantity of poison which is effective is so infinitesimally small that not the least possible harm can result to the consumer. The same holds with regard to tobacco.

Careful experimentation by Professor Garman in Kentucky and the experience of practical tobacco growers in Kentucky and South Carolina have shown that, properly used, no possible harm can result from the application of an arsenical poison. Summarizing from the practical experience on record, it is the opinion of the writer that Paris green, in the proportion of 1 pound to 125 gallons of water, is the proper mixture to apply to tobacco plants. Used at this strength, it will not kill all of the flea-beetles, but it will greatly reduce their numbers. It will also be efficacious at this strength against the young caterpillars of the horn worm, or hornblower, and against sun-

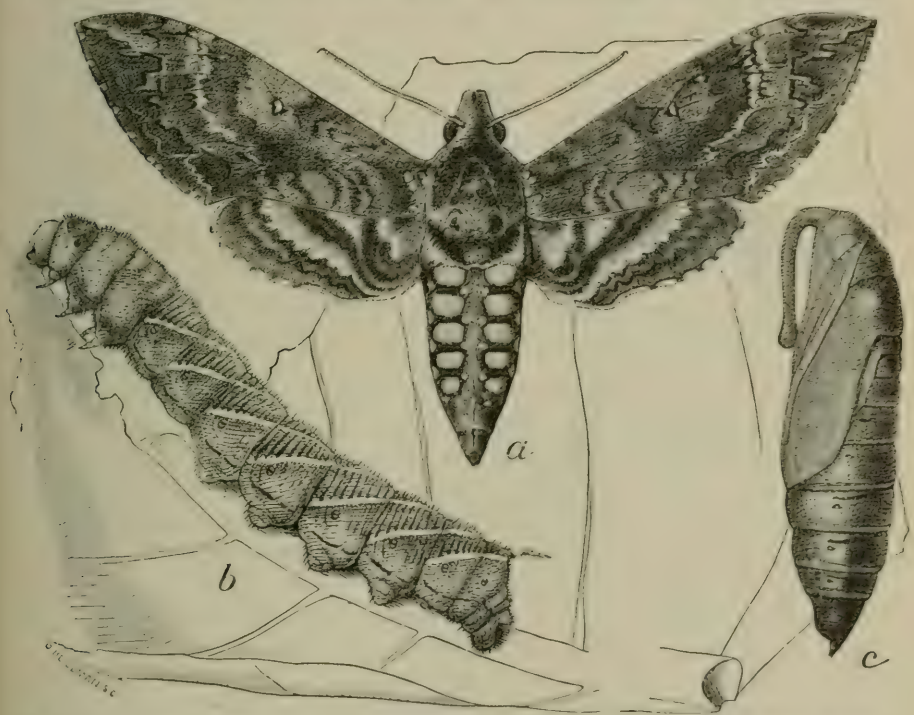

FIG 11.—Southern tobacco worm (*Protoparce carolina*): *a*, adult moth; *b*, full-grown larva; *c*, pupa—natural size (original).

dry other tobacco insects, as will later be shown. In the dry state, it may be mixed with twenty parts of spoiled flour or any fine dust, such as road dust, and dusted on the plants from one of the machines known as powder guns, or from a coarse cloth bag or sack.

After the available portions of the plants are cut in the fall, and the planter is ready to plow his fields to small grain or some other crop, there will be a positive advantage in treating the portions of the plants left in the field with a considerably stronger arsenical mixture. This, in the warm days of autumn, will kill the insects remaining in the fields, many of which would otherwise have successfully hibernated and put in an appearance ready for destructive work the

following season. The writer was particularly struck with this point the first week in November in southern Virginia The tobacco crop had been entirely harvested, but no killing frosts had occurred. The days were warm and sunny and the nights cold. On the remaining portions of the tobacco plants in the fields were many flea-beetles, bud worms, and cutworms, which, a week or so later, would have entered hibernating quarters. Just at this time, with a slight expenditure of energy, the useless remnants of the tobacco plants could have been poisoned, and practically all of these insects destroyed, much to the advantage of next year's crop.

THE TOBACCO HORN WORMS, OR HORNBLOWERS.

(*Protoparce carolina* Linn. and *Protoparce celeus* Hübn.)

There are two species of large sphinx moths whose larvæ, or caterpillars, eat the leaves of tobacco, tomato, and allied plants, including, occasionally, the Irish potato. These caterpillars, from the fact that each bears upon one of the posterior segments of its body a rather stout, curved horn, have become popularly known as horn worms. This term "horn worm" has, in some incomprehensible way, been corrupted into "hornblower" in Maryland and Virginia, where it is applied to the adult moth.

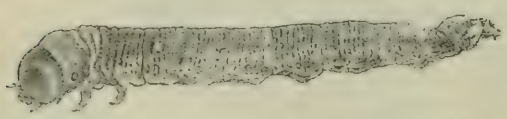

FIG. 12.—Southern tobacco worm dead and shriveled from bacterial disease—natural size (original).

Tobacco growers do not distinguish between the two different kinds of horn worms, and for practical purposes it is not in the least necessary that they should distinguish them. As a matter of general interest, however, it may be stated that the horn on the end of the body of *carolina* is red, while that of *celeus* is black. Both are green in color, with oblique white stripes on the sides of the body. These white stripes extend farther up on the back with the caterpillar of *carolina* than they do with the caterpillar of *celeus*. The curious brown pupa into which the caterpillar transforms, which is found under the surface of the ground, and which is at once recognized by the handle-shaped process which issues from the top of the head, is distinguished in the two species by the fact that the handle-shaped process, which is really the tongue case, is much longer with the pupa of *celeus* than it is with the pupa of *carolina*.[1] From these pupæ, or chrysalids, issue the adult moths. The moths of the two species may be distinguished from the fact that *carolina* is darker, and the orange spots along the sides of the body are more vivid, while the center of the hind wings of *celeus* bears two distinct, zigzag lines, which in *carolina* become blurred, darkened, and indistinct. All of these points are plainly brought out in figs. 10 and 11.

[1] The figures of both Harris and Glover are misleading on this point.

Both of these insects occur more or less abundantly in the tobacco fields over the entire tobacco-growing regions of the United States. In certain localities one species will be much more abundant than the other, and in other localities the numbers will be more evenly divided. In general, it may be said that *celeus* is the more northern species, and is found more abundantly in the more northern tobacco fields, while farther south *carolina* is apt to be much the more common. In the tobacco-growing regions of Connecticut, for example, according to Professor Fernald, *celeus* is the more common tobacco worm, while in Florida the reverse condition holds. Both species occur from Canada to Florida, and as the region of tobacco culture fails in the North, both species feed upon tomato. *Carolina* extends its range into the West Indies and South America, but *celeus* is not found south of Florida.

The life histories of both species are practically identical. Varying in date, according to the climate, the moths make their appearance, working their way out of the underground pupæ, or chrysalids, from May 1 well on into June, pair, and lay their eggs singly on the undersides of the leaves. The young caterpillars hatch from these eggs, which, by the way, are laid in the dusk of the evening, in from four to eight days, according to Professor Alwood's observation of *carolina*. In the course of their growth they cast their skin four times, and in less than a month become full grown, burrow into the soil, and transform to pupæ.

The number of generations in a year varies in different localities. In the greater part of the tobacco-growing region planters have recognized that there are two "crops" of the worms. This holds in portions of Maryland. At Blacksburg, Va., Professor Alwood has found that one "crop" is normal, and that there are occasional indications of a second "crop," or generation. In Florida, where the moths make their appearance early in May, according to Professor Quaintance, the first generation of caterpillars is not particularly destructive, but the second generation, which appears during July, causes the most damage. A third generation is normal, and probably a fourth, although in July caterpillars of various sizes may be found in the fields at one time. The retardation of development in some individuals, and acceleration in others, bring about an intermingling of generations, which is always marked in insects in the South where the number of generations exceeds three. In Cuba, where the *carolina* horn worm is said to be a severe pest to the tobacco industry, there is probably an even larger number of generations.

Actual damage done by horn worms varies greatly in different seasons. Frequently, for a number of years, they will not be too abundant to be kept down readily by hand picking, and then will come a season in which they are so numerous that it is very difficult to save the crop without incurring a prohibitive expense. Again,

comparative immunity during one summer will be followed by considerable damage the next. Professor Garman, in Bulletin No. 66 of the Kentucky Agricultural Experiment Station, states that the summer of 1896 was one of extraordinary abundance. The horn worms "were present on both tobacco and tomato in myriads, and proved so destructive that some fields of tobacco were abandoned and in the fall presented only a wilderness of stems and midribs of leaves. In such fields as many as five worms, representing both species, were frequently observed on a single plant. Their advent was so sudden that before the seriousness of the outbreak was realized tobacco that had been the pride of the owner and showed scarcely a mutilated leaf was severely injured. It was near cutting time when they became most abundant, and some growers preferred to cut their tobacco as the best means of saving it. On suckers in fields and on abandoned tobacco the worms remained until frosts killed the plants. Large numbers of both species were collected in October from such tobacco, and they were observed in fields until October 12."

Both kinds of horn worms are extremely subject to disease and to the attacks of natural enemies. Caterpillars which are observed to turn dark in color are attacked by a bacterial disease, which invariably results in their death (fig. 12). Certain parasitic insects attack others, and all tobacco growers are familiar with the appearance of a horn worm partly or entirely covered with little, white, oval cocoons. Such specimens should not be crushed, since the cocoons are made by one of the most important of the parasites of these larvæ, which, if allowed to emerge undisturbed, will increase the mortality among the caterpillars. Others may occasionally be noticed bearing very minute, oval, white eggs sticking closely to the skin. These are the eggs of a Tachina fly, and the maggots which hatch from these eggs bore into the caterpillar and eventually destroy it.

REMEDIES.

It will be unnecessary to repeat what has been said under the head of "The tobacco flea-beetle" concerning the use of arsenical poisons. When the first generation of horn worms appears (and each tobacco grower must determine the approximate date from observation in his own fields), an application of Paris green, either dry or in the liquid form, as elsewhere described, is by far the best remedy when the insects are numerous. In ordinary seasons and in certain localities the tobacco crop will not suffer so severely that it can not be protected by the ordinary process of hand picking, or "worming," as it is called. Most conservative tobacco planters send their hands through the fields to pick off the caterpillars and crush them, and rely upon no other remedial work.

The adult moth possesses a long beak, through which it sucks the nectar of flowers, being attracted especially to the sweetest flowers

and those possessing a long, tubular corolla, like the honeysuckle and the morning-glory and the flower of the Jamestown, or "jimson" weed. Many years ago it occurred to an observing planter that the jimson-weed flowers might be poisoned to advantage, and from this suggestion has grown up the custom in certain parts of the country of squirting into the flowers of the jimson weeds growing in the immediate vicinity of the tobacco fields a certain amount of sweetened water poisoned with cobalt or "fly stone." A modification of this process, described by Professor Quaintance, is as follows: "In the evening a quantity of the bloom of the jimson weed is procured and is placed promiscuously through the field under holes in horizontal slats, supported by sticks or otherwise, and into the flowers is placed, by means of a quill, a small quantity of this poisoned mixture. This poison should be of about the following proportions: Cobalt, one ounce; molasses or honey, one-fourth pint; water, one pint." This practice is so well understood among tobacco growers that it is hardly worth detailed mention, except to state that experiments at the Louisiana experiment station and elsewhere have proved that it is effective as a palliative. At the experiment station just mentioned jimson weed was grown for this purpose, and the writer remembers a doleful complaint by the director of this station some years ago to the effect that his farming visitors interfered with the experiment, since their horror of weeds was so great that, in passing through his grounds, they pulled up the jimson weeds and spoiled his experiment.

Many years ago Townend Glover, the first entomologist of the Department, in mentioning this method of catching the moths of the horn worm, suggested the manufacture of artificial porcelain or tin jimson flowers, which would be perennial in the highest degree and could be poisoned year after year. The writer is not informed, however, as to whether this suggestion has ever been followed.

A sweetened preparation, poisoned with arsenic, however, has been tried in Maryland by Prof. W. G. Johnson during the past year. The material was placed in wooden pails, perforated near the bottom and set in granite pans, into which the poisonous liquid was leached. These traps or decoys were set upon stakes about the field a little higher than the tops of the tobacco. Although the experiment appeared to be successful, Professor Johnson reserves his final conclusions until he has had an opportunity to make further tests another year.

Most tobacco growers have learned by experience the necessity of carefully removing the worms from the leaves after or during cutting and before they are carried into the barn, since otherwise they will continue to feed in the barn on the drying leaves. Where such care has not been exercised, the evaporation of bisulphide of carbon in the barn, in accordance with the directions and with the precautions which will be described under the head of remedies for the cigarette beetle,

will kill the worms before they can do further damage, and the quality of the tobacco, as we have proved by experiment, will not be injured in the least, the reverse being the case when the smoke from a damp wood fire is used, as it is sometimes for this purpose.

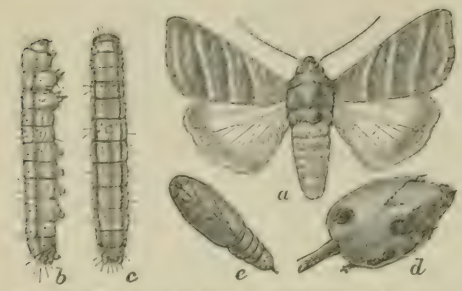

FIG. 13.—The true bud worm (*Heliothis rhexia*): *a*, adult moth; *b*, full-grown larva, from side; *c*, same, from above; *d*, seed pod bored into by larva; *e*, pupa—natural size (original).

THE BUD WORMS.

(*Heliothis rhexia* S. & A. and *Heliothis armiger* Hübn.)

Just as there are two distinct though very similar insects known as horn worms, so there are also two distinct and rather similar insects known as bud worms, which occur frequently together in the same field and work in a somewhat similar manner. We shall take the liberty of distinguishing between them by calling one the true bud worm and the other the false bud worm.

The true bud worm (*Heliothis rhexia*) occurs in the more southern portions of the tobacco-growing regions, but has not been noted in tobacco fields north of Maryland. The adult insect is a small, greenish moth, well illustrated in fig. 13. The larva or caterpillar of this moth, also characteristically shown in fig. 13, is nearly always found in the bud of the tobacco plant about the time the plant is ready to top. In some seasons they occur in large numbers and damage the tobacco considerably. In the early part of the season, as a general thing, but few of them are found, and in ordinary seasons they are not especially noticed during the early "worming" of the tobacco. In August they begin to be more abundant, and generally leave the plant about the end of the month, entering the ground, transforming to pupæ and issuing as moths toward the end of September. These dates are Virginia

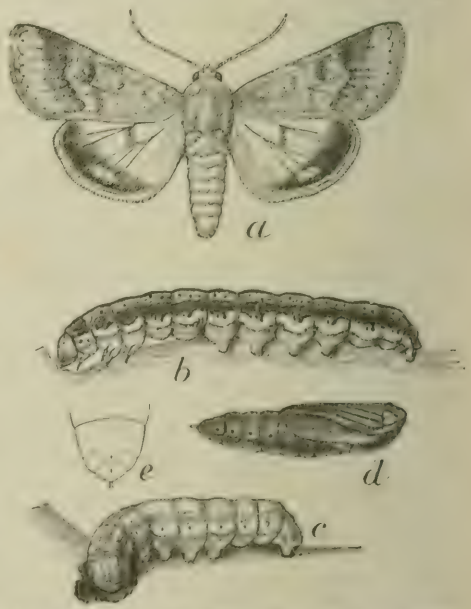

FIG. 14.—False bud worm or cotton boll worm (*Heliothis armiger*): *a*, adult moth; *b*, dark full-grown larva; *c*, light-colored full-grown larva; *d*, pupa—natural size (original).

dates, but hold reasonably well as far south as Mississippi. As just stated, the greatest damage done by this insect is by the August brood, when it enters the rolled-up leaves or bud of the plant. In September and October the next generation of caterpillars is found boring into the seed pod and occasionally into the flower stem. We have received the insect at various dates from July 10 to the end of August from Virginia, Georgia, Alabama, and Mississippi. The worst account of damage which has come to us was received in July, 1888, from Mr. J. S. Barnwell, of Darien, Ga., who said that in general this bud worm damaged his tobacco more than the horn worm. When young it occurred abundantly in the buds and ate so many holes through the young leaves as to render them unfit for wrappers.

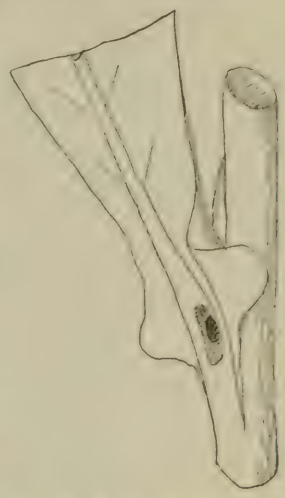

FIG. 15.—Work of full-grown false bud worm in flower stem—reduced (original.)

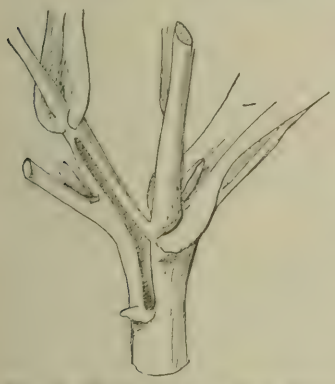

FIG. 16.—Work of young false bud worm—reduced (original).

The caterpillars of the last fall generation enter the ground and hibernate as pupæ. The insect has several other food plants aside from cotton, but its most abundant food in the South is the weed known as ground cherry (*Physalis viscosa*). It has been found on several solanaceous weeds, as well as upon cultivated geranium.

The species which we have called the false bud worm (fig. 14) is the same caterpillar which, when occurring upon cotton, is called the "cotton boll worm;" upon tomato, the "tomato fruit worm," and upon corn, the "corn-ear worm." It is the larva of *Heliothis armiger*, a cosmopolitan species of varied food habits, and which, as its different popular names denote, has a destructive propensity for boring into anything like a pod. Fortunately, tobacco is not a preferred

FIG. 17.—Work of false bud worm in seed pods—reduced (original).

food plant. The insect lives on corn until the ears are too hard for easy attack, and then transfers its attention to other plants. From this it results that it is usually only late in the season that the larvæ are found upon tobacco. Here it works much as does the true bud worm, boring into the seed pods and into the flower stalks, as indicated in figs. 15, 16, and 17, and also, more rarely, feeding upon the leaves. These remarks hold for Virginia. In Florida, however, according to Mr. Quaintance, the principal damage is done by these caterpillars during the early part of the year, when they do not have corn or cotton to feed upon. The eggs are deposited in the bud, and the larvæ do very serious harm by feeding on the young and as yet unfolded leaves. A large worm may quite devour a bud. In color and markings the false bud worm is one of the most variable of caterpillars. On tobacco the writer has found specimens of a uniform, light green color, without spot or stripe, and others the general effect of which was nearly black. Between these two extremes many variations occur. This insect, like the true bud worm, passes the winter in the pupa condition under the surface of the ground.

REMEDIES.

The arsenical spray recommended for the flea-beetle and for the horn worms will also be efficacious, to a certain degree, against the bud worms, but in Florida Mr. Quaintance has found it desirable to make a specific treatment for these insects, which, when they are very numerous, may be advisable, although it necessitates considerable trouble. He recommends sprinkling poisoned corn meal in the bud. He adds a half teaspoonful of Paris green to a quart of finely-ground corn meal, which is thoroughly mixed by stirring. He then makes a sprinkler of a baking-powder can, in the bottom of which numerous holes have been punched, so that when it is shaken the poisoned corn meal may be peppered over the bud. He advises that the poison should be frequently applied, and after heavy rains.

With these, as with other tobacco insects, there is much to be gained by clean culture, in keeping down the weeds on which the insects feed, and also by careful attention to corn and tomatoes which may be growing in the vicinity. Late fall plowing is efficacious against both species by breaking up the little earthen cells in which the pupæ are found under the ground, thus exposing them to the action of frosts.

THE NEW TOBACCO BUG, OR "SUCK-FLY."

(*Dicyphus minimus* Uhler.)

This insect is not only new as a tobacco enemy but is new to science, and was named and described by Professor Uhler in November, 1898. The specimens from which the description is drawn were received at the office of the Entomologist from Florida, but Professor Uhler had previously received specimens from Louisiana, Texas, Mississippi, and Alabama, with an account from the latter State that it feeds upon

tomatoes. It was first brought to the writer's attention in July, 1898, by Mr. T. A. Carroll, of Gainesville, Fla. Specimens which were received at that time were fed here upon tobacco through the remainder of the season. The eggs have not been found, but two generations developed between July and the killing frosts, on which date the bugs disappeared, hiding away in the full-grown condition for hibernation. The different stages of growth observed are shown in fig. 18. The species has been studied to better advantage in the field by Mr. Quaintance in Florida, who considers it a serious enemy of the crop,

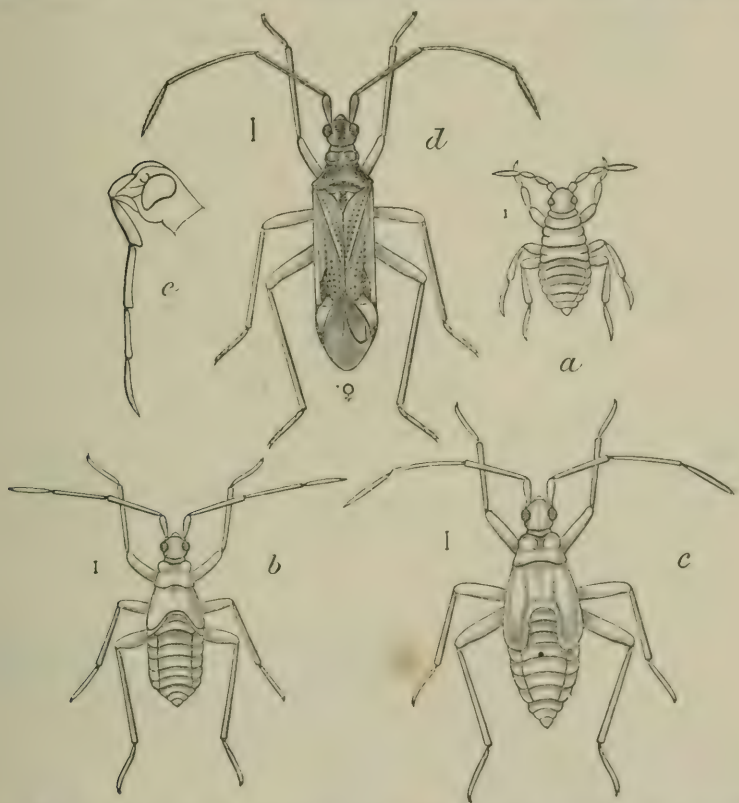

FIG. 18.—The "suck-fly" (*Dicyphus minimus*): *a*, newly hatched; *b*, second stage; *c*, nymph; *d*, adult; *e*, head and beak from side—enlarged (original).

and states that it has been known to growers in Columbia County for the past ten years. The first crop is generally not damaged to any serious extent, but the second crop and late tobacco are frequently quite destroyed. Mr. Quaintance also states that the insects make their appearance in injurious numbers during the first and second weeks in June, and that the full-grown bugs are first noticed in some restricted portion of the field, as on the plants in one corner, from which they gradually move over the field. They have been observed on neglected tobacco as late as November 22.

The insects damage the leaf by sucking the cell sap through their beaks. The infested leaf soon becomes yellowish in color and somewhat wilted, and the older leaves eventually split in places, so that they become very ragged. The immature specimens of the bug live on the underside of the leaves, but the adults live both above and below. The full-grown specimens are partial to shade, and may be observed feeding close to the margin of a shade thrown by an overhanging leaf. Experienced tobacco growers say that leaves which have been badly infested with the "suck-fly" are very difficult, if not impossible, to properly cure. Mr. Quaintance says that the eggs are deposited singly in the tissues of the leaf, and mainly in the smaller veinlets. He finds that the egg state lasts about four days, and that in Florida the entire life cycle of a given generation is only about fifteen days. He was unable to keep the adult insect alive in a breeding cage for more than six days, but we have kept them in Washington City for at least a month.

REMEDIES.

This, again, is an insect against which clean culture will be reasonably effective. A thorough cleaning up of the fields and burning of the trash in the autumn are measures which should be adopted when the insect is abundant. Actual test experiments with different insecticides were made by Mr. Quaintance, who found that a concentrated solution of nicotine, diluted with sixty parts of water, will kill a large proportion of the full-grown insects and many of the young. He advises that this spray be applied early in the morning, as at that time the insects are less active. Early set trap plants will probably be an advantage in concentrating the hibernating insects, so that they can be readily killed.

OTHER SUCKING BUGS.

Several true bugs, which damage the leaves by inserting their beaks and sucking the juices, causing a shriveling or drying of the leaf in the same way as the harlequin cabbage bug injures the leaves of the cabbage, are found in the tobacco fields. Several of these plant bugs are known indifferently to tobacco planters as "stink bugs," on account of the disagreeable odor which they give out. We have never known any of them to be a very serious factor in tobacco growing.

One of the commonest of these bugs in the more northern portions of the cotton belt is *Pœciloscytus diffusus* Uhler. This insect is found in all seasons of the year, and when very abundant the remedies recommended against the "suck-fly" may be used. The writer has found it very abundant and in all stages of growth in Virginia tobacco fields as late as November.

Another species is a green bug shown at fig. 19, and which is known scientifically as *Euschistus variolarius*. This is a species which was

found by Professor Garman wilting plants in an experimental plat of tobacco at the Kentucky Agricultural Experiment Station in the summer of 1896, and which is suspected to have done more or less damage over quite a wide extent of country that season.

FIG. 19.—*Euschistus variolarius:* nymph at left; adult at right—enlarged (original).

An interesting little bug of the family Scutelleridæ, viz, *Corimelæna extensa* Uhl., has been found damaging native tobacco at Cedar Ranch, Ariz., by Prof. C. H. T. Townsend. It is reported to be the only member of its family which lives upon tobacco, and as Professor Townsend found it to be very abundant, it is probably an important future enemy to the tobacco crop, especially if tobacco culture increases in the Southwest.

THE TOBACCO LEAF-MINER OR "SPLIT WORM."

(*Gelechia solanella* Boisd.)

This insect, which is also comparatively new in this country as a tobacco insect, was first brought to the writer's attention as an enemy to this plant early in 1896 by Prof. Gerald McCarthy, formerly of the North Carolina experiment station. The adult insect is a minute, grayish moth, shown in fig. 20. Its eggs are laid upon the leaves, and the minute caterpillar bores between the surfaces of the leaf, making a flat mine, often of considerable size, with a gray discoloration visible from both sides of the leaf. Frequently there is a distortion when the mine occurs near a large vein, as shown in fig. 21. There are two or more generations in the course of the summer, and the insect is more noticeable in the autumn than at an earlier date. Down to the present year the insect was known to occur as a tobacco insect in this country in North Carolina only, the exact locality not having been given to us by Professor McCarthy, nor did he mention it in the little account of the insect which was published in Bulletin No. 141, of the North

FIG. 20.—Tobacco split worm: adult moth above; larva below at right; pupa below at left, with side view of enlarged anal segment—all enlarged (original).

Carolina Agricultural Experiment Station. During the present year, however, Mr. Quaintance has found the insect damaging tobacco in many localities in Florida, and the writer discovered it mining tobacco leaves in Pittsylvania County, Va. Specimens have also been received from Mr. J. J. Wolfe, of Sandy Run, Lexington County, S. C., who states that he was troubled the past season by this insect, which made its appearance early and increased its damage as the season advanced. The writer of this paper is indebted to Mr. Wolfe for the characteristic name of "split worm," by which he states the insect is commonly known in his vicinity. He also states that during the past year it did more damage in his neighborhood than all other insects combined.

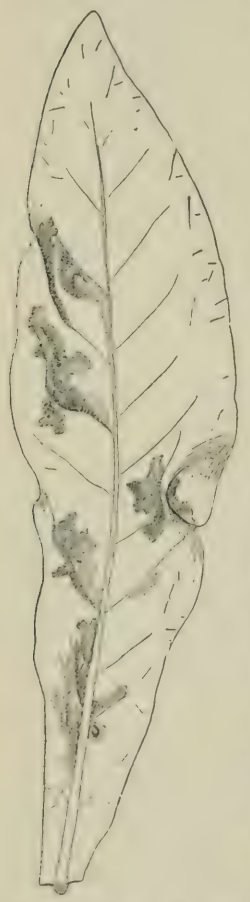

FIG. 21.—Work of split worm—reduced (original).

When Professor McCarthy first sent this insect to the Entomologist for identification, there was found to be some difficulty in ascertaining just what it was. On consulting a specialist in the group of insects to which this one belongs, it was decided to be *Gelechia piscipellis* of Zeller, an insect which has been reared in this country from the common horse nettle or ball nettle (*Solanum carolinense*), and under this name it was treated in the North Carolina bulletin by Mr. McCarthy, and in the Florida bulletin by Mr. Quaintance. A more careful study was given to the insect, however, during the preparation of this paper, and a great similarity was noticed between it and an insect which has been known as the potato tuber moth, an article on which was published in Insect Life (Vol. IV, p. 239 to 242), and which, after being recorded as damaging the tubers of the Irish potato in Algeria, Australia, and New Zealand, made its appearance in portions of California, also working in potato tubers; in fact, the only difference noted in the series reared from potato tubers from California and from tobacco leaves in North Carolina was a general difference in size. On comparison of the larvæ and pupæ from the two food plants these also were found to be identical.

To settle the matter beyond all question, a series of the moths from potato and tobacco were sent to Lord Walsingham, the English authority on the insects of this group, who confirmed our surmise as to their identity; and the tobacco leaf-miner must now be known as *Gelechia solanella* Boisduval. It transpires also that the same insect has been observed injuring tobacco in New South Wales "by burrowing

within the stems and larger branches;"[1] that it also occurs in tobacco in Algeria, and that it has also been described under the different name (*Gelechia tabacella* Ragonot) as injuring tobacco in Algeria. In this country it has also been observed by Professor McCarthy as mining in the leaves of horse nettle (*Solanum carolinense*) on the margins of tobacco fields, and is recorded by Mr. Quaintance as mining in the leaves of tomato and in the leaves and boring into the fruit of the eggplant. We have, therefore, as its food plants, potato, tobacco, horse nettle, tomato, and eggplant; and as its localities, eastern Australia, New Zealand, California, Colorado, Florida, South Carolina, North Carolina, and Virginia.

In Florida the leaf-miners make their appearance about the last of May, and are said to occur as late as October. There are several generations each year. In southern Virginia the writer found full-grown larvæ in the lower leaves of tobacco plants about the margins of the fields as late as November 2. The insect was not known to tobacco growers in that vicinity, and when one prominent and exceptionally well-informed tobacco planter was shown these leaf blotches he said: "That is not the work of an insect, but is what we call 'wet weather rot,'" and appeared surprised when the writer pulled apart the two surfaces of the leaf and showed him the little worm. At that season of the year the little mining caterpillar was something over a quarter of an inch in length and of a dull greenish color, with darker head and thorax.

REMEDIES.

Professor Quaintance has shown that in Florida this leaf-miner, when feeding, does not pass its entire life in one place, but after eating for awhile it will gnaw to the outside, and then crawling around over the leaf, will finally enter the tissue again in a new place. From this habit of the insect, it at once becomes evident that it will be subject to destruction by an arsenical spray, just as are the caterpillars which uniformly feed externally upon the leaves. Moreover, from the fact that in Virginia and North Carolina it is frequently well on into July before the tobacco crop is planted out, the early generation of the insect must be passed in some other food plant. Where horse nettles are present in the vicinity of the fields the insects will feed in the leaves of this plant, and the second generation will attack the tobacco fields. The destruction of all horse nettles, then, about June 1, will be a practical measure which will reduce the numbers of the split worms in tobacco to a minimum.

Although this insect has not been found in the nightshade and the jimson weed, it is altogether likely that it will also attack these weeds, and their destruction, therefore, is equally to be recommended.

The insect doubtless passes the winter in the leaves as a larva or a pupa, and the advisability of destroying old, blotched leaves which

[1] A. S. Olliff, Agr. Gaz., N. S. W., September, 1892.

have no value is at once evident. Clean culture in this direction is advisable on other grounds, and is certainly desirable as a means of reducing the numbers of this species.

The partial synonymy furnished to the writer by Lord Walsingham is as follows:

Solanella, Bdv.

Gelechia terrella,[1] Wkr. Cat. Lp. Ins. B. M., XXX, 1024 (1864). *Bryotropha solanella* Bdv., J. B. Soc. Cent. Hort. 1874; Rag. Bull. Soc. Ent. Fr. 1875, XXXV-XXXVII. *Gelechia tabacella*, Rag. Bull. Soc. Ent. Fr. 1879, CXLVI-CXLVII. *Gelechia solanella*, Meyr. Pr. Lin. Soc. N. S. W., 112 (1879); N. Z. Jr. Sc., II, 590 (1885). *Lita tabacella*, Rag. Bull. Soc. Ent. Fr. 1885, CXI-CXII. *Gelechia solanella*, Meyr. Tr. N. Z. Inst., XVIII, 166-7 (1886). *Lita solanella* (Olliff), Agr. Gaz. N. S. W., II, 158-9 (1891).

CUTWORMS.

Tobacco is no less subject to the attacks of cutworms than are many other crops. Grown in seed beds, as it is, and set out in newly plowed fields in the summer, the plants are naturally attacked by the hungry worms, which for some days at least had existed in the soil deprived of food. It is a common experience with tobacco growers, as well as other agriculturists, that cutworms are always more numerous in fields left in fallow for a period before being planted to certain crops. There is a greater variety of vegetation in such fields, and the moths which lay the eggs which produce the cutworms are more apt to be attracted. Tobacco growers who have planted their fields to clover after the removal of the tobacco crop are also apt to find that there are plenty of cutworms present the following season. Those who plant winter grain, however, find that the following crop is less liable to damage by cutworms. This indicates the relative value of different cropping methods. It is a comparatively simple matter, however, to rid a field of cutworms before planting out the tobacco, and as a measure of safety this course may be followed to advantage. After the field is

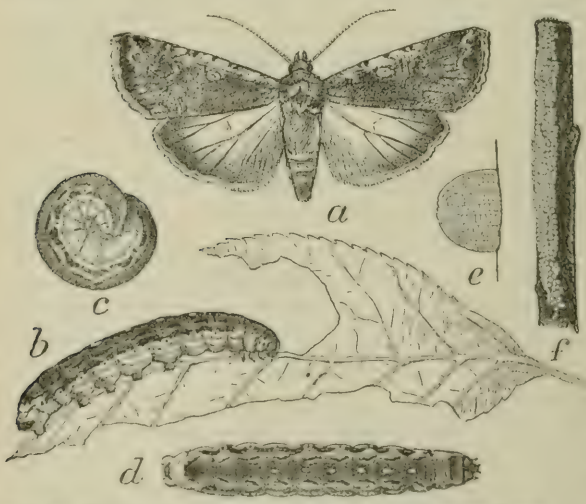

FIG. 22.—*Peridromia saucia*: *a*, adult; *b*, *c*, *d*, full-grown larvæ; *e*, *f*, eggs—all natural size except *e*, which is greatly enlarged (original).

[1] Oldest name but a homonym.

plowed and is bare of vegetation and ready for planting, if the tobacco grower will thoroughly spray a patch of grass or weeds with Paris green and water, and will then cut it and drop it in little bunches here and there throughout the tobacco field, he will find that the cutworms in the soil, in the absence of other food, will eat this cut poisoned vegetation and will be destroyed, so that the tobacco plants can be set out without fear of damage.

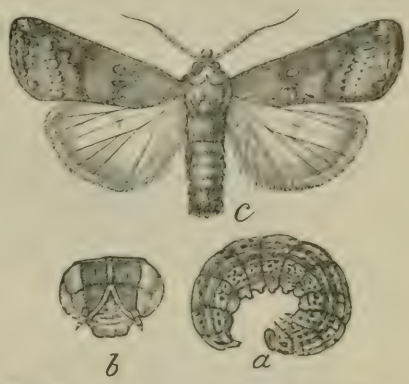

FIG. 23.—*Agrostis ypsilon*, one of the tobacco cutworms: *a*, larva; *b*, head of same; *c*, adult—natural size (original).

Without such preventive treatment (and especially when, as indicated above, the land has grown up with weeds, grass, and other wild vegetation) before the planting out of the tobacco crop, the result will frequently be the cutting down by the cutworms of a large proportion of the tobacco plants; and the writer has known of instances where more than one-half of the crop had to be replanted.

Some farmers, instead of a poisoned trap of green vegetation, prefer the so-called bran-arsenic mash, which originally came into use as a remedy against insects in California, where it was successfully used against the California devastating grasshopper. It was first tried against cutworms in California also successfully. In the East it has been used against cutworms affecting different crops, and with the greatest success in southern Virginia against the American locust or grasshopper. In the tobacco field it has also been successfully used against cutworms in Florida. The bait, or mash, is prepared by thoroughly mixing Paris green and bran at the rate of 1 pound of Paris green to 50 or 75 pounds of bran. Just before using, it should be moistened slightly with water and sweetened with molasses. The Florida custom is to put a small ring of the poisoned mixture around each newly set plant, or to place a teaspoonful at two or three different places. Cutworms prefer this poisoned mash even to green vegetation. It should be renewed frequently, and fowls or live stock should not be allowed access to it. Mr. Quaintance recommends that where seed beds are

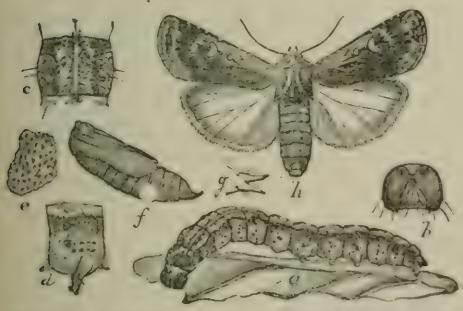

FIG. 24.—*Agrostis annexa:* *a*, larva; *f*, pupa; *h*, adult—natural size (*h*, original; others from Ann. Rept. U. S. Dept. Agr., 1894).

badly infested with cutworms the poisoned bran should be drilled along in various parts of the bed where it will be readily accessible to them. The bran-arsenic mash produces the best results when it is used as we have recommended for the poisoned-vegetation trap to rid the land of cutworms before the tobacco plants are transferred from seed bed to field. In this case the land is prepared beforehand, and a little of the mash is dropped in the drill near the place where the plant will be set. Prof. W. G. Johnson recommends that this should be done from three to five days before the plants are set out.

FIG. 25.—The cabbage Plusia: *a*, moth; *b*, full-grown larva; *c*, pupa, with its cocoon—natural size (original).

A number of different species of cutworms may be concerned in this damage, and some of the characteristic forms which have actually been found in the tobacco field are illustrated in figs. 22, 23, and 24.

OTHER TOBACCO LEAF-FEEDERS.

Several insects of less economic importance than those which we have already mentioned are occasionally found feeding upon the leaves of the plant.

The so-called cabbage Plusia (*Plusia brassicæ* Riley).—This insect (fig. 25), which occurs in most parts of the United States and has a number of different food plants, has been found in tobacco fields in Maryland, feeding upon the leaves, by Mr. F. C. Pratt, of the Division of Entomology, although not in sufficient numbers to give it a high rank as a tobacco insect. It is one of the species which is readily destroyed by the arsenical spray.

Mamestra legitima Grote.—This insect (fig. 26), which is allied to the cutworms, feeds exposed upon the foliage of different plants. Its larva is a very handsome caterpillar, bright yellow in color, with velvety-black longitudinal lines. It has never been recorded as a tobacco insect, but was found rather abundantly by the writer in tobacco fields in southern Virginia upon the leaves, which, in some cases, were badly ragged. This insect can also be easily destroyed by the arsenical spray.

The tobacco thrips (*Thrips tabaci* Lindeman).—This minute insect, which sometimes does considerable damage to onions and which has been popularly known in this country as the "onion thrips," was originally described, in 1888, by Professor Lindeman, of Russia, as an

enemy of tobacco in Bessarabia. It occurs upon many plants in this country, but has never been found upon tobacco. although in southern Russia it at one time caused much damage to the leaves, puncturing them and causing them to wilt. As this insect, occurring in this country as it does from the Atlantic to the Pacific, may at any time be found upon tobacco, it is worthy of mention and of an illustration in this connection. It is shown at fig. 27.

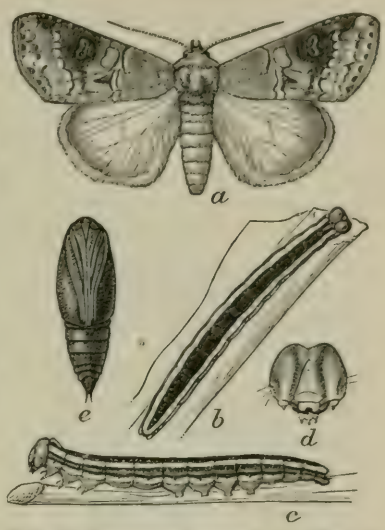

FIG. 26.—*Mamestra legitima:* *a*, adult; *b*, larva from above; *c*, same from side; *d*, head of same from front; *e*, pupa—all natural size except *d*, which is enlarged (original).

The "white fly" of tobacco (*Aleyrodes tabaci* Gennadius).—One of the insects especially noticeable in Europe is a minute form which looks like a small scale insect on the under side of the leaf. Its damage to tobacco in Greece was demonstrated by Professor Gennadius in 1889. A closely allied or identical species occurs upon tomato in this country, but European specimens from tobacco have not been compared with our tomato species, so that we can not speak positively as to their identity. The tomato species is, however, liable to be found upon tobacco.

Tree crickets (*Oecanthus fasciatus*).—Young tree crickets are occasionally found upon tobacco, eating the leaves to some slight extent. They do no especial damage, but are worth mentioning in this connection. The greatest damage done by tree crickets is occasioned by the punctures in the stems of plants like raspberry and blackberry, which are made by the females in laying their eggs. So far as known, they have not been observed to puncture tobacco for this purpose. In portions of Maryland these little insects are known as "chatteracks," presumably from the song of the male.

FIG. 27.—*Thrips tabaci:* *a*, adult; *b*, antenna of same; *c*, young larva; *d*, full grown larva—enlarged (original).

The mealy bug (*Dactylopius citri* Risso).—In the course of greenhouse observations on tobacco plants at Washington City it has been found that the common mealy bug thrives and multiplies alarmingly upon tobacco plants. Since this mealy bug is an outdoor pest of many plants in the South, it seems from this experience that it has

only to be brought into the immediate vicinity of a tobacco field to spread upon the crop, and under favorable conditions it may occasionally do considerable damage.

Plant lice.—Several species of plant lice are known in Europe to occur occasionally upon tobacco, and several of our American species which affect solanaceous plants are liable at any time to be found upon tobacco. As a matter of fact, however, we have never known any especial damage to be done to tobacco by these insects. Late in the autumn of the present year the terminal leaves of the tobacco plants growing in the experimental plats of the Division of Entomology became covered with a plant louse known as *Nectarophora tabaci* Pergande. This species has been found by its describer, Mr. Pergande, of the Division, during the last two years upon the leaves of young pear trees on the grounds of the Department of Agriculture, and also upon the leaves of apple, Rumex, Leucanthemum, and Forsythia, as well as tomato and eggplant. During the summer the same species was received from Dr. F. P. Phelps, of Mount Holly, Md., with the information that 5 acres of tomato plants were covered with countless millions of these lice. The writer would not be at all surprised if in the near future considerable damage to tobacco by this species should be reported.

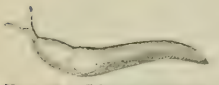

FIG. 28. *Limax campestris*—natural size (after Binney).

The twelve-spotted Diabrotica, or "corn-root worm" (Diabrotica 12-punctata).—In Kentucky, according to Professor Garman, this small, greenish beetle, marked with twelve black spots, which is so common on cucumbers, squashes, melons, and other cucurbitaceous plants, is often found on tobacco leaves, eating small round holes. Its larvæ feed on the roots of corn, and the beetle is only a casual visitor of the tobacco field. It can not be considered a dangerous insect by the tobacco grower.

Slugs (Limax campestris Binney, and allied species).—Damage is occasionally done to young tobacco plants in seed beds by slugs. Specimens were received last summer from Dr. H. T. Fernald, the State zoologist of Pennsylvania, which he said had very seriously damaged some of the tobacco beds by eating the young leaves. These specimens were submitted to Dr. W. H. Dall, of the Smithsonian Institution, who said that they were young and badly contracted, but probably belonged to the species known as *Limax campestris* Binney, which is shown by fig. 28.

THE CIGARETTE BEETLE.

(*Lasioderma serricorne* Fabr.)

Of the insects injurious to cured tobacco none approach, in economic importance, the species which has become known as the cigarette beetle. The name "cigarette beetle" is more or less of a misnomer, since the insect not only feeds in all kinds of dried tobacco, and even in snuff, but also in many other substances, such as rhubarb, ginger,

cayenne pepper, ergot, turmeric, yeast cakes, rice, figs, prepared fish food, and dried plants prepared for the herbarium.

Working as it does in all kinds of cured tobacco and living in this substance during all stages of its existence, it damages cigarettes and cigars principally by boring out of them, making round holes in the wrappers so that they will not draw (fig. 29). Leaf tobacco is injured for wrapping purposes by being punctured with holes made both by the larvæ and the beetles, and fillers and fine cut are injured by the reduction of their substance by the actual amount consumed by the larvæ. The adulteration of fine cut by the bodies of the insects and by their excrement is also a kind of damage, though an entomological acquaintance of the writer insists that he buys infested short cut by preference, both because he can get it cheaper and because the bodies of the insects impart a distinct and not disagreeable flavor to the tobacco. He admits, however, that it is a cultivated taste.

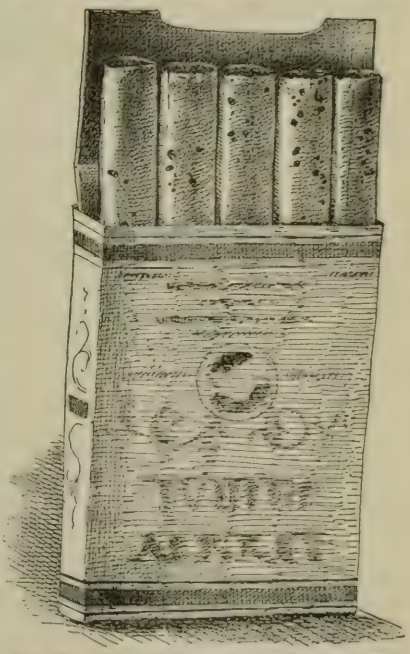

FIG. 29.—Work of cigarette beetle—reduced one third (original).

The cigarette beetle is practically cosmopolitan, and probably occurs in most tobacco factories in the Southern States, as well as in most wholesale drug stores. In the far South this insect multiplies rapidly throughout the greater part of the year, and its development is practically continuous in artificially warmed factories farther north. Observations upon the life history of the species were made by Prof. George F. Atkinson some years ago, when he was connected with the North Carolina Agricultural Experiment Station, and more recently by Mr. Chittenden, of the Division of Entomology. It seems tolerably certain that there are two generations produced each year in the District of Columbia. Professor Atkinson says that he has seen the beetles in copulation in January at Chapel Hill, N. C., but Mr. Chittenden has never seen the beetles later than November or earlier than May. It passes the coldest of the winter months in the larva state. In artificially warmed buildings the insect is apt to be present in all stages at almost any time of the year. Professor Atkinson observed that the larvæ hatch in eleven days from the time of egg laying, and that they remain as larvæ from sixty to seventy days. The larva (fig. 30) when full grown spins a fairly compact cocoon of a silky substance covered with bits of whatever substance the insect is breeding in. In this cocoon it soon transforms to a pupa and the adult beetles emerge

later. Mr. Chittenden has found that in a warm room the entire life round may be undergone in forty-seven days. These insects were reared in a dry yeast cake, however, and not in tobacco.

It is only within comparatively recent years that the cigarette beetle has become at all serious to tobacco manufacturers in this country, but it has been increasing and spreading of late, and at the present time it is found not only in many factories, but also in warehouses, tobacco barns, and retail establishments. The writer knows of one little shop into which it was accidentally introduced in some plug tobacco. It increased, entered the show cases, and ruined a large number of high-priced cigars and cigarettes. The shopkeeper was in despair, but finally, at the advice of the writer, submitted his entire stock to fumigation with bisulphide of carbon, and thus completely rid his establishment of the beetle.

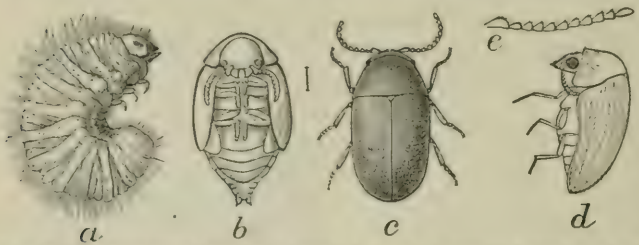

FIG. 30.—The cigarette beetle: *a*, larva; *b*, pupa; *c*, adult; *d*, side view of adult; *e*, antenna—all greatly enlarged, *e* still more enlarged (re-engraved from Chittenden's illustration).

REMEDIES.

With a small establishment like the one just mentioned, it is a comparatively simple matter to destroy the insect by means of the fumes of bisulphide of carbon. The place was clean and well-swept and dusted, and all that was necessary was to have a tight case (a show case was used) and the entire stock of tobaccos, cigarettes, and cigars was placed in the case in installments, and a saucerful of bisulphide of carbon was evaporated over night. In the morning the contents of the case were removed, the store was aired, and the next night another lot was fumigated. For some time after this experience the shopkeeper in question used the same case as a quarantine box, and put all of the tobacco which he bought through the fumigating process before he placed it on his shelves. Gradually, however, his vigilance was relaxed, and he has since had no experience with the cigarette beetle.

In a large factory, however, the case is, of course, very complicated. The average factory is not a clean place. It is frequently an old building, roughly built, with innumerable cracks in the floors and walls, which, in the course of years, have become filled with tobacco dust and fragments. Even the crevices about the windows are filled with comminuted tobacco. Frequently large stocks of tobacco are kept on hand a long time. When the cigarette beetle has once obtained a foothold in such an establishment, it is a matter of considerable time, expense, and energy to get rid of it, and at the same time it is as much as the reputation of such a factory is worth to allow goods to go out containing any specimens of the insect in any form.

There is an unfortunate and, the writer believes, wholly unjustified prejudice against steaming tobacco. Experiments carried on by Professor Atkinson in 1885 or 1886 showed that proper steaming will destroy this insect in all of its different stages, and the practical experience of several tobacco manufacturers, whose establishments have been visited by the writer, has indicated the same thing. With this knowledge, therefore, barring prejudice, there is no reason why a tobacco manufacturer should ever put out any infested tobacco. It becomes important, however, to entirely rid his establishment of the insect, and here nothing but heroic measures will avail. Taking a room at a time, the floor and walls must be thoroughly cleaned, the walls whitewashed, and all beams and floor cracks subjected either to steaming or to a thorough spraying with kerosene or benzine, great care being taken to avoid fire in case the latter substance is used. Benzine is preferable to kerosene on account of its greater volatility, in that the establishment can be more readily rid of the odor, but it is more dangerous on account of its higher inflammability. The beetles are quite inclined to fly to the light and to settle about the windows; therefore the window cracks should be especially looked after. With such a thorough treatment as this, taking room after room, the writer feels sure that the insect can be exterminated in almost any tobacco factory.

Where it is not desired to use steam, experience has shown that, as above indicated, bisulphide of carbon may be used to good advantage. With leaf tobacco such a fumigation must be very thorough to kill the insects embedded in the mass of the leaves. Experiments made in the writer's office with hydrocyanic-acid gas show that it is not to be compared in efficiency with bisulphide of carbon for this work. While the bisulphide treatment is preferably made in a tight bin, it may also be carried on in a tight room. In either case 1 ounce of the liquid should be evaporated for every 62½ cubic feet of space, or 1 pound for every 1,000 cubic feet. Every precaution should be taken, however, to see that the room is perfectly tight, and also that no fire is allowed to enter the room until after it has been most thoroughly aired. The vapor of bisulphide of carbon in confinement is inflammable and explosive.

In cigar and cigarette factories much that we have just said will be applicable. The tobacco, before use, should be steamed, if possible. Loose tobacco should not be left exposed at night. Boxes or piles of cigarettes or cigars, after being made, should be covered very tightly to prevent the access of the beetles. These precautions are more important during May and late August and September than at other times of the year, since at these periods the adult insects are flying about in great numbers. This statement holds for Virginia and Maryland, but for Key West and other Southern points the dates will have to be altered.

As a matter of interest, it may be said that there is a little four-winged fly which is parasitic on the cigarette beetle, laying its eggs in the larva of the beetle. This parasite is known scientifically as *Catolaccus anthonomi* Ashmead, and has been found in several

tobacco factories. It is doubtful, however, whether by its work it will ever rid an establishment of the beetle, but it undoubtedly helps to prevent rapid multiplication, and consequent great damage.

OTHER INSECTS INJURING DRIED TOBACCO.

There are several beetles which occasionally affect tobacco after the leaves are dried, in much the same manner as does the cigarette beetle, but none of them, as we have said, approximate in importance the latter insect. The so-called drug-store beetle (*Sitodrepa panicea*, fig. 31), an insect which has an enormous range of food, and occurs upon very many articles found on the shelves of drug stores, whence its popular name, will also breed successfully in tobacco, although we can not say that this substance is its preferred food. No cases have been brought to our attention of any serious damage to tobacco by this species. The ordinary rice weevil (*Calandra oryza*), another insect which feeds upon various stored products, has also been found breeding in tobacco, although its importance as a tobacco insect does

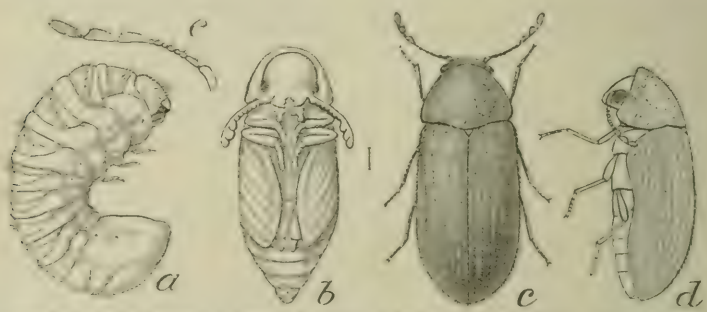

FIG. 31 The drug-store beetle: *a*, larva; *b*, pupa; *c*, adult; *d*, adult from side; *e*, antenna—all greatly enlarged, *e* still more enlarged (reengraved from Chittenden's illustration).

not exceed that of the drug-store beetle, if indeed it equals it. Another insect which, though not at all a tobacco insect, became, some years ago, the cause of a curious litigation regarding the rejection of a large cargo of tobacco from this country by the French Government, is the so-called leather beetle (*Dermestes vulpinus*). The tobacco in question, in numerous hogsheads, was received in France, and upon examination it was found to have been perforated by numbers of the larvæ of this latter beetle, which had burrowed into the tobacco for a considerable distance and transformed to pupæ and later into beetles. The entire cargo was rejected by the French Government and returned to America, and the litigation which ensued was through the endeavor to place the responsibility for the entrance of the insect upon either the shippers or the carriers. It was shown that the tobacco must, at some period of its journey, have been stored in close proximity to bales of hides affected by this insect. The larva of the Dermestes, instinctively on reaching full growth, crawls away from its original habitat and bores into any near-by substance to find a protected spot for pupation. In this case the larvæ were

attracted by the cracks in the tobacco hogsheads, and not deterred by the pungent character of the contents of the hogsheads, they bored their way in, searching for a secure place to transform.

FOREIGN TOBACCO INSECTS WHICH HAVE NOT YET REACHED THE UNITED STATES.

In a previous paragraph we have mentioned incidentally the little scale-like insect known as *Aleyrodes tabaci* as one which has probably not made its appearance in American tobacco fields. Professor Targioni-Tozzetti, the Italian writer, to whose work reference is made in the first page of this paper, has listed 144 species of insects found in tobacco fields of Europe and adjoining countries, the great majority of which, however, are not important enemies of this crop and most of which are never likely to be brought to this country. There are in south Europe several distinctive cutworms which injure the crop in the same way as do allied forms in the United States; several grasshoppers, which feed upon the leaves of the plant, and several caterpillars which do occasionally more or less damage in the same way as do the leaf-feeding caterpillars which we have incidentally mentioned. In south Russia (Bessarabia) there is a tenebrionid beetle (*Opatrum intermedium*) which injures tobacco by attacking the stems underground. There are several plant bugs, several species of plant lice, wireworms, and other forms of greater or less importance which are recorded by the writer, but, on the whole, probably none of them are worthy of extended mention in the short space of this paper.

CONCLUSIONS.

REMEDIES IN GENERAL.

Upon looking over the whole ground, it seems to the writer that the tobacco crop is not a difficult one to protect from insects. It has not so many insect enemies as many other important crops, and the method of cropping is itself unfavorable to the increase of insects and favorable to their ready treatment. This is especially true of all portions of the cotton belt north of Florida.

In the seed beds there is in general no great danger of insect damage, but if insects should obtain a foothold most of them can be readily and safely treated by means of the arsenical spray.

After the plowing of a field into which plants are to be set attention should be paid to ridding the soil of cutworms. This can be done safely and easily by means of the poison-trap crop or the bran-arsenic mash mentioned in detail under the head "Cutworms." Where either of these remedies is used it is really a matter of indifference from the insect standpoint whether the land has been left fallow or whether clover or small grain has been grown. The planter can really follow just which course he thinks is best for his land without reference to cutworms, whereas without this treatment, as previously stated, fallow land or land planted to clover is apt to be full of worms, and the tobacco crop will have to be in part replanted.

At this time, or preferably earlier, it is important that the solanaceous weeds in the immediate vicinity of the field, and particularly the nightshade (*Solanum nigrum*), the horse nettle or bull nettle (*Solanum carolinense*), and the jimson weed (*Datura stramonium*), should be cut down, with the exception of a few marked clumps. These clumps will act as traps for nearly all of the tobacco insects. Practically all of the tobacco insects in the vicinity will be attracted to them and can be readily and economically treated with heavy doses of Paris green for the leaf-feeding species and with a spray of kerosene and water for the sucking bugs. Large numbers of these insects can be easily killed in this way, greatly to the protection of the young tobacco plants when they are set out.

During the growing season of the plants in the field there can be no doubt of the availability and usefulness of the arsenical spray. When used with reasonable care there can be no possible danger, as has been shown by careful experimental work and by chemical analysis of sprayed plants. Poison distributers, both for dry and liquid poison, are on the market, and the process is not an expensive one. It is used already by many practical growers, and it seems to the writer that the man who does not adopt it in time of necessity is behind the times.

After the crop has been cut the stubs of the plants and many leaves will be left. Moreover, in a warm autumn there will be considerable suckering. All of the tobacco insects left in the field which can by any possibility reach this sparse remaining tobacco vegetation will do so. Most of the horn worms, it is true, have gone into the ground and transformed into pupæ, but cutworms, budworms, leaf-feeding caterpillars, the last generation of split worms, all of the sucking bugs and the flea-beetles, during the warm, sunny, autumn days which precede the first killing frost will rely upon these remaining leaves and suckers for food. This is apt to be just the time when the tobacco planter pays no attention to the insect question, since his crop is gathered, but it is nevertheless just the time when he has his tobacco insects more or less concentrated, and upon worthless vegetation, which he can treat with heavy doses of arsenical poisons or even with pure kerosene without fear of loss. There can be no doubt that a little insecticide work at this time of the year will so greatly reduce the number of the insect enemies of the crop that the benefit will be felt in a marked degree the following season. The expense of such treatment would be very slight. A single individual in a day could cover a very large field.

Two of the points just mentioned, namely, the use of solanaceous weeds as traps in the spring and the treatment of mutilated plants and suckers in the fall, have not previously been mentioned in any article upon tobacco insects as far as the writer is aware. He believes that both suggestions are eminently practical, and that by their adoption an enterprising tobacco planter can reduce insect damage to a minimum.

PRUNING OF TREES AND OTHER PLANTS.

By William Saunders,
Horticulturist.

GENERAL REMARKS.

Natural laws are constant and unvaried in their operations. Our knowledge of natural laws is derived from accurate observations of causes and effects, and science offers the systematized explanation of these observations. The science of pruning, therefore, gives the explanation derived from the accumulated knowledge of ages of observations and experiences of effects produced by manipulation upon the branches and other portions of plants. When we take into consideration the lengthened period during which pruning has been practiced, the general intelligence of the operators, and the countless repetitions of similar processes ending in similar results, it is reasonable enough to presume that a sufficient number of facts have been observed to establish a complete science and determine principles the practical application of which can be readily understood and easily effected; but the frequent and apparently conflicting opinions that are constantly being expressed by cultivators and writers on this subject prove that the operation of pruning, in its various applications, is not generally performed from an intelligent standpoint.

Pruning is an operation of much importance in the management of trees, and complete success is not attained in fruit culture unless its principles are clearly understood. Plants left to nature maintain a reciprocal action between the branches and roots, and every branch and leaf removed must exercise an influence either injurious or beneficial; therefore no one should remove a branch until satisfied of a reason for doing so and foreseeing the influence and effects of such removal.

It is the opinion of many fruit growers that the most uniform and satisfactory crops of fruit are produced in orchards where but little, if any, pruning is given to the trees. While it is true that the injuries to fruit trees and the losses to fruit growers from vicious and altogether unnecessary pruning can not be estimated, yet it would be erroneous to assert that trees should not be pruned at all. It is always judicious to thin out the tops of trees when the branches become overcrowded—to thin out dead and weakly branches or to arrest the growth of unruly or misplaced shoots; but the system,

which is altogether too prevalent, of making an annual visit through the orchard, removing or shortening branches as a matter of routine, and clipping the tops of shoots without any special object in view will in a few years assuredly diminish the fruiting capacity of the trees.

TIME OF PRUNING.

The season of pruning is, in some cases, an important factor in the management of trees. Generally any time during the winter or early spring months is chosen for pruning orchards. Where the object is merely the thinning out of thickly branched trees the season is not of much importance, and the work may be performed at any time when convenient; but when it is deemed expedient to remove certain branches for the purpose of adding additional vigor to those retained, then much will be gained by pruning early in the fall, or as soon as the trees have matured their growth and become deciduous. If pruned at this time the succeeding growths will be stronger than they would be if the pruning were performed later. This arises from the circumstance that during winter plants continue to absorb nutriment by their roots. This nutriment is disseminated to all portions of their structure, thus increasing the size and strength of the buds. As the flow of sap is always directed to the extreme points of shoots, the highest buds are most fully developed; so that, when pruning is delayed till spring, and the points or upper portions of branches removed at that time, all the accumulated food in these portions is destroyed, and to that extent the plant is weakened. On the other hand, when the pruning is performed early in the fall the buds which are retained will benefit by the accumulated nutriment, which would otherwise have been distributed over a greater number, and these will, in consequence, start more vigorously in the spring, advance more rapidly in growth during summer, and their maturity will be materially hastened, a condition of great importance when the summer seasons are rather limited for the perfection of certain crops.

Late spring pruning has a decided influence in retarding early summer growth; hence, the operation is sometimes purposely delayed until just before leafing in order to diminish early luxuriance.

Branches which have become diseased from the effects of blight or from any other cause should be removed as soon as they are observed. Prompt removal of these will check the further progress of the malady, which would otherwise destroy the tree.

The action of sudden freezing of immature and imperfectly ripened wood in the fall or early winter is a fruitful source of disease. That apparently incurable malady in plants known as "yellows," in the opinion of the writer, based on forty years' experience, is the result of sap contamination of these frozen points, the prompt removal of which will, he is convinced, prevent the spread of the disease, and thus save the plants from speedy and ultimate destruction.

"Prune in summer for fruit and in winter for wood."

Perhaps no advice that has been given in fruit culture is so vague and disappointing in its practical application as that embodied in the brief, and apparently pithy, words quoted above. It is evidently intended as a short, practical rule capable of general use, producing a certain well-defined result, while in reality it is a mere expedient that may be valuable under some conditions, and is always an operation of experiment rather than one of certainty. The principle upon which the advice "Prune in summer for fruit" is based, recognizes barrenness in fruit trees as being the result of a predominancy of wood growth; also that any process or manipulation tending to reduce redundant growth, so long as it does not seriously involve the health of the plant, will favor the production of flowers and fruit. By persisting in the removal of foliage from the tree while it is in active growth its vitality will be weakened and its general health impaired by the destruction of roots, which always follows the destruction of active foliage.

There are various processes applied in the management of plants which have for their object the better production of fruit. Some of these are known in horticulture under the technical term *dwarfing*, such as grafting the pear on quince stocks, which represses the wood growth of the former and hastens its fruiting period. Other expedients are those of root pruning, tying down branches below a horizontal position, and that already mentioned, repressing growth by the removal of foliage during summer, this last being the least definite or direct, because its usefulness depends upon conditions which can not always be foreseen or controlled.

In the practical application of summer pruning, difficulties and perplexities are encountered which, as already remarked, render the operation one of uncertain result. For example, if the growing shoots of an apple or pear tree are checked in their extension by removing a portion of their points, say toward the latter part of June, the lower buds on the shoots will be forced into growth, thus forming numerous side branches, which have no immediate connection with fruiting spurs, and which will simply tend to a further thicket of twigs for removal in winter. But if the shoots are not checked in their extension until August, and the weather afterwards continues to be warm and dry, the probabilities are that the lower buds on these shoots will start into rather feeble side growth or short spur-like shoots, which will ultimately furnish fruiting buds. If, on the other hand, the season happens to be wet, and mild weather prevails until close to winter, these same side shoots will lengthen into slender twigs which will not thoroughly mature and which will be of no value whatever. The difficulty in reaching successful results lies in the uncertainty as to the proper time to prune, because no two seasons are exactly alike, and also because trees vary in their vigor from

year to year. Yet, upon this uncertain, indefinite, and constantly experimental procedure is founded the advice, "Prune in summer for fruit."

"Prune in winter for wood." A plant in a healthy growing condition will maintain proper balance between the roots and branches, and any destruction of either will to a certain extent destroy this natural balance, so that if a portion of the branches is removed after the seasonal growth is matured the roots will to that extent have the preponderance; the buds being thus reduced, those which are retained will receive increased vigor, and while the branches produced will be fewer in number they will be stronger in growth. It is questionable whether a greater aggregate of wood will be procured from the few buds than would have been furnished by the greater number provided no pruning had been done, but there is no question as to the fact that a greater degree of vigor is imparted to the fewer buds, and that it is a well-known and valuable expedient for increasing vigor of the growths of unhealthy and weak-growing plants. To suppose, however, that winter pruning, as a practical rule, increases the quantity of timber in healthy trees is a fallacy.

PRUNING BY PINCHING AND DISBUDDING.

"Pinching" is a technical term used in horticultural literature, which, although well understood by the initiated, has a very indefinite meaning to the general reader, at least in its horticultural application. It is a method of summer pruning whereby robust shoots are checked at an early stage of growth by removing their extreme points with a pinch between the finger and thumb, without the further removal of foliage. This operation retards for a time the extension of such shoots, induces additional growths in other buds, and develops shoots where a more active extension is required.

"Disbudding" is the removal of buds or young shoots that have not made more than one inch of growth, and it is the best practical method of preventing growths where they are not wanted without interfering with the health of the plant.

Pinching and disbudding are the most rational modes of directing the growth of plants. If rigidly practiced there would be but little necessity for winter pruning or the removal of branches, small or large, at any time. It certainly seems an inconsistent practice to allow a tree to make growths of wood during summer to be cut out in winter by saw and pruning knife, thus sacrificing and destroying what it has been the aim of the cultivator to produce, leaving out of the question any injury to the vitality of the tree.

Even from an economical standpoint, with reference to labor, it is obvious that a saving will be gained by rubbing off a bud in May instead of having to cut a branch in December. Indeed, by proper attention to pinching and disbudding the amputation of branches

will be rendered unnecessary, and the health of the plant will also be maintained, which is not the case where frequent pruning of branches is a routine practice.

The perfection of summer pruning provides for the complete control and disposition of growth without involving any material removal of foliage. When the extreme terminal bud of a growing shoot is removed growth will be checked without removing foliage and without injury to the vitality of the plant. The injury sustained by a rude and careless destruction of foliage is well exemplified in the management of grapes, where the summer pruning is delayed until it is considered necessary to cut from 12 to 20 inches from the point of each shoot, so checking the plants that further growth will be slow and the fruit fail to mature, the berries remaining green until frost. Nothing is more certain than this, that the full and perfect maturity of fruit depends upon a full growth of healthy matured foliage.

PRUNING AT TRANSPLANTING.

In removing trees it is all but impracticable to secure the whole of their roots, and the larger the tree the fewer, in proportion, will be the roots secured; it is therefore essential to the well-being of the tree that the branches be reduced in order to restore in some degree the correlation that existed between roots and branches previous to the disturbing operation of removal. The quantity of branches to be removed will of course depend upon the extent of root mutilation, and as this is rather an unknown factor it is a wise precaution to give the roots the benefit of any doubt by pruning the branches rather severely.

In regard to trees from three to five years old, if lifted with ordinary care, it will be sufficient to cut the whole of the last yearly growths to within a couple of inches of the point from which they started the previous spring; this will reduce the leaf surface and still preserve the original contour and ramifications of the tree. Older and larger trees, in addition to this general shortening of the young wood, and where it is apparent that only a meager supply of roots has been secured, will be benefited by a judicious thinning of the larger branches, carefully preserving the form of the head and avoiding any appearance of heading back old branches. The branches should be thinned without leaving any trace of the operation, so far as the shape of the tree is concerned.

These remarks are more directly applicable to spring planting. It has been stated as an argument against pruning at transplanting that, since the growth of roots is dependent upon the action of leaves, the destruction of leaves by pruning the branches will retard the growth of roots just when they are the most needed. While this is true in the main, yet the evaporation of moisture from leaves has to be considered. If the leaves are not abridged the juices of the tree will

be exhausted by leaf evaporation before the roots become sufficiently active to supply the demand. Before roots can be renewed the plant may be completely drained of its sap, and of course perish. This is the reason why spring-planted trees may often send out a fine show of foliage at first, but as the summer advances and as the juices are exhausted the whole plant succumbs; investigation will prove that root growth has made no progress since the plant was removed. This is not so likely to occur in damp climates as it is in dry climates and under hot suns.

Root growth is not always dependent upon a simultaneous action of foliage. Trees planted early in the fall, or as soon as they become deciduous, will immediately commence to form young roots, and will continue to do so more or less during winter. In the absence of leaves there is but little loss from evaporation, so that the sap of the tree will furnish material for root growth, instead of being exhausted in the air, as is the case in early summer. The condition of the soil is also more favorable for root growth than it is in spring, being, during the month of October, several degrees warmer than the air, thus favoring growth of root, while there is no tendency to growth by the buds, so that in early fall planting very little pruning will be required. It will thus be evident that the necessity of pruning trees when transplanted is greatest when spring planting is in question; but in fall planting it may usually be entirely omitted, especially when planting is done immediately after the fall of the leaves.

PRUNING ROOTS.

It is an axiom in vegetable physiology that the production of flower buds depends upon the presence of nutritious matter in sufficient abundance for their support; but to solve all the causes which will influence a plant to convert some of its buds into flowers while others will produce shoots is a difficult matter. There are, however, certain facts established by observation upon which reliance can be placed, and upon which practices have been founded with a view of hastening the period of fruiting in plants.

One of the most apparent facts connected with this subject is, that a rapid growth and a fruitful habit do not simultaneously exist in the same plant. Young, vigorous trees do not fruit to any extent, while those that from any cause receive a check to growth will become fruitful; hence, it has been given as a rule that whatever produces excessive vigor in plants is favorable to the formation of leaf buds and unfavorable to the production of flower buds; while, on the other hand, such circumstances as tend to diminish luxuriance and to check rapid vegetation, without affecting the health of the individual, are more favorable to the production of flower buds than of leaf buds.

Many expedients based upon similar observations have long been practiced by cultivators; such operations as ringing branches, root

pruning, and bending luxuriant growths have been familiar to many generations of fruit growers.

When a tree has attained to a fruit-bearing size and shows no indications of fruiting, but continues to maintain a vigorous growth of branches, and is evidently barren from excessive luxuriance, a judicious root pruning will have the effect of encouraging the formation of fruit buds instead of wood buds. Trees in this condition, if root pruned about the first of August, will receive a check to growth which will cause the formation of fruiting buds during the fall and show a flowering disposition the following spring.

Some Asiatic conifers, such as the Japan cedar (*Cryptomeria japonica*), continue their growth so late in the season that they are overtaken by frost to the injury of leading shoots. Many of the evergreen trees from the Pacific coast suffer in a similar manner. These plants are apt to take a second growth when the weather is moist and warm during the fall, which growth is mostly destroyed by the first frost. Root pruning in August will prevent this late growth, and the trees will pass through winter without injury. The operation is performed by digging out a circular trench at a distance of from 3 to 6 feet from the stem, according to the size and age of the tree, and from 2 to 4 feet in depth, cutting all the roots that may be encountered or can be reached If but few strong roots are met with, and if it appears evident that strong taproots exist, the soil should be undermined with a sharp mattock, severing all the strong roots that can be reached; the soil is then returned, being well firmed as the trench is filled, and the process is completed.

PRUNING HEDGES.

The only form in which a hedge can be kept, to be of service as a fence, or as an ornament, or for purposes of shelter, is that of a pyramid. When it has attained a height of 5 feet it should be about 3 feet wide at its base, or surface of the ground, and all pruning should be directed with a view of securing this form.

When the plants are first set out in line they should be pruned or shortened to within 2 or 3 inches of the ground and allowed to grow undisturbed during the first season. At the end of the yearly growth, the plants should again be pruned down to within 6 or 8 inches of the first pruning, any side or horizontal growths pruned within an inch of the main stem. During the growth of the second season the hedge may be partially shaped by an occasional pinching out of the points of stronger upright shoots, but preserving every shoot and leaf on the weaker side growths. In thus repressing the upright shoots and encouraging side growths a breadth of base will be secured, which at this stage is most important. During the following winter the hedge, if it has progressed favorably, may be pruned into shape, that is, formed into a pointed pyramid, the sides being from 8 to 10 inches from the center. These operations are in accordance with the principles

that summer pruning will arrest growth to some extent, and that winter pruning will encourage the production of strong growths. By keeping these factors in view a hedge can readily be shaped without much destruction of growths, and as readily maintained in a pyramidal form; but if the more upright or top shoots are allowed to predominate, the lower side shoots will soon lose vigor, and thus the hedge will lose its efficiency as a barrier and its beauty as an object of ornamental utility.

These details apply to deciduous plants, of which the Osage orange is an example. Evergreens, such as the arbor vitæ, require less labor in preparation or training and maintenance than deciduous plants, as most of them naturally assume a pyramidal form, and by a practice based upon the principles already noted good hedges can easily be produced. The main points are to keep the top of the hedge shaped to a point and allow the sides to expand sufficiently, so that all parts of the hedge surface be exposed to light. Very rarely will it be necessary to trim more than once a year, and the best time for the work is just before the commencement of growth in spring.

PRUNING STREET TREES.

The ideal street tree is one having a straight, well-defined, central stem throughout its entire length, with side branches regularly disposed around it and subordinate to it. Trees grown in this shape will withstand fierce storms and sudden bursts of wind without injury. Not many deciduous trees naturally assume this form, but by timely pruning when young they can be greatly helped to approach it. This training process should commence while the tree is young and growth easily controlled. Not later than the second year after planting a careful inspection should be made after the leaves fall, and if more than one shoot seems developing to leaders, select the fittest and remove the tops from the others; also cut the points of any side branches that appear to require checking, so as to maintain symmetry in the tree. Practically, the training process should commence in the nursery, where the growth of a leading shoot should be maintained and all side branches kept back by pinching their points. These should not be removed entirely, as they tend to strengthen the main stem, and can be removed later. The tree should remain under nursery culture until it has reached a height of 8 to 10 feet, and at transplanting all the side shoots should be removed by cutting them close to the main stem to a height of at least 6 feet. No further pruning will be necessary at this time.

The removal of all lower branches is rendered necessary, in order that they may not interfere with the proper use of the sidewalks and streets, but such removal has a tendency to weaken the main body of the tree and diminish its powers of resistance against the sweeping blasts to which street trees are oftentimes subjected. This trimming

up from below will require attention for a number of years, because as the lower branches extend they will droop at the ends and become an interference. The points of these drooping branches may be removed for a time, but this will afford only temporary relief, and ultimately the whole branch will have to be removed by cutting it off close to the main stem, but this should not be done until it becomes absolutely necessary.

The best method of pruning large trees in cities is sometimes a difficult question to decide. As a rule, the worst treatment they can receive is to cut off their tops, "heading down" as it is termed; when this involves the removal of heavy branches, so as to leave a mere skeleton of stumps, it not only destroys the beauty of the tree but induces decay, especially with trees that do not speedily send out growth immediately below the cut. Heading down is objectionable in so far as it causes a low, dense growth, not desirable even as shade, and increases the liability of destruction from windstorms.

When trees become thickly branched and crowded as to space they are not improved by cutting the ends of the shoots, which merely aggravates the evil. They should, rather, be judiciously thinned by the complete removal of some of the branches. A skillful operator will remove one-third or more of the branches of a thickly set tree, so that the ordinary observer will not perceive that any pruning has been done, the tree looking as natural in its ramifications as if it had not been disturbed, and this should be the aim in all pruning operations as applied to street trees.

There are some trees that respond more satisfactorily than others after severe cutting back. Of these, the two species of Platanus (buttonwood), *P. occidentalis* and *P. orientalis*, may be specially mentioned. They are well fitted for wide streets or avenues. Their branches are wide-spreading and far-reaching, and they should not be set within 25 feet of a building; even at that distance the horizontal branches may, after a growth of ten or twelve or more years, become objectionably large, but they can then be pruned back with great advantage.

This pruning is performed by cutting back the lower branches to within, say, 8 feet of the main stem, gradually shortening this distance as the operation proceeds upward until it terminates at a point at top. Trees treated in this way will start young growths at every cut regularly and evenly over the entire system, and after the growth of one year will present a mass of fine foliage, bringing out fully the pyramidal shape, which will increase in beauty for many years without further attention as to pruning. The best time for this work is immediately after the trees become deciduous. Perhaps no other trees will endure this kind of cutting back so well as these buttonwoods.

PRUNING TREES FOR TIMBER.

In growing trees solely for the sake of their timber there will be but very little pruning required, and that mostly to regulate growths when the trees are young. The object being to secure lengthened clean trunks, instead of short stems and bushy tops, it follows that an upright leading shoot should be encouraged, and all other branches kept subordinate. In the case of a young tree producing several upright, or leading branches, the best placed and most central should be selected as a permanent leader and all others checked by pruning a small portion from their points. Trees that are planted purposely for timber are set quite closely, so that they may become crowded and drawn up to tops with but few side branches. Of course, they are thinned when they become overcrowded by cutting off all weak side branches quite close to the trunk. The sooner such branches are removed the better; if not over 2 inches in diameter when pruned the wood will heal over them and knots in the timber will be largely prevented. All dead branches should be similarly taken off close to the trunk, so that they may sooner be covered over with sound wood. For the same reason this pruning back should be performed early in the summer when the healing-over process will be most active, and decay will be prevented.

PRUNING FLOWERING SHRUBS.

The only pruning that may be considered essential for ordinary shrubbery is that of thinning out the plants by removing old branches that are about destitute of young growths. The worst treatment they can receive is that of shortening the summer growths during the fall, especially that of shearing them into round, stubby forms with hedge shears, at once destroying the natural, graceful beauty of the plants and removing the best of their flowering shoots just as they are preparing for an abundance of blossoms. For example, the Forsythia, usually a free-growing, hardy plant, will make shoots several feet in length during summer, covered with flower buds toward fall, and prepared to blossom profusely early the following year. Any pruning which shortens the shoots simply removes the flowering wood and can not in any degree benefit the plant. Deutzias, Spiræas, Weigelas, and similar flowering shrubs require the same kind of treatment. The bushes should be kept rather open, so that the branches may receive full benefit of light and air. This is effected by pruning out some of the oldest branches or thinning out some of the young shoots where they are too dense, and these should be cut close to the base of the plant, which will encourage the growth of vigorous flowering branches, thus keeping the plant floriferous from year to year.

PRUNING RASPBERRIES AND BLACKBERRIES.

The fruiting canes or shoots of these plants decay after the ripening of the fruits and new canes are produced annually which bear the following season. In other words, they are biennial. The canes grow up in one season, produce fruit the next year, and then die. These old canes should be cut and burned as soon as practicable after the fruit is gathered; they are of no further use to the plant, their removal allows freedom of growth to the young canes, and their destruction by fire effectually disposes of eggs of injurious insects that may be lodged in the old wood and bark.

One of the most important operations in the pruning of raspberries is that of stopping the upward growth of young canes. When these have attained a height of between 2 and 3 feet the extreme points are pinched so as to remove the terminal bud. This, while checking the upward extension of the cane, will promote the pushing of side or lateral shoots from the lower buds, and when these attain a length of 10 or 12 inches they should be checked by pinching their points; these side shoots will produce the forthcoming crop of fruit.

When the plants are three or more years old they will send up several young canes. These should be thinned to 10 or 12 inches apart, selecting the best and destroying all others as they appear.

After growth has ceased in the fall, shorten the side shoots to about 10 inches. This early fall pruning will be specially important if the growth has been suddenly arrested by frost, as the frozen immature points, if not promptly removed, may lead to a diseased condition of the canes. Early fall pruning will prepare the plants for winter covering in localities where protection is necessary.

The ripening period may be extended by cutting down some of the canes to about 18 inches in height or pruning back the laterals to three or four buds after growth has started in spring; the buds which are left will make a later growth, and consequently the fruit will be later in ripening, but this extension of the ripening period will be at the expense of both the size and quantity of fruit produced.

The blackberry may be treated in a similar manner, with the exception that in summer, pinching the canes may be left until they are 5 feet in length; the side shoots may also be allowed greater latitude, and the young canes may be given a space of 15 to 18 inches apart.

PRUNING GOOSEBERRIES AND CURRANTS.

The gooseberry produces fruit from spurs which form on the older parts of branches, the best and largest usually on two-year-old wood. The plant should be kept in the form of a low spreading bush having six or more branches, which should be 10 inches apart, and rather open in the center, so that the branches may fruit uniformly their entire length, which they can not do if densely crowded throughout.

The main object in pruning these bushes is to promote and maintain a sufficient number of healthy, vigorous fruiting spurs, and as it is found that spurs on wood over four years old are vastly inferior to those on younger stems, a system of renewal should be followed whereby young branches will take the place of older stems to be removed. There will be no lack of young growths for renewal purposes, as shoots are constantly being produced from the base of the plants. Select one of the strongest of these, prune it back in the fall to about one foot in length, taking care to prune to a bud which points outward, so as to preserve the spreading habit of the bush. The growth of the following season should receive similar treatment, the leading shoots shortened back, and any side shoots cut down to within an inch or so of the main stem. After the third year this new branch will take the place of an older one, which is to be cut out from the base. The annual pruning consists in cutting out all side shoots and shortening in the leading points, which should be performed during the fall, the sooner after the leaves decay the better for the crop.

In all respects the currant should be pruned similarly to the gooseberry. Gooseberries and currants are propagated from cuttings of the young wood made into lengths of about 6 inches, set in the ground so that the topmost bud will appear level with the surface; except in extreme northern districts they should be set out in late September. Previous to planting, all the buds should be cut out except the two uppermost; this is to prevent the growth of root suckers, which otherwise become troublesome in the proper management of the plants.

PRUNING THE APPLE, PEAR, PLUM, AND CHERRY.

These trees are similar in so far as they produce their fruits on spurs which develop on wood of two, three, or more years' growth, so that their treatment in regard to pruning should be very similar in the main. If the tree has been properly pruned at transplanting, the first summer will develop the foundation of a well-defined top. As this result depends upon the arrangement and equality of growth of the young shoots, these will require attention, so that in the event of any of them showing a superior vigor, to the detriment of others of equal importance for future branches, the points of such shoots should be pinched off; but in so doing let there be as small a removal of foliage as possible, the object being not to materially weaken, but merely to equalize, growth. If the pinching and disbudding has been intelligently and systematically followed, there will be no necessity for winter pruning, and by pursuing the same general treatment during the second summer the foundation for a properly formed tree can be well established. If more branches are deemed necessary, they can readily be obtained by pinching the points of leading shoots during the earliest stages of growth, which will cause a growth of side shoots, of which a selection is made and others rubbed off. It is

not well to start a young tree with a great number of branches, as they soon become crowded, to the great injury of the plant with reference to fruiting. A young tree managed as above described can be as well established in three years as it can in five years where the foundation of the plant is sought to be obtained by winter pruning with the shears or pruning knife, entailing the total loss of much of the vital energy, instead of utilizing the entire growth in permanently building up the tree.

This system also encourages the formation of fruit buds. There is nothing more certain than that by pruning back the ends of yearling shoots the fruit-producing period is retarded and the fruit-producing capabilities of the trees abridged. Fruiting buds will not be formed where the shoots are pruned to a few buds, which are thus forced into the production of more shoots instead of forming fruit spurs; this would speedily occur if the buds were left to their natural mode and condition of growth.

It is perfectly practical to train a tree to any desired form without having recourse to winter pruning. When training is performed while growth is active, and the position of a branch is directed according to the wish of the operator, either by pinching the points of a growing shoot or by removing buds where shoots are not required, the greatest amount of vital energy is economized; but where the growth of a whole season is undisturbed until the wood is matured, and probably one-fourth or even more of these yearly growths is destroyed, there is a positive loss of time, labor, and material for which there is no compensating advantage, to say nothing of its depreciating influence on the future of the tree.

As the trees advance in age they will become somewhat crowded with branches, some of which can be removed from time to time as seems necessary for the well-being of the trees; but this thinning should be done judiciously, and only a small portion removed during any one season. Yearly inspections should be made, and those branches that have become destitute of fruiting spurs, except at their terminal points, should be preferably cut out in thinning and a young twig allowed to grow up and furnish new fruiting branches in the way of renewal. There will be no lack of young shoots for this purpose, as they will sprout from the base of the cut branch, and the strongest and best placed should be selected if it is desired to introduce a new branch; if new branches are not desired, all such growths should be removed as they appear.

The plum and cherry are very liable to gum exudation when the knife is used in pruning branches of any considerable size, consequently the training of these trees should, as far as practicable, be controlled by pinching and disbudding. Some varieties of both of these species, when in a healthy condition, will make shoots several feet in length in one season, and under general treatment these

growths are pruned back after the wood is matured, otherwise, long naked branches would result. The proper management is to pinch the points of these luxuriant shoots when they have extended about 2 feet, which will cause the pushing and growth from the lower buds. Such of these shoots as are required for branches should be allowed to extend, and all other growths pinched at their points when they have made a growth of 2 inches; these latter will in time form a nucleus for fruiting spurs.

The main object in the pruning of all these trees is to economize all the growth, to procure additional branches by arresting the extension of shoots while vegetation is active by pinching or removing their extreme points without waste of foliage, and by rubbing off buds where shoots are not required, instead of allowing an accumulation of yearly growths to mature, then removing and throwing them forth as waste, in furtherance of pursuing a reckless operation called winter pruning.

PRUNING THE PEACH AND NECTARINE.

The peach and nectarine produce their fruits on young growths of the preceding year, so that one of the aims of the pruner is to secure young growths fairly distributed over all parts of the tree, and to render these valuable by an arrangement of the main branches, which will result in the full exposure to light of all parts of the tree. An unpruned peach tree will in a few years exhibit the appearance of a few long, comparatively slender branches almost destitute of foliage or fruit except at their extreme ends, and which are likely to break down with even a moderate crop.

A young tree during its growth the first season after planting will require but little care; presuming that it was closely pruned when planted, it may be allowed to make all the growth possible; the greater the amount of foliage the more will roots be extended, so that a good basis may be established for the future well-being of the tree. Pinching may be necessary so far as to suppress the extension of any of the shoots that seem to interfere with uniformity of growth. If pinching has been performed when necessity indicated, there will be but little, if any, winter pruning required, and then only to shorten back shoots in order to maintain regularity in the formation of the future tree.

The principal treatment of peach trees, so far as pruning is concerned, is that of shortening back the new growths yearly, especially the strongest shoots. This is in many ways beneficial, tending to reduce the fruiting buds so as to prevent an overabundant crop, which is to be avoided so far as possible; it also tends to keep the trees low, which renders it easier to harvest the fruit, as well as keeping the trees in proper form. When the heads become too thick, as they probably will from the pruning of young shoots, they can be kept in shape by cutting out some of the older branches well back to

short stubs, from which young shoots will be produced, and in this way the entire head can, from time to time, be renewed.

Trees that are apparently worn out and have nothing but a few pole-like branches, unhealthy of growth and destitute of fruitful shoots, may be renovated by cutting them down to stumps, when a new head will form of vigorous growths, and in time become fruitful, bearing large-sized fine fruit. Peach trees that make a late growth, and are caught by frost when their leaves are still green and the points of shoots succulent, should have the points of the shoots pruned back at once, removing all of the immature points. This will save them from being affected by diseases which follow the freezing of unripened wood.

PRUNING THE GRAPE.

The grape, like the peach, fruits only on the young wood made during the preceding year; so that the salient point in pruning the vine is to provide for the retention of a sufficient amount of young wood to secure a crop. The time to prune is immediately after the leaves fall. This early pruning is important, especially in climates where the season is barely of sufficient length to ripen the fruits, as the spring growth will be more vigorous, will afford a better showing of fruit, and the shoots will advance rapidly in growth and attain maturity sooner than would be the case if pruning were delayed to a later period.

The pruning of the grape is sometimes modified to the method adopted for training, but all methods of training must conform to certain principles of pruning if the best results of fruiting are expected.

Any system of training which depends upon the retention of wood more than three or four years old as a foundation will be deficient in permanent success. The best fruit is always obtained from the growths of leading shoots, as compared with that produced from side shoots on older wood, such as are the result of what is known as spur pruning; the fruit from these side shoots will be a week later in ripening than the bunches produced on heavier wood on the terminal or leading canes. Hence, the best method of pruning is to arrange for fruiting on the vigorous terminal growths only, and not attempt to produce fruit on side shoots that have borne fruit, but remove them entirely, cutting them off so close to the central cane that no further growth will proceed from the main stem at that point.

This mode of treatment may be further explained: Starting with a one-year-old plant set out in the spring, in favorable soil, it will be allowed to grow the first season without the removal of shoot or leaf, and a good root formation will thus be secured. At the fall pruning all of the growths are to be cut close down except the strongest, which should be cut back to four buds. This ends the first season. When

growth commences the following spring numerous shoots will proceed from the plant; after these have grown 6 or 8 inches in length, pinch the points from all except the strongest, which is to be allowed to grow undisturbed, and which will form the fruiting cane for the following year. The summer treatment will consist in pinching the point out of the leading shoot when it has reached a height of 4 or 5 feet; then it will be allowed to grow during the remainder of the season. The smaller shoots around the base of the plant should be kept shortened, but not entirely removed.

At the winter pruning the leading cane is to be cut back to 4 feet, and all the smaller shoots cut close down to one or two eyes. This ends the second season. The main cane will fruit the third year, and, in general, the fruiting shoots should be allowed to extend at will, exception to be made if any one of these should be apparently growing more vigorous than the others, when it may be checked by pinching out its point of five or six leaves beyond the bunch of fruit. The main shoot should be allowed to extend until it reaches a length of 4 feet, when the point is to be removed, and afterwards no further summer pruning will be necessary. Among the lower growths select the strongest and encourage it by repressing all other shoots, and, as it extends, submit it to similar treatment as the main shoot received the previous summer. At the winter pruning all the side shoots that proceed from the main cane, whether they fruited or not, should be removed, cutting them so close back that no buds will be left for further growths. The leading cane and the cane which has been produced from the base of the plant should be cut back to 4 feet in length. This terminates the third season.

Two fruiting points are now available, and the lowest cane should be tied to the part which fruited last year; this will give a fruiting space 8 feet in length, composed of two distinct shoots. This system can be pursued indefinitely, a new cane being brought up from the base of the plant annually to maintain material for fruiting canes. The older canes should be extended yearly, so that their terminal shoots can be utilized for fruiting; all wood that has fruited should be removed, and after using a main service branch for three or four years it should also be removed by cutting back to the neck of the plant, thus keeping up a renewal of shoots as far and as long as necessary.

As to summer pruning or pinching back the young bearing shoots, on any system of management, the less done the better. Fruit will form on weakly shoots, which in many cases should be removed, as these shoots will not ripen, remaining green, even when the fruits will color up and appear ripe; but it must be realized that properly ripened fruit can not be obtained from unripe shoots, even though the fruit appears to be ripe as far as color is concerned.

POLLINATION OF POMACEOUS FRUITS.

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INTRODUCTION.

The failure of orchards to yield satisfactory crops from year to year after reaching the normal bearing age is of frequent occurrence, and although adequate explanations can often be given for such failure, yet the reasons are sometimes very obscure. In the course of other investigations the writer has demonstrated that cross pollination is an important factor in the production of pome fruits, and his experiments, begun in the spring of 1890 and continued in 1892 and 1893, opened up an interesting line of work in this connection. This paper consists of a brief review of the principal results of the work on the pear, published in Bulletin No. 5 ("The pollination of pear flowers") of the Division of Vegetable Physiology and Pathology, with additional information obtained in the experiments of 1893 and 1894, and a fuller discussion of the apple and quince.

HISTORICAL.

More than one hundred years ago there was published in Germany a remarkable book by a botanist named Sprengel, in which was shown, as a result of observations, the important part played by insects in the pollination of flowers. This author even observed that in certain species of flowers cross pollination takes place, but he did not understand the importance of crossing, and in fact regarded it as simply accidental. Later, Andrew Knight, a famous hybridizer of plants, concluded that nature intended that crossing should take place between neighboring plants of the same species, but it was not until the master mind of Darwin attacked the problem that the true value of cross pollination and of the interesting modifications of floral structure for this purpose became known. One of the ways by which the benefits of crossing are insured to plants is through their sterility to their own pollen. Some fifty or more species of plants are already known to be more or less completely fruitless when only pollen from the same plant is applied to their flowers, although the same plants mature fruits and seeds when pollen from another plant is used. From what follows, it will be seen that there is a very strong tendency to self-sterility in the pear and apple, the tendency varying in the different varieties.

CROSS POLLINATION OF PEARS.

DESCRIPTION OF THE PEAR BLOSSOM.

The pear flower has all the organs of a typical blossom, these being arranged in fives or some multiple of five. It consists of five brownish-green sepals, five white or pinkish petals, twenty stamens in four whorls of five each, a five-celled ovary, and five styles and stigmas (fig. 32). The young green pear grows underneath the showy

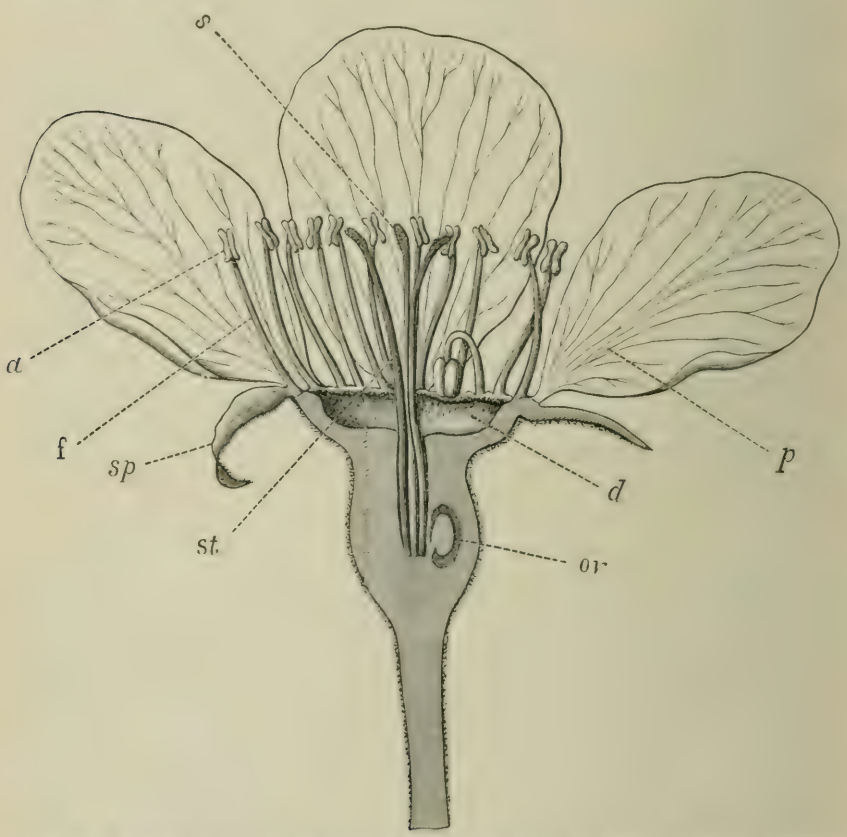

FIG. 32.—Enlarged section of a Bartlett pear flower: *st*, style; *sp*, sepal; *f*, filament; *a*, anther; *s*, stigma; *p*, petal; *d*, disk; *ov*, ovule.

part of the blossom and looks like a swelling of the flower stem. In the center of the flower is a small, greenish-yellow, saucer-shaped disk, as shown in fig. 32, *d* on which the nectar is secreted. Extending through the center of the disk down to the ovary are five styles. The ovary contains the ovules, which are small, light-colored bodies that grow into seeds when properly fecundated. The ends of the green styles and a short strip down one side are rough, and this feature fits them especially for receiving and retaining the pollen. When

seen under a magnifying glass this roughness is found to consist of minute, finger-like projections. The stamens, which surround the edge of the disk, terminate in small, roundish bodies, the anthers. These contain the yellow pollen, and are very complicated, being made up of four cells, as may be seen by examining a very thin section. When mature, the anther splits at the partition, the latter shriveling away, and the pollen comes out in two masses, as if the anther were two-celled.

FIG. 33.—Cluster of Bartlett pear blossoms (natural size, from a photograph).

FUNCTIONS OF THE DIFFERENT PARTS OF THE BLOSSOM.

The nectar is secreted copiously in the disk, often filling the cup with a large drop, and serves to attract bees and other insects, as does also the pollen. The white, showy petals are a guide to the insects, and as the flowers grow in clusters (fig. 33) and the clusters are numerous, a tree in full bloom attracts insects from long distances. When a bee alights on the flower the stigma brushes from its hairy

coat some of the pollen which adhered to it in previous visits to other trees, and, if these trees were of a different variety, the flowers are thus cross pollinated. The pistils mature two or three days before the stamens of the same flower, and the fully expanded stigma often protrudes through the petals before they are open, thus becoming pollinated from some earlier-opening flower before the pollen of its own flower is ready—another means by which cross pollination takes place. Soon after its protrusion, the stigma secretes a sugary fluid, often in sufficient quantity to be quite perceptible. In this the pollen grain readily germinates and throws out a slender, thread-like tube, which grows downward into the pistil and through specially soft tissue, adapted to its growth, until it reaches the ovules. Here it enters an opening in the two outer coats of the ovule and comes in contact with the germ cell, or egg cell. A number of interesting and complicated changes now take place in the protoplasm of this cell and in the end of the pollen tube. A part of the contents of the latter actually passes through the cell walls into the egg cell, which, under this stimulus, immediately begins to grow and divide, ultimately developing into the germ of the seed. This stimulus not only causes the seed to grow, but also the surrounding fruit, the latter depending upon seed development in most cases. In some cases, however, the growth of the pollen tube may help to stimulate the fruit to develop independently of the fecundation of the ovule, which may or may not afterwards result, and this probably accounts for the fact that many little fruits begin to develop, but afterwards drop off.

FIG. 34.—Buds of Bartlett pear.

FIG. 35.—Flower of the Bartlett pear (natural size).

FIG. 36. Bud of the Bartlett pear, with petals removed, showing the incurved stamens (natural size).

EXPERIMENTS IN CROSSING.

The writer's first experiments to determine the usefulness of cross pollination in securing the fruitfulness of pears and other pome fruits consisted in preventing insect visits and the entrance of foreign pollen

by placing bags made of paper, cheese cloth, or mosquito netting over the buds a day or two before they opened, that is, when they began to show the white of the petals, but before any great number of blossoms opened. Great precautions were taken not to bag any flower which had opened sufficiently to expose the stigma to insects. A much more exact method of making experiments of this kind is to carefully hand-pollinate emasculated flowers. This method was followed in all experiments after the first series. Full-grown, unopened buds, like those shown in fig. 34, were selected for the purpose. With a pair of fine, sharp-pointed scissors, or, still better, a small, sharp knife or a scalpel, the outside floral organs, including the calyx tips, petals, and stamens, were removed (figs. 35, 36, and 37). The five pistils, which were unharmed by this process, were then pollinated and at once covered with a paper bag, this being fastened around the stem with a piece of soft copper wire, to which the label was attached. All unused flowers were cut off the clusters. The pollinating was done by picking out freshly opened anthers from the flowers with a pair of small forceps and rubbing the pollen masses upon the stigmas. Usually the blossoms from which the pollen was taken were cut directly from the trees and carried about in a paper bag, but in some cases the preferable way was followed of allowing the flowers to open and burst the anthers in a warm room free from flies. After the fruits were all set the number resulting from the different kinds of pollen were tabulated, and from this the percentages of efficiency were computed.

FIG. 37.—Emasculated bud of the Bartlett pear, showing only the five pistils (natural size).

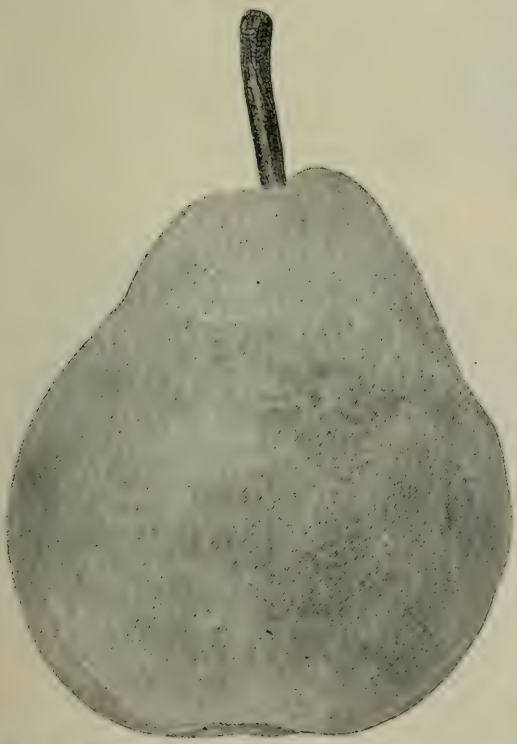

FIG. 38.—Bartlett pear cross pollinated with the pollen of the Easter pear.

Very early in the experiments it was found that some varieties of the pear, such as Anjou, Clapps Favorite, Bartlett, and Winter Nelis,

were unable to fruit when covered with bags, or, in other words, when insect visits and foreign pollen were excluded. The kind of bag used, that is, whether of paper, cheese cloth, or netting, seemed to make no difference in the results, but in later experiments some difference was observed in favor of net bags as compared with paper bags. The latter probably confine the flowers too closely, but as all the hand-pollinated flowers were covered with this kind of bag and still set an extremely high percentage of fruit, it is evident that they could not have caused any pronounced injury. On the other hand, in the case of the net bags, there is the possibility of small insects passing through the meshes of the net and introducing foreign pollen. The results obtained with the varieties above named were verified by very careful hand pollinations of emasculated flowers, the work being done at Brockport, N. Y., in 1891, at Chestnut Farm, Va., and at Rochester and Geneva, N. Y., in 1892, and at Parry, N. J., and again at Rochester in 1893.

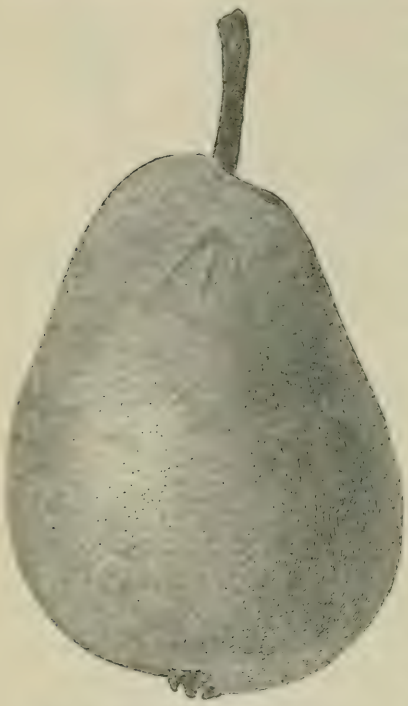

FIG. 39.—Self-pollinated Bartlett pear.

DISCUSSION OF VARIETIES IN THEIR RELATION TO CROSS POLLINATION.

It is well known that the so-called varieties of pears are propagated by budding, grafting, or by cuttings from some original seedling. For instance, all the Kieffer pear trees in the country have been propagated from portions of the original Kieffer tree, which grew near Philadelphia from seed, and therefore, strictly speaking, they are all portions of the same individual and of the same original seedling. The same is true in case of the Bartlett, Anjou, and all the other varieties, or, in other words, our horticultural varieties of fruit trees propagated by budding or grafting or by cuttings are all parts of an original individual seedling and do not inherently differ from it.

FIG. 40.—Seeds from crossed and from self-pollinated Bartlett pears: *a*, from crossed pears; *b*, from self-pollinated pears.

Among the sorts which were found to be more or less completely self-sterile are the Anjou, Bartlett, Boussock, Clairgeau, Clapps Favorite, Easter, Howell, Lawrence, Louise Bonne de Jersey, Sheldon, Souvenir de Congress, Superfin, and Winter Nelis; and among those more or less self-fertile are Angouleme, Bosc, Buffum, Flemish Beauty, Heathcote, Mannings Elizabeth, and Seckel, and, in the South, Kieffer and Le Conte. The two last varieties are especially inclined to self-sterility in the North, particularly in cold, wet springs, but in Southern locations they fruit heavily, even in large blocks where no other varieties are near. The writer is not inclined to attach much importance to the strict classification of pears into self-sterile and self-fertile varieties, as the more he experimented along this line the more the results tended to run the two classes together. The kinds classed as self-sterile, like Anjou and Bartlett, yielded a small percentage of fruit in favorable seasons with self-pollination where the trees were in good soil and were well pruned and well cultivated, while the sorts classed as self-fertile, like Angouleme, Seckel, and Kieffer, were almost self-sterile in unfavorable seasons. The question therefore arises as to whether pears which grow to such perfection in California, as Bartlett, Clapps Favorite, and Clairgeau, do not find the climate of that State so favorable as to be self-fertile.

FIG. 41.—Section of an apple blossom.

FIG. 42.—Baldwin apple cross pollinated with pollen of the Bellflower apple.

The crossed and self-pollinated fruits resulting from most of the experiments were collected and studied and quite perceptible differences were found between them, consisting essentially in a better

development of the blossom end of the crossed fruits, and narrower, slimmer, and less pyriform self-pollinated fruits. This is well illustrated in figs. 38 and 39, which show a typical cross and a self-pollinated Bartlett. Another interesting point brought out by these studies was that the self-pollinated fruits had only small, abortive seeds, or, in common parlance, were seedless, while there was an abundance of seeds, often the full number, ten, in the crosses (fig. 40).

FIG. 43.—Large specimen of self-pollinated Baldwin apple.

In the self-pollinated fruits of late varieties there was a tendency to wither when ripening, while the crossed fruits, gathered at the same time, ripened well. The fruits not bagged on the trees were also carefully observed, and as a rule were found to agree with the crosses rather than with the self-fertilized pears.

CONCLUSIONS REGARDING CROSS POLLINATION OF PEARS.

The following is a brief summary of the conclusions drawn from the experiments and already published in Bulletin No. 5 of the Division of Vegetable Physiology and Pathology:

(1) Many of the common varieties of pears require cross pollination, being partially or wholly incapable of setting fruit when limited to their own pollen.

(2) Some varieties are capable of self-fertilization.

(3) Cross pollination consists in applying pollen from a distinct horticultural variety, that is, one which has grown from a distinct seed, and not in using pollen from another tree of the same grafted variety, which is no better than that from the same tree.

FIG. 44.—Small specimen of self-pollinated Baldwin apple.

(4) Self-pollination takes place no matter whether foreign pollen is present or not. The failure to fruit with self-pollination is due to sterility of the pollen and not to mechanical causes, the impotency being due to lack of affinity between the pollen and the ovules of the same variety.

(5) Varieties that are absolutely self-sterile may be perfectly cross fertile.

(6) The condition of nutrition and the general environment affect the ability of the tree to set fruit either with its own pollen or with that from another variety.

(7) Pollen is transported from tree to tree by bees and other insects and not by the wind.

(8) Bad weather during flowering time has a decidedly injurious influence on fruitage by keeping away insect visitors and affecting the fecundation of the flowers, and, conversely, fine weather favors cross pollination and the setting of the fruit.

(9) Pears resulting from self-fertilization are very uniform in shape. They differ from crosses not only in size and shape, but also, in some cases, in time of ripening and in flavor.

(10) Among the crosses the differences were slight or variable, so that the variations can not be ascribed with certainty to differences in pollen.

(11) Self-fecundated pears are deficient in seeds, and the seeds produced are usually abortive. The crosses are well supplied with sound seeds.

(12) Even with those varieties which are capable of self-fecundation the pollen of another variety is prepotent, and unless the entrance of foreign pollen is prevented the greater number of fruits will be affected by it.

(13) The normal typical fruits and in most cases the largest and finest specimens from both the so-called self-sterile and self-fertile varieties are crosses.

CROSS POLLINATION OF APPLES.

In connection with the experiments on pears, a large amount of work was done on apples, this being possible because of the apple blossoms beginning to open just as the pears go out of flower.

DESCRIPTION OF THE APPLE BLOSSOM.

Apple blossoms are borne in somewhat smaller clusters than pear blossoms, there being usually only six flowers per cluster. The flowers also vary more in size than do those of the pear, the central one often being much larger, shorter stemmed, and earlier than the others. This is especially striking in the King apple and other early-blooming varieties. The apple blossom is more highly developed than the pear blossom, and on account of its delicate perfume, higher coloration, and larger size is more attractive to insects, especially to the larger bees. It is formed on the same general plan (fig. 41) as the pear flower, the only striking difference being that the bases of its stamens are enlarged and hairy, and instead of curving outward they all draw together toward the center, and fit closely around the styles. By this arrangement the nectar disk is completely covered, and hence only the larger

insects, such as bees and bumblebees, which can force the stamens apart and reach the honey with their mouth parts, can make use of the blossoms. Large bumblebees very seldom visit the pear, and when they do, they soon fly away; but they work continuously and in large numbers on the apple. In the writer's opinion the honey from the apple blossoms is superior in flavor to that from pear blossoms. As apple blossoms are more attractive to insects than pear blossoms, it is probable that the latter, in the evolution of these plants, were forced to bloom earlier, so that the bees might not be attracted away from them. In fact, the pear blossom could not compete with the apple blossom for insect attention if obliged to open at the same time. Apple blossoms are certainly abundantly visited by insects, but in western New York the writer noticed that although the first trees to bloom were well covered with bees and bumblebees, yet when the main body of the orchards came into flower there were not enough for all the trees. This is liable to be the case where an orchard is very large and in sections where apple growing is the main industry.

Notwithstanding the higher development of the apple blossom, more of the pear blossoms set fruit. A set of 5 or 6 per cent of an average bloom gives a heavy apple crop, 10 to 15 per cent being rare, while 13.3 per cent is the average set for pear flowers, or one fruit per cluster, the latter averaging about seven and a half flowers each. The apple being ordinarily a larger tree and a more vigorous grower than the pear, it is usually less within the orchardist's control by methods of cultivation and pruning; in other words, it is much better able to take care of itself than the pear.

EXPERIMENTS IN CROSSING.

The methods followed in the work on the apple were the same as in the experiments with pears. Some of the flowers were emasculated with the scalpel and hand-pollinated by applying the open anthers to the pistils, while others were simply covered with bags made of paper, cheese cloth, or mosquito-net, from forty to sixty of the three kinds of bags being used on each tree. In a general way the results were similar to those obtained in the experiments with pears. The division of the varieties into self-fertile and self-sterile sorts was not nearly so well marked.

Crossing gave decidedly better results in all cases than self-pollination. The Baldwin, which was experimented upon freely, may be cited as a variety that comes as near being self-fertile as any, and yet even this is far from being entirely so, for in the best trees the percentage of fruit resulting from self-pollination was not more than one-fourth of that which resulted from crossing. Some of the Baldwin trees in fact seemed to be self-sterile, and trees of all the varieties occasionally set self-pollinated fruit.

The few clusters of Nortons Melon experimented upon indicated

that this variety, which produces the choicest apples as to quality, is quite inclined to be self-fertile. This was also found to be true in the case of Seckel pears, and indicates that high quality is not necessarily associated with self-sterility. On the other hand, Rhode Island Greening, Talman Sweet, Esopus Spitzenburg, and Twenty Ounce gave very poor results from self-pollination, but quite a number of the trees of these varieties experimented with refused to fruit even under the stimulus of cross pollination. This occurred but a few times in the experiments with pears, and in such cases the appearance of the foliage and the growth of the tree usually indicated that something was wrong, but there was no apparent reason why the apple blossoms on these particular trees should refuse to set fruit.

The apples resulting from some of the experiments were collected and studied, and the results were found to be parallel with those obtained in the experiments with pears, the crosses being larger, more highly colored, and better supplied with seed (fig. 42). For example, the hand-crossed Baldwin apples were highly colored, well matured, and contained abundant seeds, while the self-fertilized fruits were only slightly colored, were but one-fourth to two-thirds the regular size, and seedless. The crosses were, in other words, like the better specimens of apples, not bagged, from the same trees, and the self-fertilized fruits corresponded with the undersized, poorly-colored specimens.

The unsatisfactory character of the fruits obtained from self-pollination (figs. 43 and 44) was more pronounced in the apples than in the pears, and gave still further evidence that self-pollination is not to be relied upon for apple production, especially in unfavorable seasons.

CONCLUSIONS REGARDING CROSS POLLINATION OF APPLES.

The practical conclusions drawn from the experiments with apples are the same as those from the work on pears. There are so many varieties of apples, and the conditions in different sections vary so much, that different sets of varieties are planted in different regions. All the work here described was done at Rochester, Brockport, and Geneva, N. Y., and as the natural conditions in that region are very favorable to the apple, any tendency to self-fertility was probably pretty well brought out.

Although several orchards of single varieties of apples in Missouri have not yielded satisfactorily, yet the experience with large blocks of Ben Davis at the Olden fruit farm in that State, and in other extensive orchards in the West, where single varieties are planted in large blocks, shows that under certain circumstances crossing between different varieties is not necessary.

CROSS POLLINATION OF QUINCES.

DESCRIPTION OF THE QUINCE BLOSSOM.

The quince flower is larger and more showy than that of the apple, but is not so delicately colored and is of much coarser texture. The stamens and pistils are fully twice as large as those of the apple, and are considerably thicker than those of the apple or pear. The ovary is also larger and each carpel contains a dozen or more seeds. The flowers bloom later than those of the apple or pear, and are much better adapted to self-pollination than either, the stamens being so arranged that the anthers often touch the stigmas. The large size of the flowers is doubtless due to the fact that each winter bud produces but one, instead of a cluster of six or eight, as in the case of apples and pears. These buds grow on the sides of the shoots instead of at the tips of the fruit spurs or fruiting branches. The flowers are abundantly visited by insects.

EXPERIMENTS IN CROSSING.

Experiments in crossing were carried on with the quince at Rochester, N. Y., in 1892 and 1893. Pollen from Orange, Rea, Champion, and Meach was used, and the emasculated flowers were covered with paper bags or cheese-cloth bags. Both the crossed and self-pollinated flowers produced a fairly good percentage of fruit, no difference existing between them that could not be readily attributed to accidental variation. The experiments showed no such striking benefits from insect visits, as did those with the pear and apple.

MISCELLANEOUS FACTORS INFLUENCING FRUITFULNESS.

Although the main purpose of this paper is to bring out the importance of cross pollination as a factor in fruit production, the importance of other well-known factors influencing fruitfulness must not be overlooked. To plant an orchard and give attention to this feature only would be to invite failure. Unless the other conditions are favorable, the orchard will not be a complete success even with abundant cross pollination.

It is of vital importance to plant varieties naturally fruitful and adapted to the soil and climate of the region. The Ben Davis and Winesap apples, and the Kieffer, Le Conte, and Duchess pears, for example, have an inherent tendency to bear fruit, and unless all odds are against them they will produce crops. However, it is only necessary to mention the subject of varieties here, as its importance is already well understood; in fact, horticulturists are inclined to let it overshadow all other factors.

The vegetative vigor of the tree exerts a decided influence on its capacity for setting and maturing fruit. To be in good condition a tree must have a proper proportion of vegetative shoots. In the case

of young trees too much vigor of the vegetative parts tends to retard the formation of fruit spurs and blossom buds and prevents the fruit from setting on blossoms that have formed. On the other hand, when the tree has once formed the bearing habit its capacity for fruit production is largely determined by the vigor of the tree. Declining vigor first renders the tree completely self-sterile and eventually sterile to cross pollination. There is an apparent exception to this general rule, however, in trees which have been severely injured or which are about to die from disease, such trees loading themselves down with fruit. Under such circumstances the fruit is small and of inferior quality.

The weather during the blooming period exerts both a direct and indirect influence on the setting of fruit. Even when not injured by frost the blossoms are often chilled by the cold to such an extent as to interfere with fecundation. Moderate cold renders the self-fertile trees self-sterile and severe cold renders them sterile to cross pollination as well. Warm and sunny weather at this time indirectly aids the fertilization by favoring insects in their work of cross pollination. An excessive degree of humidity favors fungous diseases, which may destroy the blossoms or the young fruit. Dry winds, on the other hand, reduce the flow of honey to almost nothing and, the writer suspects, also cut down the stigmatic secretion and interfere with fecundation. Cold, rainy weather during the flowering period may be disastrous, the rains knocking off the pollen, washing away the secretion of the stigma, and preventing pollination by insects. Fruit will not set unless a reasonable amount of warm, sunny weather occurs during flowering time. The vitality of the tree is injured and the young fruit often killed by fungous diseases which destroy the foliage; hence, such diseases often exert sufficient influence to cause crop failures. Again, the amount of fruit a tree bears one year generally determines the yield the following year, and sometimes all possibility of a crop is cut off by the trees failing to bloom.

The object in pointing out these various influences is to prevent too much importance being attached to cross pollination. It may also be well to caution the reader against laying too much stress on classification into self-fertile and self-sterile varieties. The experiments showed that self-fertility and self-sterility were not to be relied upon implicitly.

The number of insect visitors in any orchard determines to a great extent the amount of cross pollination carried on. The pollen of the pear and the apple is not produced in sufficient quantity nor is it of the right consistency to be carried by the wind, and the pollination of these trees is therefore dependent on the activity of insects. In an ordinary spring there is usually an abundance of insects to thoroughly cross pollinate orchards of a few hundred trees, but in the case of large commercial orchards, especially where several are close to each

other, there is not a sufficient number of insects for cross pollination when the main body of the trees is in bloom. If there is no apiary in the neighborhood, therefore, each large orchardist should keep a number of hives of bees. Honey bees and other members of the bee family are the best workers in cross pollination.

PRACTICAL CONCLUSIONS.

In order to insure cross pollination the following rules should be observed in planting orchards of pears or apples:

(1) Use several varieties and plant not more than three or four rows of one kind together unless the variety is known to be perfectly self-fertile. If it is desired to grow one kind mainly, then every third tree in every third or fourth row should be of some other kind.

(2) Where large blocks of trees of one variety have blossomed well for several years, but have failed to produce fruit without any apparent reason, graft in other varieties and supply foreign pollen, as the trouble is probably due to lack of cross pollination.

(3) Be sure that there are sufficient bees in the neighborhood, or at least within 2 or 3 miles, to properly visit the blossoms. When possible, endeavor to favor the bees by selecting sheltered situations for the orchard or by planting wind-breaks.

NOTES ON SOME FOREST PROBLEMS.

By Gifford Pinchot,
Forester.

THE PUBLIC STANDING OF FORESTRY.

The meaning of the word "forestry" changes in the public mind from decade to decade. The change is due not only to a better understanding of the subjects with which forestry deals, but also to a radical difference in the way forestry is esteemed. The progress of the knowledge of any subject is almost always accompanied by a change in the point of view from which that subject is regarded. Thus, electricity, from being a matter of purely scientific curiosity, has made its way in public thought to the position of one of the foremost industrial forces of the time, with the promise of such future usefulness that whatever relates to it finds a ready hearing. In somewhat the same way forestry is gradually winning a better standing and a larger place in the consideration of the people. At first forestry was understood to relate to trees; and it was not until recently that it began to be seen that it has far less to do with individual trees than with forests. At that time landscape work and forestry were completely confounded, nor even at this day is the distinction always clearly made. Street trees were supposed to be the special province of the forester, and even yet one of the great Eastern cities has a city forester, whose duties are not concerned with any forest land. This point of view has served a most useful purpose, it is true, in enlisting the countenance and support of very many persons whose interest in forest matters, rightly so called, would have been small indeed, but it may fairly be questioned whether there has not been a counterbalancing loss of the good will and consideration of practical lumbermen and owners of forest land. Apart from the æsthetic point of view just referred to, a serious check to the progress of forestry, or, as this side of it might well be called, of conservative lumbering, was the general praise given to European methods of forest management and the frequent and strenuous, but utterly impracticable, advice to apply them in the forests of North America. To very many of the men upon whom the introduction of forestry in the forest depended and still depends, this was a complete barrier, for it made forestry seem unworthy of even the most casual consideration. But these were mere temporary obstacles to a true understanding of forestry and marked what may have been inevitable stages of its progress. Another

and a worthier point of view has been that of the effect of forests upon climate, a subject of which, it must be confessed, we know comparatively little. To-day this subject is largely replaced in general discussion by the effect of forests on water supply, with which we are better acquainted. This, at last, is one of the real and vital issues with which true forestry is concerned.

THE TRUE CHARACTER OF FORESTRY.

This brief mention of some of the phases through which the public estimate of forestry has passed or is passing is in no sense intended as a criticism. It is merely an introduction to a short description of what the writer believes to be the true character and right field of forestry in the United States. The subject may be described under two great divisions, as follows:

FORESTRY IN THE WOODED REGIONS.

In wooded regions forestry has to do with the protection and preservation of forests, but most of all with their use. The prime object of the forester is to make his forest produce wood, and to do that trees must be cut down. But in order to continue producing wood the existence of the forest must be preserved, although the mature trees which help to compose it may be removed. Not only so, but the essential condition of the best health and productiveness of a forest is the timely removal of trees ripe for the ax. To put the statement of the same fact in different form, the lumberman and the forester both harvest the forest crop, with this difference: That in most cases the lumberman neither expects a second crop nor tries to provide for it, while the forester always does. Instead of being hostile or divided, as is sometimes mistakenly supposed, the forester and the lumberman are as necessary to each other as the ax and its helve. Without the ax the helve strikes but a weak blow; without the helve the ax is lacking in reach and in direction. In the same way the forester, without the special knowledge of the lumberman, can never do effective work in preserving the forests by using them nor succeed in a money way, while without the methods of the forester the lumberman will speedily exhaust his supplies of timber and disappear with the forests he has destroyed. But working together, lumberman and forester can perpetuate the supply of lumber while saving the forests, and so secure the essential objects of both.

FORESTRY IN THE TREELESS REGIONS.

In the drier regions of the West, where the timber is confined to the mountains and the river bottoms, the duties of the forester are somewhat different. There water is as important as wood, so that the protection of the mountain forests has a double use. In addition, there is the broad question of tree planting in the plains and the

treeless valleys. At first blush such work might seem to fall outside the province of the forester, on the ground that it has to do with trees and not with forests. But when it is remembered that protection and wood supply are the two objects of the work, and how important a public service may be rendered by the introduction of better trees and better ways of planting them, it appears at once that this also is one of the tasks of true forestry.

GOVERNMENT FOREST WORK.

The work of the Government in forestry is at present conducted by the General Land Office, the United States Geological Survey, and the Division of Forestry.

The care of the reserved and unreserved forest lands of the United States falls to the General Land Office as custodian of the public domain. It is charged with the safety of the public timber, outside the boundaries of the forest reserves, through the medium of its corps of special agents. The protection of the timber within the reserves is intrusted to forest superintendents, supervisors, and rangers, whose duties are chiefly those of a forest police. The mapping and description of the forest reserves and adjacent public lands are assigned to the United States Geological Survey. Both the Land Office and the Geological Survey are in the Department of the Interior.

The Division of Forestry of the Department of Agriculture is concerned chiefly with forest investigations of various kinds, such as those which relate to fire, to the growth of timber, and to better ways of handling forest lands—questions which affect the welfare of Government and private timber lands alike. It is the only Government agency directly related to the vast interests of private forest lands in the United States. How great these interests are will appear when it is known that the forest included in farms alone covers more than 200,000,000 acres—more than four times the area of all the forest reserves of the Government.

This dispersion of the branches of a single subject among three separate organizations is trebly unfortunate. It involves a waste of energy, it conspires to prevent the attainment of results which might flow from united effort, and it forces each contributor to the general progress of forestry into comparatively narrow and imperfectly useful channels. The steps by which this separation developed were natural and perhaps inevitable, but as time goes on the essential need of united effort will continue to make itself increasingly felt.

CONSERVATIVE LUMBERING.

EFFECT OF HEAVY TAXES.

Conservative lumbering is related to the matter of taxes in a very intimate way. The whole problem of private forest lands is summed up in the question, Can I afford to hold my land for a second crop?

Every forest owner must answer this question before he begins to cut, even though he may never put it to himself in words. The first consideration that arises is that of taxes. "What will it cost me," reasons the forest owner, "to pay taxes on my land for the years which must elapse between this cut and the next? It will take so many years for the crop to ripen, and during that time I must pay yearly so much per acre in State and county taxes, without getting any return to offset the expense. I could bear the cost of protecting my timber from theft, and even from fire, but can I stand the taxes?" The general answer is "No." Here is the key to much, if not most, of the destruction of forests by lumbering in this country—this and the fact that the methods of conservative lumbering are not yet well known among men interested in timber land. It is true that many other considerations have weight, such as the necessity or desire to take every stick that can be moved at a profit over an expensive railroad, pole road, or slide, or driven with the help of a costly dam, none of which will ever be used again. But the reason why they can serve but once is not free from the taint of the tax question. It will not pay to hold the land for the second crop because of the taxes, and so all the improvements are put in with the intention of moving them away or abandoning them when the timber is cut. Hundreds of thousands of acres in the white-pine region, notably in Pennsylvania, and in Michigan, Wisconsin, and Minnesota, have been cut over, abandoned, sold for taxes, and finally reduced by fire to a useless wilderness because of the shortsighted policy of heavy taxation. To lay heavy taxes on timber land is to set a premium on forest destruction, a premium that is doing more than any other single factor to hinder the spread of conservative lumbering among the owners of large bodies of timber land. Not only does this policy lead to the destruction of the forest, but it reduces eventually the sums raised by taxation. Devastated lands are valueless, and therefore can not be assessed at anything like their former rates. Then follows a reduction in the sums raised, and then a higher tax rate for the rest of the real property in the region; and so, by a roundabout but certain road, the chickens come home to roost, and the men who invited the destruction of the timber that should have made and kept them prosperous have to pay some part at least of the penalty of their shortsightedness.

It does not change such facts as these to explain how the heavy taxes happened to be assessed. It is true that the temptation to tax nonresident owners is very great; that companies are often made to suffer for their local unpopularity, and that the burden of building and maintaining roads and bridges and court-houses in sparsely settled countries bears heavily on their people. But when every allowance has been made, the fact still remains that heavy taxes are responsible for the barrenness of thousands of square miles which should never have ceased to be productive, and which must now lie fallow

for many decades before they can be counted again among the wealth-making assets of the nation. It is not greatly to the interest of any man to protect such wastes, and so fire runs over them year after year, and their possible utility recedes further and further into the future.

One of the foremost objects of the advocates of better methods of lumbering should be to bring about a change in the tax rate of forest lands held chiefly for lumber. Farmers' wood lots are far less apt to suffer. Until such agitation is followed by a modification of the tax rate, one of the most stubborn enemies of the forest will keep the field—alive and powerful for harm. The extent of its power will appear when it is stated that in Minnesota, for example, the aggregate State and county tax on forest land sometimes amounts to 6 per cent per annum on its actual market value.

The best way to accomplish the reduction of taxes on timber land is still a matter for discussion. Perhaps the most promising suggestion is to allow a definite rebate so long as the land is covered with growing timber, as is done in Pennsylvania, coupled with a much higher rate for the years when the crop is harvested. In some such way the capital invested in forest should be relieved of heavy taxes until the harvest, or while it is not producing a money return. Very carefully drawn laws would be essential in the adjustment of this very delicate matter, for the merchantable forest crop is not always harvested in full at a single cutting.

LACK OF KNOWLEDGE.

Another of the strong reasons which conspire against the introduction of better ways of lumbering is the general uncertainty among forest owners as to what the best methods are and what they cost. The lumberman who is disposed to consider whether he can not avoid the devastation of the region in which he is operating, or at least do as little harm as possible to its future productive power, is very often checked at the outset by his lack of knowledge. With all the good will in the world, in very many cases, and with a sincere desire to prevent the disastrous results which, within his own experience, have so often followed lumbering and fire, he is uncertain as to what he can do. Two things are clear: The old way of lumbering is practical, familiar from end to end, and the risk of loss is no greater for him than for his competitors, while the way to go to work to get his logs out cheaply, and yet keep the productive power of the forest unharmed, is unfamiliar, full of uncertainties, and perhaps discredited by the remembered advice of some thoughtless lover of trees, to "plant a tree every time you cut one down, as the Germans do." This proverbial remedy for all the forest evils that we deplore is, it may be said in passing, untrue in fact, impractical in operation, and wholly unsuited to bring about the end it seeks. It is therefore not

to be wondered at that it does not commend itself to the practical woodsman, already disposed to skepticism by not infrequent references to his own supposed vandalism and soulless greed. But the chief obstacle is his lack of information as to just what new methods of cutting or logging he should adopt, or, rather, how far the old methods require modification before they will secure the continued productive power of the forest without destroying the lumberman's profit. This is the question in a nutshell. To put it in a slightly different form, How can the lumberman get out his logs without destroying the capital value of his land? It must be confessed that hitherto there has not been much done toward answering this vital question, although it lies at the foundation of the whole matter. Throughout by far the greater part of the United States the lumberman will look in vain for actual examples of conservative lumbering in forests similar to his own, or for printed directions to guide him in his work. Methods of conservative lumbering have been devised for two important tracts in the Adirondack Mountains of New York, a description of which, together with their results in the first year's cut, will be printed during the spring of 1899 as a bulletin of the Division of Forestry. The earlier work at Biltmore, N. C., is already well known among men interested in such matters. But in general there has been, until recently, no ready means by which practical information and assistance could be obtained by timber-land owners desirous of assuring a future value for their forests without sacrificing their present interests too much. Such information and assistance the Division of Forestry now undertakes to give.

The general plan under which the Division cooperates with forest owners is as follows: When any forest owner makes known his desire to secure the assistance offered, the first step is a preliminary examination of the land by an expert of the Division. That done, the owner and the Division are in a position to consult as to further work. If they are agreed upon the advisability of preparing a definite scheme or working plan for the handling of the forest, an agreement is signed by which the Division undertakes to conduct any investigation that may be needed, such as careful cruising, or a study of the trees, or of methods of lumbering, while the owner agrees to pay the necessary traveling expenses and supply the woodsmen who may be required as assistants. Estimates upon these items are included in the agreement. Then, when the scheme of conservative lumbering has been worked out, and if it is approved by the owner, the Division, under the same conditions, will give practical assistance in putting it into effect, by marking the trees to fall, inspecting the work done, and in general contributing the same expert knowledge to the execution of the plan as it did to its preparation. Finally, the working plans prepared in this way will be printed, with such fullness of detail as will not interfere with the business interests of the owners,

but with sufficient exactness, on the other hand, to enable other forest owners to examine, understand, and, whenever possible, to apply their methods. The fundamental idea of the whole arrangement is to provide successful examples of conservative lumbering, and by giving them wide publicity to acquaint forest owners with better ways of handling their timber lands.

Applications have been received covering more than 1,000,000 acres, the plans for 100,000 acres of which have been prepared and are now in operation.

FOREST GRAZING.

The question of grazing has aroused more opposition to the forest reserves than perhaps any other single issue. For years the chief complaint was expressed by the determined opposition to the Cascade Range Forest Reserve in Oregon, maintained by the owners of large bands of sheep on the east side, which they had been in the habit of summer grazing on the mountains. (See Pl. X, fig. 1.) It was contended by the sheep men that, as the price of wool was lowered by the charcoal stains which followed the passage of the sheep through burned timber, it was strongly to their interest to prevent the spread of forest fires in the mountains. On the other hand, it was thoroughly well established that in the past forest fires have followed sheep ranging in timbered regions; that by far the greater part of such ranging would be impossible except for the clearings made by fire (see Pl. X, fig. 2), and that, whether it was to the interest of the owner or not, the sheep herders, carelessly or by intention, have frequently set fire to the forest.

A careful study of the whole question has been made on the ground by Mr. Frederick V. Coville, Botanist of the Department of Agriculture, whose conclusions are to be trusted. His results are strictly applicable only to Oregon, but taken together with facts of wider range—on the one hand, the tramping out of young growth by the sharp hoofs of passing sheep, and, on the other, the vast numbers of domestic animals annually grazed in the Government forests of British India without serious harm to their productiveness and general health—they point unmistakably to the following general conclusions:

(1) To regulate pasturage, if it is rightly done, is usually far better than to prohibit it altogether. In the majority of cases the complete exclusion of grazing animals is not required. Throughout great stretches of open forest there is excellent grass and other forage, the harvesting of which by sheep, cattle, or horses will have little or no harmful effect, provided the ranges are not overstocked, and provided again (and this is of the first importance) that before cutting begins, or as soon as the reproduction of the forest is desired, grazing animals of all kinds are completely excluded. When the reproduction is accomplished, and the young trees are old enough to be safe from harm, the animals may again be admitted, but never without careful

supervision and control. The length of time during which such forests should be protected will vary from about one-tenth to one-fifth of the time that is required to produce a merchantable tree. The regulation of pasturage should mean that each sheep owner should have the exclusive right to his range for a reasonable time and at a reasonable fee; that no range should be overstocked; that definite rules should be made and enforced, and that serious breaches of them, or the continued occurrence of fire in any range, should forfeit the rights of the sheep man and the money he paid for them to the Government.

(2) Many forest regions should be entirely protected against sheep. Such are mountains where the steepness and character of the ground and the importance of the water supply to the valleys below make the protection of the latter of vital consequence to the resident population. This is the case, for example, throughout the greater part of the Sierra Nevada in California, and in the mountains in the southern part of that State, where pasturing animals have already done the most serious injury to the interests of the farmers in the valleys.

TREE PLANTING IN THE PLAINS.

Tree planting in the plains, where it has not been regarded merely as a method of acquiring land under the timber-culture act, has had a double purpose—protection from wind and a supply of wood for domestic consumption. Such planting has been carried out on a vast scale during the past thirty years. Some of it has been successful, but much of it has failed to answer the purpose for which the time and money were expended. Failure and success alike have, however, been useful in furnishing experience in the light of which old methods may be improved, new methods devised, and additional and better kinds of trees selected for the work in the future.

As yet no comprehensive study has been made of the planting already accomplished, and the vast amount of experience accumulated through the successes and failures of the past has not yet been made fully and easily accessible to those who would profit most by a knowledge of its results. Such a study the Division of Forestry is about to undertake as a first and necessary step in the preparation of a scheme of experimental planting at such places as will best represent an average of the soils and climates of different parts of the treeless West.

By far the greater number of available native trees, and especially such as can be supplied by commercial nurseries, have already been tested on the plains under such a variety of conditions of soil, moisture, and exposure that further experiments with them will, in very many cases, be rendered unnecessary by a thorough knowledge of what has already been done. To acquire such a knowledge, however, will involve long and careful work in the field. Forestry under this

aspect, as in nearly all others, can best be studied where the trees grow.

Since 1896 experimental planting by the Division of Forestry has been in progress in cooperation with various agricultural colleges and experiment stations in the treeless regions. The work already done will be incorporated, so far as the circumstances will permit, in the new plan.

FOREST FIRES.

One of the first and most essential facts about forest fires is their commonness. Year by year they spread over vast stretches of country, and every spring and every fall accounts of their ravages are brought to public attention. Few forest regions escape, and by far the greater part of the whole forest area of the United States bears the marks of fire. Yet, the forests have not disappeared. They have suffered enormously, and their losses from this cause increase rather than diminish as time goes on, but the forests are still standing in more or less health and value over great areas that have been burned over tens or hundreds of times. The explanation lies in two facts, each less generally appreciated than it should be, which have a vast influence on the present condition and value of North American forests. The first of these facts, established by the fire scars which mark the lower trunks of forest trees over so large a portion of our forests, is this: In most regions of the United States the fires that kill the old timber are the great exceptions. Ordinarily, fires simply run over the ground, burn the leaves and fallen twigs, or the grass where the trees stand far apart, kill a few or many or all of the young seedlings or sprouts, and leave the older trees scarred and blackened at the base, but alive.

Where there is little combustible material on the ground, as generally happens in very open forests, it is easy to understand that the fires are not fierce and the heat not great, so that the thicker bark of the old trees is usually a sufficient protection. Even here, however, the damage that fires do is sometimes very great, as shown in Pl. XI, where the effect of slight fire scars, at the base of a tree, upon its soundness and utility, is seen to have been most serious. But in dense forests, where the layer of inflammable material on the ground is often a foot or more in thickness, it is at first not easy to see why fire does not make the clean sweep that marks the exceptional devastating conflagration. It is very common, in such a forest, to find every tree marked by fire, but not one killed. The reason is that only the upper layer of the litter, to the depth of an inch or a few inches at most, was dry enough to burn at the time the fire went through. Such an instance is shown in Pl. XII, fig. 1, together with an illustration (Pl. XII, fig. 2), drawn from the same region, in which the whole forest has succumbed.

The second of the influential facts above referred to is that the

trees now on the ground are the successors of tens or hundreds, or, perhaps, of thousands of others which formerly occupied the surface of the country, and in due course grew old and died, or were killed by fire or thrown by the wind or the ax, and so have made room for their followers. In the same way present generations must eventually be followed by others, whether decay, wind, fire, or the ax be the final means of their taking off. The important point is that a forest once destroyed is rarely destroyed forever. If this were not true, it is safe to say that scarcely an acre of timber would now be standing on this continent. The home-coming of the forest to land from which it has disappeared is often a very slow and delicate process, but in the end some sort of forest cover may be counted on to take the place of that which has gone. Hence, it is that the devastating fires which have swept over this country for centuries have not succeeded in leaving it barren of trees. Forests, like nations, endure only at the expense of a constant succession of births and deaths among the individuals which compose them.

The question from a practical point of view, however, is not whether a given area will eventually grow trees again, but rather whether it can be of some practical use to mankind without prohibitory delay. Thus, a fire which may be only one of a long series of periodic devastations in the life history of a forest may mean the loss of all its value to humanity for so long a time that it is common to hear it said that such and such a piece of forest land has been made desert forever.

A typical illustration of the relation of fire to the existence of a great forest, and an indication of its power in determining the kinds of trees of which the forest is composed, is found on the north side of the Olympic Mountains of western Washington. The magnificent forest about the base of this range would seem at the first glance to be wholly untouched and unaffected by any enemy except the wind and the ax. It has been described as the one region in the United States where the forest is entirely unaffected by human action. Yet, a little study shows that great stretches of it, at least, have been burned over within a comparatively recent time. Underneath and among the roots of the standing trees there is a layer of charcoal left by the fire that cleared the ground for their occupation, which may be brought to light by a little digging, or which can be seen with less trouble when the wind has overthrown the trees and exposed the ground in which they stood. But still more conclusive evidence is supplied by the rotting, fire-scarred stubs of old trees standing in the midst of the young, unscorched generation which followed the fire. (See Pl. XIII.)

Here is a perfect example of the entire recovery of a forest after its apparent destruction by fire, but the case has yet another interest. The Douglas Fir (Red Fir) is the most important timber tree of this forest, through which it is very widely scattered. It is a curious

fact that during a trip of some length through the northern Olympic region the writer was unable to find a single seedling of this tree under the forest cover. Yet, wherever there was an opening cleared by fire they were plentiful. This seems to show, although further evidence must be gathered before the case can be fully established, that the composition of this great forest is largely determined by fire. We have already seen how intimately fire is related to its very existence.

So much for some of the more obvious characteristics of forest fires. Yet, even such elementary facts as these are little known, and what scant knowledge has been gathered and printed regards only a very few of the forest types which are so numerous and so diverse over the vast wooded areas of this continent. As yet the study of forest fires in North America can hardly be said to have made more than the most elementary progress.

The broad and vital question of forest fires falls naturally into two parts, one largely statistical, the other dealing with the natural history of the fires. About neither of them has a satisfactory volume of facts been gathered, although much more is known of the damage they do and the area they cover than of the details of their behavior and the effect they have on the soil, the trees, and the general character of the forest. The records of fires, for the most part, are found only in the forests themselves, in the vast numbers of scattered references to them in the public press, and in the statistical files of those insurance companies whose policies, directly or indirectly, they affect. Hence, one of the most important pieces of work in regard to forest fires yet unaccomplished has recently been begun by the Division of Forestry. It is a study of the number, date, extent, and damage of the fires which, both before and since the advent of the white man, have swept from time to time through the forests of the United States; and already a classified list of over 1,200 fires has been made. Such a record will furnish the best available means for estimating the prodigious loss yearly suffered by the country from this cause, and at the same time will show, more clearly than is possible at present, the dangerous zones, the centers from which fires spread, and the relative degree in which particular localities throughout the country have already been heavy losers in the past, or are likely to need special precautions in the future. It is true, of course, that the great danger belts are already known, and that the people who live in places specially exposed to fire are already acquainted with the risks they run; but until the record of fires is far more complete than it is at present, many of the facts essentially needed to provide against loss or to awaken public sentiment will remain out of reach of any but local inquiry.

Beyond the somewhat trite fact that they burn and do indefinite damage, little is known about the real nature of forest fires in the

different regions and types of forest in the United States. How they move over the ground in wet and dry weather, how they are helped and hindered, how they affect the soil, what harm they do to the standing trees and why, how they affect the reproduction of the forest and determine the kinds of trees of which it is made up—all these questions have been left almost untouched except upon the surface. It is true that vague general answers can be given to most of them, but of real study of forest fires there has hitherto been very little. In this line also the Division of Forestry has recently undertaken to supply the lacking information. During the past season field work was begun in Colorado, Wyoming, Montana, Wisconsin, and New York, chiefly in cooperation with the United States Geological Survey, and some progress has been made.

It may fairly be asked what is the practical value of such studies of the history and nature of fires as those just described. The answer is that every kind of knowledge of an enemy may be used against him. Thus, if it is learned that in a certain region fire travels in a wedge-shaped mass, with the fiercest heat and the most rapid progress at the point, it follows that the place to attack it is at the point of the wedge, and that the very common method of attacking the wings is usually a waste of time. In a similar way an accurate knowledge of the great damage which follows hasty and unwise backfiring in any given region will be of use in suppressing it.

The study of how the fires burn yields direct assistance to the men whose homes lie in the threatened district. In a somewhat different way the historical study of fires will be of use, for whatever helps to call attention to the magnitude of an evil helps at the same time to weaken its capacity for harm. If the vast destruction fires have occasioned can be brought thoroughly home to the public mind in terms of lives lost, homes destroyed, and wealth gone up in smoke, a factor of notable power will be set to work in bringing about the final extinction of this gigantic leakage of the national resources. There is no friend of any public wrong so powerful as uncertainty or obscurity, and no foe to loss by fire so efficient as an awakened public sentiment.

In these and many other ways a full and clear knowledge of forest fires under their various forms will help to rid the country of the immense and useless loss they bring from year to year.

FIG. 1.—BAND OF SHEEP GRAZING ON CASCADE RANGE FOREST RESERVE, WASCO COUNTY, OREGON. (HIGH PRAIRIE; ALTITUDE, 4,000 FEET.)

FIG. 2. SEVEN-YEAR-OLD BURN WITHOUT REPRODUCTION, ON CASCADE RANGE FOREST RESERVE, WASCO COUNTY, OREGON. (ALTITUDE, 3,500 FEET.)

FIG. 1.—WESTERN YELLOW PINE SCARRED AT THE BASE BY FIRE, HAY CANYON, BLACK HILLS FOREST RESERVE, SOUTH DAKOTA.

FIG. 2.—TIMBER RUINED BY FIRE SCARS MANY YEARS AFTER THE FIRE, NEAR HILL CITY, S. DAK., BLACK HILLS FOREST RESERVE.

(By permission of Henry Gannett, geographer, U. S. Geological Survey.)

FIG. 1.—ROOTS OF WESTERN HEMLOCK PARTLY EXPOSED BY FIRE, OLYMPIC FOREST RESERVE, WASHINGTON. (SOIL STILL COVERED WITH INFLAMMABLE WASTE, WHICH AT THE TIME OF THE FIRE WAS TOO WET TO BURN.)

FIG. 2.—MINERAL SOIL LAID BARE BY FIRE, WITH CHARRED FRAGMENTS OF DOUGLAS FIR (RED FIR), LAKE CRESCENT, OLYMPIC MOUNTAINS, WASHINGTON.

FIG. 1.—CHARRED STUB OF DOUGLAS FIR (YELLOW FIR), WITH YOUNG TREES OF DOUGLAS FIR (RED FIR) GROWN SINCE THE FIRE. SOLEDUC VALLEY, OLYMPIC FOREST RESERVE, WASHINGTON.

FIG. 2.—GENERAL VIEW OF OLD FIRE-KILLED STUBS (ON THE LEFT AND IN THE BACKGROUND) AND YOUNG TREES GROWN SINCE THE FIRE, ALL OF DOUGLAS FIR (YELLOW AND RED FIR), SOLEDUC VALLEY, OLYMPIC FOREST RESERVE, WASHINGTON.

WEEDS IN CITIES AND TOWNS.

By Lyster H. Dewey,
Assistant Botanist.

GENERAL REMARKS.

In all cities and villages there are vacant lots awaiting purchasers, and in many agricultural districts the unused land in towns often exceeds in proportion the unused land in the surrounding farms. These vacant lots are held in expectation that they will be used some time for building sites, and their value depends on their situation and adaptability for this purpose. Until buildings are erected upon them they are usually given up to whatever will grow. While unused land in the country is generally covered with native vegetation, chiefly perennial grasses and timber, that in cities and towns has usually at some time been under cultivation, so that the native vegetation has been destroyed, and its situation is such that it is most readily seeded with migratory weeds. The seeds are introduced in the packing of crockery, the sweepings from stores, rubbish from yards, cleanings from stables and stock cars, and in various kinds of garbage and refuse, too commonly deposited on vacant lots. Sometimes lot owners encourage the dumping of all kinds of material on their land to bring it up to the grade of adjacent streets, and when the desired grade is obtained the made ground, full of weed seeds, is left untouched. The conditions for weed production have been most admirably prepared, and the natural result is a plentiful crop of weeds.

There is no direct pecuniary incentive to destroy the weeds, since no crops are injured by their presence. In fixing the value of a residence site the distant view of mountain, lake, or river is an item of considerable importance, but a weed patch across the street or on the next lot is too often not taken into account.

CHARACTERISTICS OF CITY WEEDS.

The weeds of cities and villages are usually of the migratory class, cosmopolitan in character, and capable of thriving under a wide range of environment. According to the early European works on botany, plants from Asia, adventive in Europe, usually appeared first in cities. Many of these plants are now found about the cities and towns of this country. Others are native plants which have withstood the changed conditions due to cultivation and have acquired a weed-like habit. In the Eastern cities and in those on the Pacific coast Old

World species predominate, while in the cities of the interior, especially in those west of the Mississippi River, there is a larger proportion of native plants. The species vary in different cities, in different years, and in different seasons.

In Washington, D. C., the wild onion of winter and early spring is followed by the dandelion and bulbous buttercup; then come the wild carrot, prickly lettuce, and sweet clover, and these in turn are partly displaced in the fall by horseweed, ragweed, cocklebur (fig. 45), Mexican tea, slender pigweed, and jimson weed. Chicory, horse-

FIG. 45.—Cocklebur (*Xanthium canadense*).

FIG. 46.—Tall ragweed (*Ambrosia trifida*).

nettle, burdock, and gum succory are in abundant evidence throughout the season. Some of the most prominent weeds in Boston are burdock, rough pigweed, chicory, and fall dandelion. In Chicago rough pigweed, tall ragweed (fig. 46), and cocklebur are abundant, while there are hundreds of acres within the city limits covered almost completely with Canada thistle, and in several places Russian thistle is rapidly increasing. In Denver false ragweed, squirrel-tail grass, and Russian thistle are among the most noticeable weeds, and in San Jose, Cal., the vacant lots are chiefly occupied by wild licorice, spiny

cocklebur, wild heliotrope, milk thistle, and tarweeds. In Atlanta, Augusta, Auburn, Mobile, and most of the cities of the Gulf States the weed that is by far the most injurious and the most prominent after midsummer is fine-leaved sneezeweed (fig. 47), a very bitter, yellow-flowered composite, which has been introduced during the past fifty years from west of the Mississippi.

Among the most noticeable introductions in cities during the past ten years are galinsoga (fig. 48) in several cities of the Northeastern States;

FIG. 47.—Fine-leaved sneezeweed (*Helenium tenuifolium*).

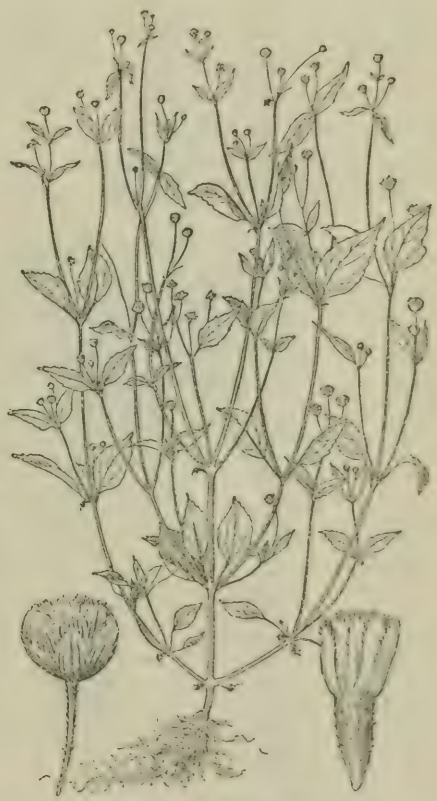

FIG. 48.—Galinsoga (*Galinsoga parviflora*).

Russian thistle, spreading eastward in cities from Michigan to Massachusetts; buffalo bur, also migrating eastward; wild carrot, migrating westward; false ragweed (fig. 49) in the valleys of the Missouri and Upper Mississippi, and prickly lettuce in all parts of the country.

All methods of seed dispersion are represented in city weeds, but those weeds having seeds adapted for distribution by wind or by burs are most abundant. In the vacant land about woolen mills bur-bearing weeds are especially abundant, while in the vicinity of grain elevators those weeds abound whose seeds are frequently found in grain.

SOME GOOD EFFECTS OF WEEDS.

The presence of weeds on vacant city lots is not quite an unmixed evil. While young and growing they are certainly more pleasing to the eye than the bare ground or the more unsightly rubbish which they conceal. Some species, such as oxeye daisy, wild carrot or "Queen Anne's lace," and the wild asters, have very pretty flowers that would be considered beautiful if they did not grow on common weeds. The pokeweed, with its bright red stems, variegated foliage, and shining purple-black berries, gives a touch of brilliant autumn color; and poison ivy, which is too often retained in parks for the beautiful effect of its foliage in autumn, decorates as well many walls and fences about neglected vacant lots.

FIG. 49.—False ragweed (*Iva xanthifolia*).

The weeds growing within easy reach of pupils and teachers in city schools furnish some material for botanical studies, though this source of material does not seem to arouse botanical enthusiasm like a ramble in the woods.

Birds find in weed seeds a considerable portion of their food supply, and sometimes make their nests in the larger weeds; but cockleburs, burdock, thistles, ragweeds, and other coarse species might well be replaced by seed-bearing grasses and clovers, which are better liked by seed-eating birds.

Asters, sweet clovers, thistles, and some other weeds when in flower furnish honey bees with nectar, but if the coarse weeds were cut there would doubtless be plenty of honey-producing plants left for the few bees which are kept in cities and villages.

Growing weeds, like other plants, purify the air, and herein lies the chief benefit conferred by their presence in cities, where numerous fires in dwellings, factories, and locomotives, and the breathing of the people continually rob the air of its oxygen and charge it with carbonic-acid gas. Growing plants, weeds as well as others, reverse this process. They withdraw from the air carbonic-acid gas and sometimes other injurious gases, and give off oxygen, thus tending

to purify the air and keep it supplied with the most essential element. A vacant lot covered with healthy growing weeds is better for the public health and is certainly more pleasing to the eye than the bare ground.

SOME BAD EFFECTS OF WEEDS.

The injuries resulting from the presence of weeds outweigh many times all the good that can be ascribed to them. They harbor injurious insects and fungous and bacterial diseases of cultivated plants. Many insects injurious to garden and field crops also live on weeds, upon which they thrive and multiply, and thus keep up their numbers ready to attack their favorite cultivated crop as soon as it is left unprotected. The control of insect enemies and fungous and bacterial diseases of field and garden crops is rendered much more difficult and their extermination, in some instances, is made practically impossible, because they exist on weeds that are not subject to the care bestowed on cultivated crops.

While weeds are growing they aid in purifying the air, but when growth stops and they begin to decay their effect is just the opposite. They then absorb oxygen and give off carbonic-acid gas. A mass of rank vegetation decaying on vacant lots, such as is often seen even in the finest residence sections of large cities, can not be otherwise than unhealthful. Growing weeds also absorb and evaporate the surplus moisture from the soil, but when dead, absorption ceases and they shade the soil from the purifying and drying effects of sun and wind, and keep it damp and sour, a fit breeding place for malaria.

Some of the most abundant and widely distributed species, as the ragweeds, produce immense quantities of pollen, which is extremely irritating to persons afflicted with hay fever and asthma.

Several species of weeds produce very disagreeable odors, as the mayweed, stinkweed, and tarweed. Residents of Eastern cities complain bitterly of the flavor of garlic in the milk delivered to them, yet they allow the garlic to grow so abundantly in their own yards that the odor fills all the houses in the vicinity when the lawns are mowed.

Plants that are dangerously poisonous are found in a large number of the cities and villages throughout the country. Henbane or deadly nightshade is found in a few localities. Jimson weed and purple thorn apple are common in most cities east of the Mississippi River. Their seeds, which are somewhat attractive, are very poisonous, and children fall victims to them every year. Nine cases of poisoning from this source were reported to the Department of Agriculture in 1897. Pokeweed, the root and seeds of which contain a virulent poison, is abundant in most of our cities. Poison ivy in the North, low poison ivy in the South, and poison oak on the Pacific coast, although not strictly weeds, deserve mention among the dangerous plants which are frequently allowed to grow in cities and villages.

There is usually very little space for children's playgrounds in cities, and often the open places that might be used for such purposes, including the occasional vacant lots in sections where land is valued at from $10 to $50 per square foot, are covered with coarse weeds and poisonous plants. In Washington, D. C., a vacant lot three blocks from the White House was covered during the summer of 1898 with a luxuriant growth of burdocks, even the signboard being hidden by the weeds. Opposite a million-dollar mansion, in the same city, is a vacant lot, which, for five years, has been given up almost exclusively to Canada thistle, chicory, and ragweed. This weed patch, which would be a disgrace even in the back fields of a careless farmer, is practically all that can be seen, save the backs of houses, from the front windows of the mansion. Close by, in striking contrast with this neglected lot, is a beautiful public park with carefully trimmed green lawn and well-kept shrubbery. These two extremes are found in close proximity in many of our large cities, and from these must the children draw their daily lessons of nature. In one she is ugly and repellant with thistles and burs, and in the other she is too fine to be touched. In less valuable sections of the cities the children keep down weeds on parts of vacant lots by their constant tramping.

Weed patches may be places of interest for the amateur botanist who watches the coming and going of the different species and notes the various adaptations of plants to city life, but for the majority of city dwellers they ruin what little taste may be left for the beautiful in nature.

State weed laws are rendered ineffective by the unchecked production of weeds in cities. The Canada-thistle law in Illinois is probably better enforced in the country districts of that State than are the weed laws in any other section of the country, and the thistle could be easily kept in control there were it not allowed to grow undisturbed in Chicago and other large cities, whence the seeds are carried by wind and railway cars to infest new areas. In many of the smaller villages the State weed laws are well enforced, or the weeds are kept down because of local pride in neatness, without recourse to the law, but this is seldom true in the larger cities.

Injurious migratory weeds are usually first introduced into cities and spread from them to the farms. There are a dozen chances for the original introduction of a weed in cities to one upon the farm. Fine-leaved sneezeweed first appeared about cities in the South, and is now spreading to the grazing lands and cotton fields. The Canada thistle in its progress across the continent has been distributed by railways, first to the cities. Prickly lettuce has usually been first observed in cities and towns in its remarkably rapid spread over the country. The Russian thistle, indeed, was first introduced into the United States on a farm, but being taken to the cities, it now most frequently spreads from them to the farms. In many instances these

introduced species could have been easily destroyed upon their first appearance in the cities and towns, and millions of dollars damage to the farmers thus averted.

SUGGESTIONS FOR IMPROVEMENT.

A vacant lot unused and given up to the growth of weeds is of very little benefit to anyone, and is, furthermore, a source of danger if not of certain injury to the community. The public welfare demands that all elements dangerous to life or health be removed. This would require the extermination of the jimson weed, pokeweed, and other poisonous plants. It would also require the removal or destruction by fire of all masses of coarse weeds as soon as they stop growing. These requirements are sometimes secured by the regulations of health officers.

Something beyond mere sanitation should be demanded, however. A vacant lot should be made to yield its highest possible value in use to the people. There will then be greater incentive to keep it free from weeds. The vacancy of a lot, even though regarded as only a temporary condition, should not prevent it from being put to good use until needed for building purposes. In the crowded portions of cities its best possible use is doubtless to form a playground for children. These need not be elaborately fitted up with costly apparatus like the modern playgrounds in the parks. They need only to have the weeds removed and the surface made reasonably level, cleared of rubbish, and seeded to some hardy perennial grass. Many lots, long vacant, will be already partly covered with turf-forming grasses, and will require only the removal of the weeds, when the grasses already established will spread over the entire surface. Other lots having nothing but a growth of ragweeds and cockleburs will have to be plowed, harrowed, and seeded to grasses. Recently graded lots, or those with sterile soil, will not at first support a good growth of grass, but white melilot, the "white sweet clover" so common on waste land, may be grown on them unless the soil is too sandy. This plant forms dense copses 3 to 6 feet in height, offering some of the bad features of tall weeds, but it is less objectionable than cockleburs, burdocks, and thistles, and it is rarely a troublesome weed on farms. It should be mowed or plowed under soon after flowering. This will rapidly improve the fertility of the soil so that grass may be grown. The grasses which survive best in waste land, unwatered lawns, or in parks may well be taken as an indication of those best adapted for seeding vacant lots. Soil, rainfall, and climate will determine which may be best in specific cases, but in general the following kinds are recommended: For the South, Bermuda grass, St. Augustine grass, and carpet grass; for the North, Kentucky blue grass, various-leaved fescue, creeping bent, and smooth brome grass. Common white clover in the North and Japan clover in the South are recommended

for sandy soils. After the land has been leveled and covered with a turf it will require little further attention except an occasional mowing. The children, by their tramping, will keep down some of the weeds, and they may be encouraged to destroy others that appear. It is not expected that a fine, even turf will be maintained equal to that in the parks, nor is this essential for the purpose in view. The grass will remain green during most of the year, and when the leaves do turn yellow and decay there will not be enough of them to pollute the air or induce disease.

In the outskirts of cities or in villages where there is plenty of open space for the children, vacant lots may well be used by the needy or by people out of employment for the cultivation of vegetables, according to the plan tried in Detroit, Buffalo, Columbus, Brooklyn, and Chicago, which has generally proved very successful for the purpose intended. Besides supplying the immediate wants of the deserving poor and providing healthful exercise, this work tends to give a wholesome taste for agricultural life. To obtain the highest benefit from vacant lots used for this purpose, and to prevent them from being overrun with autumn weeds, they should be cleared up and seeded either to crimson clover (where this will grow) early in the fall or later to rye. These plants will cover the naked ground and keep down weeds. Crimson clover will increase the fertility of the soil, and in the spring its bright flowers will repay many times the slight expense of growing it.

Where there are large areas of partly improved parks or subdivisions not yet placed upon the market, the vegetation may be kept down at slight expense by pasturing sheep on them. This method is pursued in Druid Hill Park, Baltimore, and in Central Park, New York, and it is found that the sheep make very effective and very economical lawn mowers.

The work of destroying the weeds and improving vacant lots can doubtless be done best by municipal direction under the immediate supervision of the park or street departments. In the larger cities it may be difficult to obtain the necessary municipal legislation. City authorities may wait to feel the pressure of public sentiment, and public sentiment may need to be educated to a just appreciation of the benefits to be gained. A few good examples, which may be produced through individual effort or by the united action of a small community, will demonstrate the practical utility of the work and lead to its extension. Examples of this kind are now found in many villages and suburban towns. If the practice can be made general in the cities and towns throughout the country it will cut off one of the principal avenues for the introduction of foreign weeds.

THE USE OF KITES IN THE EXPLORATION OF THE UPPER AIR.

By C. F. Marvin,
Professor of Meteorology, Weather Bureau.

HISTORICAL NOTES.

Ever since man began to observe and measure the conditions of the atmosphere around him a good deal of effort has been expended to find out what sort of conditions prevail high up in the free air. From what is known at present it seems that kites, which are so old that history does not tell us certainly of their origin, were the first things employed to gain this information. Nearly one hundred and fifty years ago Dr. Alexander Wilson, an astronomer in Edinburgh, Scotland, attached thermometers to kites which he flew to great heights, and thus ascertained the temperature in the clouds. Two years after this, but without any knowledge of Dr. Wilson's work, our own Franklin drew the lightning from the thunder clouds by means of a kite, and demonstrated its likeness to the electrical sparks produced by the laboratory machines. Balloons were unknown at this time, and over fifty years elapsed before scientists began to use them for conducting researches in the upper air.

In 1895 Prof. Willis L. Moore, the present Chief of the Weather Bureau, decided to undertake, by means of kites, the most complete survey of the free upper air ever before attempted. The plan adopted was to equip a number of stations distributed over the United States with kites and to make daily ascensions, sending up automatic instruments to a nearly uniform height of a mile if possible, the object being to secure a record of the meteorological conditions in the free air. Prior experiments made at the Weather Bureau and by others elsewhere had demonstrated the possibility of using kites for such a purpose, but very much remained to be done to bring the whole kite apparatus to that state of efficiency required in securing a successful execution of so difficult an undertaking.

While the Weather Bureau has been conducting this work, which comprises almost daily observations in a free horizontal air stratum about a mile high, independent kite ascensions have been made by several private individuals, the most important of which in the United States are the ascensions made at the Blue Hill Observatory, near Boston, under the direction of Mr. A. L. Rotch.

The results from a single station of this sort serve to show only the

change in atmospheric conditions as the kites pass up or down through successive strata; or, if the kites are kept continuously at a fixed elevation, the observations show the change in conditions from hour to hour.

In Europe small balloons, equipped with automatic instruments, have been cast free, from time to time, and have ascended to very great heights before losing their bouyancy, when, slowly falling to the ground, they have thus brought back records of the conditions at extreme heights in the atmosphere which were never reached before. Lately European meteorologists have employed both kites and balloons for atmospheric explorations, so that we may fairly say that kites are now no longer toys only, but are highly valuable pieces of scientific apparatus as well, the use of which will no doubt be greatly extended in the near future.

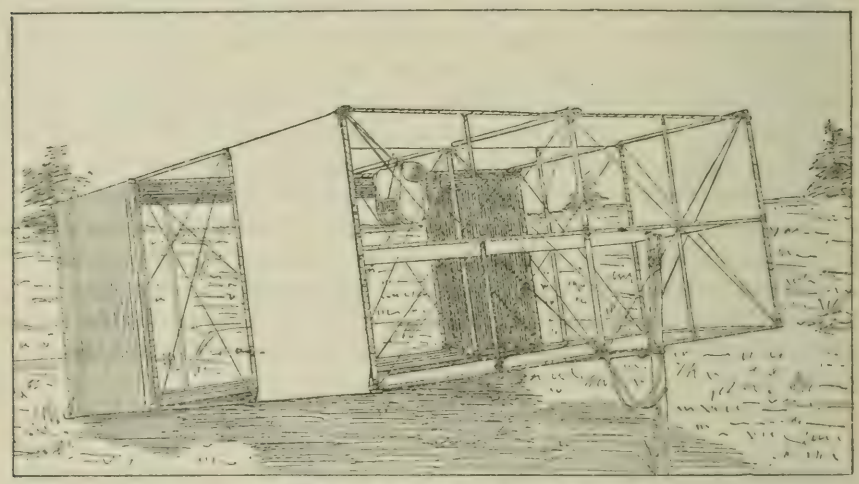

FIG. 50.—Standard Weather Bureau kite.

STANDARD WEATHER BUREAU KITE AND APPARATUS.

THE KITE.

The modern scientific kite is a far more efficient structure than any of the well-known toys, but its construction is correspondingly complicated, and, in most cases, somewhat more than the average mechanical skill and facilities are required to build one. Fig. 50 is taken from a photograph of one of those used by the Weather Bureau in its aerial work. The oval object seen suspended between the cells is the automatic instrument which produces the desired record. This kite contains nearly 70 square feet of supporting surface, and, in a strong wind, will exert a pull amounting to from 60 to 100 pounds and over. Of course, such a kite can not be flown and managed directly from the hand. The line is carried upon substantial reeling apparatus, which, in turn, is securely anchored to the ground.

DESCRIPTION OF REELS.

One of the hand reels employed at kite stations is shown in fig. 51. The large iron drum contains between 2 and 3 miles of fine steel music wire, joined in one continuous length. The greater part of this is often carried out by the kite in making a high ascension.

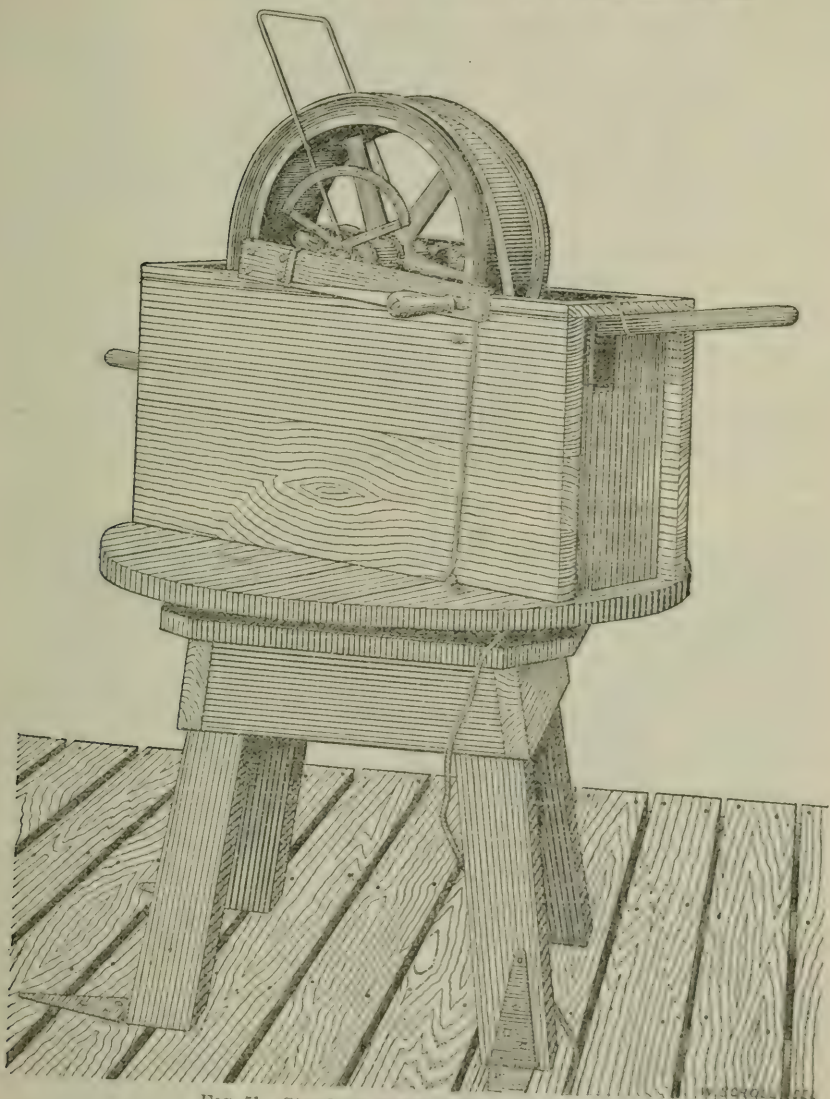

FIG. 51.—Standard Weather Bureau hand reel.

This wire is the lightest, and, relatively, the finest and strongest material known. The size employed in the Weather Bureau work is about the thickness of an ordinary pin, and yet has a tensile strength at the point of breaking of quite 200 pounds. The box containing the

reel revolves upon the table beneath, thus permitting the wire to lead off to the kite in whatever direction it may take.

The unwinding of the wire under the pull of the kite is perfectly and easily controlled by a brake, the lever of which is seen projecting to the right in the figure. A spring attached to one of the crank handles enables the pull of the kite, in pounds, to be determined. Certain dials arranged on the axle of the drum give the amount of wire out to the kite, and finally, the inclination of the wire is shown by means of a graduated arc and radius rod, seen over the drum in the figure.

A matter of great importance in the construction of a kite reel is to secure sufficient strength in the rim to withstand the enormous cumulative pressure exerted by a large amount of wire wound in under great tension. A single turn of wire around the drum under a uniform strain of 50 pounds, for example, tends to produce a compressive stress of 50 pounds at every point around the rim. The next turn, at the same tension, adds 50 pounds to the preceding stress, and so on. Two thousand turns at this rate will, therefore, produce a pressure of 100,000 pounds, or 500 tons. The heavy rim of the cast-iron drum, shown in fig. 51, is calculated to safely resist a crushing pressure of fully 1,000 tons. In actual practice the crushing pressure is not quite so great as that calculated by the process indicated above, because the material of the reel yields a little as the pressure increases, and this lessens the tension on the turns of wire already wound on the drum. The side flanges of the drum must also be very strong, as the wire crowds sidewise against these with great force. It is best on this account not to wind the wire on in smooth and even layers, but rather to crisscross the turns of wire slightly, but in a regular manner. Wound in this way, the wire tends to support itself, even without side flanges; at any rate, the lateral pressure is greatly reduced, and, moreover, the outside turns of wire are not able to squeeze down through what is already wound on the reel, as they tend to do when the wire is wound in an even manner like thread on a spool.

When flying at an elevation of from 5,000 to 7,000 feet, one of the Weather Bureau kites, supporting its instrument, will pull from 60 to 80 pounds, if not more, and from 8,000 to 10,000 feet of wire will be out. To wind all this wire in under such conditions is really a very laborious operation, and generally requires two men at pretty hard work for from a half to three-quarters of an hour or more.

In fig. 52 the automatic hand or steam kite reel, designed by the writer for use at the central station just outside of Washington, D. C., is seen as it appears completely housed and not in use. The reel, with a portion of the engine arranged for service, is shown in Pl. XIV, fig. 1.

The drum is of the same strength and construction as the one shown in fig. 51 and can be operated by hand by aid of cranks, which can be applied or detached at any moment desired. One is seen in Pl. XIV,

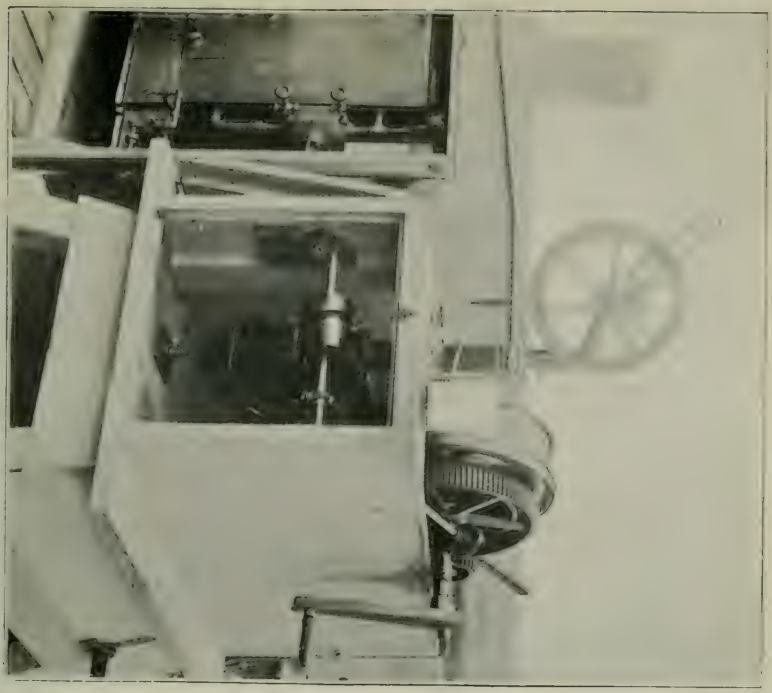

FIG. 1. AUTOMATIC KITE REEL, ARRANGED FOR SERVICE.

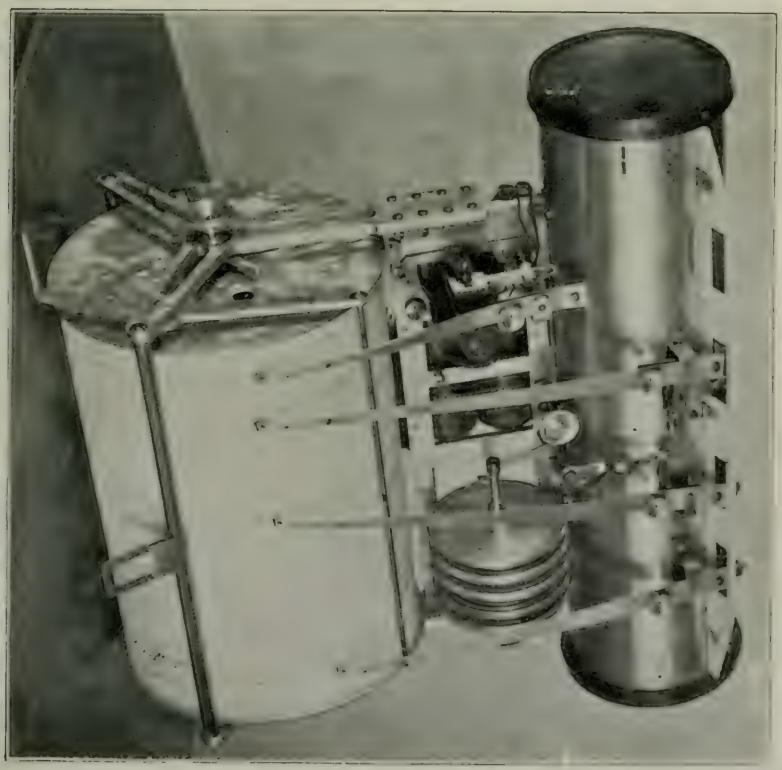

FIG. 2.—KITE METEOROGRAPH (MARVIN).

fig. 1, on the end of the axis of the drum. It is usually employed in this position to aid in starting a kite in flight during light winds. The crank can also be operated on the end of the shaft, seen a little farther back in the same figure. In this position of the crank the drum is driven indirectly, but with increased power, by means of the gearing shown.

In a favorable wind the tension on the line is more than sufficient to unwind the wire and the ascension of the kite is then controlled by means of the lever projecting upward at an angle in the rear of the drum. This operates the strap-iron brake fitted around the flange of the drum, and a very gentle pressure suffices to regulate the speed of the drum or to stop it completely even with the wire under the greatest tension.

Ordinarily, the work of winding in the line is done with the engine, the main shaft of which is extended across the reel box close to the

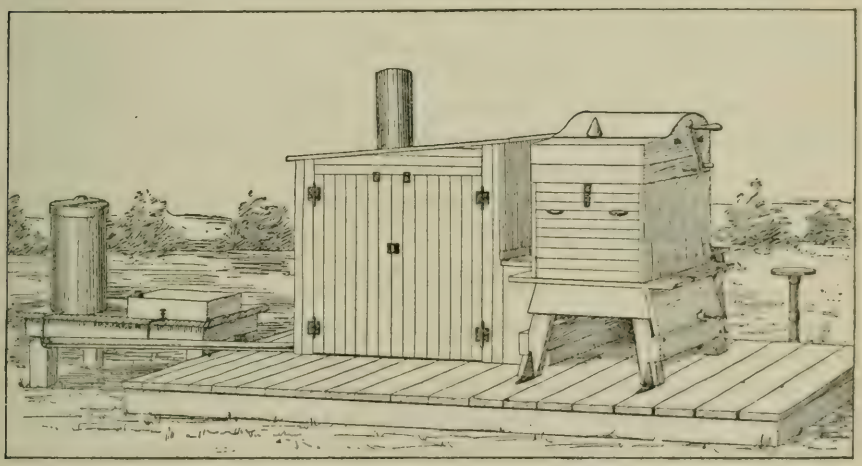

FIG. 52.—Automatic hand or steam reel housed.

floor. A belt from this runs the shaft carrying the small gear wheel. The large gear wheel runs loose on the axis of the drum, but when it is desired to wind in wire a lever at the back of the reel, not seen in Pl. XIV, fig. 1, is gradually shifted, thereby slowly starting the drum into revolution by means of a friction-clutch connecting it to the large gear wheel.

The arrangement of wheels seen in Pl. XIV, fig. 1, in front of the drum serves several purposes. The wire from the drum passes first downward and underneath the dynamometer and distributing wheel, thence up through the hollow support of the wheel seen at the top of the figure, over which the wire passes out to the kite. This latter wheel is free to turn, castor fashion, on ball bearings, about a vertical axis and align itself to the direction of the kite.

The first wheel inside the box, around which the wire passes, is

mounted in a pivoted frame governed by springs. The pull of the wire stretches the springs more or less, and the corresponding motion of the pivoted frame is communicated to the index and recording pen of the dynamograph, the recording cylinder of which, with some of the details, can be seen in the front of the figure. By this arrangement the tension on the line is indicated and can be continuously recorded at all times, no matter whether the wire is in motion either way or standing still.

Furthermore, this same wheel in its pivoted frame is so mounted as to oscillate laterally in a regular manner, thereby guiding and distributing the wire over the surface of the drum in a prescribed manner. The oscillating motion is given to the wheel by means of the cam, plainly seen in the figure. For the reasons already given, the guiding mechanisms distribute the wire in a crisscross fashion, so arranged that the turning point at the flanges of the drum occur successively at different points around the circumference, thus avoiding the heaping up of the wire at certain points.

The wheel at the top of the figure is just 3 feet in circumference, and serves to indicate the length of wire out by means of a suitable dial mounted at its axis. The length of the wire is also indicated by another set of dials operated directly from the axis of the main drum.

The bent radial arm and graduated arc, seen attached to the top wheel, are employed to measure the angular inclination of the wire as it leads off to the kite.

THE METEOROGRAPH.

The instrument sent up with the kite to secure the automatic record of the conditions of the air is called a meteorograph. It is quite a complicated and remarkable affair, and withal, is very light, weighing only about 2.1 pounds. The instrument is seen in fig. 50 as it appears attached to the kite and inclosed within its light, aluminum case. Pl. XIV, fig. 2, shows the mechanism inside the case.

The sheet upon which the record is produced is wound around the cylinder seen at the bottom of the figure. A clock-work inside the cylinder causes it to revolve at a slow and uniform rate of one revolution in twelve hours.

Four different meteorological conditions are recorded by the four pens of this instrument. The pen on the right traces a line on the paper which shows the humidity of the air, the pen being actuated by a strand of human hairs stretched inside the long tube seen at the top of the figure. These hairs have the property of lengthening when subjected to moist air and shortening in dry air.

The next pen toward the left traces a line upon the record sheet, which shows the pressure of the air, the pen being actuated by the gang of five round, thin, objects seen between the pressure and humidity pens in the figure.

The next pen in order traces a line showing the temperature of the air, which acts upon a special form of thermometer contained within the long tube at the top. When the instrument is attached to the kite the wind blows directly through this tube, thereby acting strongly upon both the thermometer and the hair hygrometer inside.

The pen at the extreme left is designed to record, electrically, the velocity of the wind. For this purpose a small anemometer, not shown in any of the illustrations, is fixed to the kite and connected to the instrument by wires The pen will then make little marks on the record sheet corresponding to every 2 miles of wind movement.

OBJECTS OF EXPLORATIONS.

A very few remarks will show the great importance in meteorological studies and weather forecasting of such observations as can be obtained by means of kites. These give the conditions prevailing in the free atmosphere, often in and above the clouds themselves, at points far removed from the disturbing effects of great cities, forests, the earth's surface, etc. In fact, observations thus obtained are truly characteristic conditions of great masses of the atmosphere, and when regularly and completely determined they afford far more exact and probably earlier indications of important forthcoming atmospheric changes than the most elaborate observations taken at the surface. The tops of our highest buildings are, after all, but an insignificant distance up in the free air, and all surface conditions are always modified as a result of the actual contact of the air with the earth and the immediate effect of the latter upon adjacent portions of the air.

CONSTRUCTION OF A MODERN KITE.

As some of the readers of this paper may desire to build and fly a good tailless kite of modern type, a simple method of constructing a small-sized cellular kite for pleasure purposes is given in detail. Fig. 53 shows a perspective view of the kite complete.

THE STICKS.

The sticks are best made of straight-grained spruce, but white pine also answers very well. Either lonsdale cambric or calico may be used for the covering. Some small tacks and coarse, waxed, linen thread are also required. The sticks should be cut to the following dimensions:

Four longitudinal corner spines, one-fourth of an inch thick, five-eighths of an inch wide, and 40 inches long.

Two central longitudinal spines, three-eighths of an inch square by 40 inches long.

Two short vertical struts, one-fourth of an inch thick, 1 inch wide, and 11⅜ inches long.

Four diagonal struts, one-fourth of an inch thick, five-eighths of an inch wide, and 37¾ inches long.

The real backbone of the kite consists of a central truss, which is made up as shown in fig. 54.

The long sticks are three-eighths of an inch square. At $5\frac{1}{2}$ inches from each end a slight notch is formed on one side to receive the uprights. A notch is shown at *n*, and its depth should not exceed one-

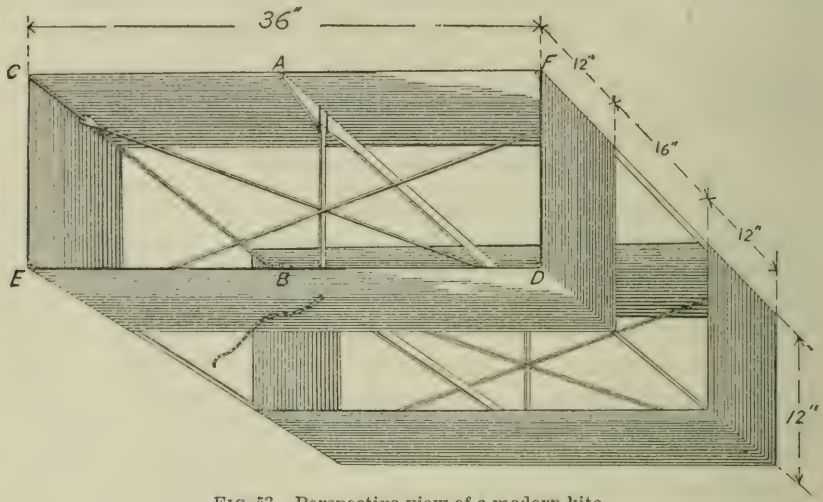

FIG. 53.—Perspective view of a modern kite.

sixteenth of an inch. The notches may, indeed, be omitted entirely. The uprights must be cut perfectly square and true on the ends, and are then cut to the form shown at *B*. These are seated squarely in the notches of the long spines and firmly lashed in place with coarse, waxed, linen thread, as shown enlarged in fig. 57. Waxed shoe-

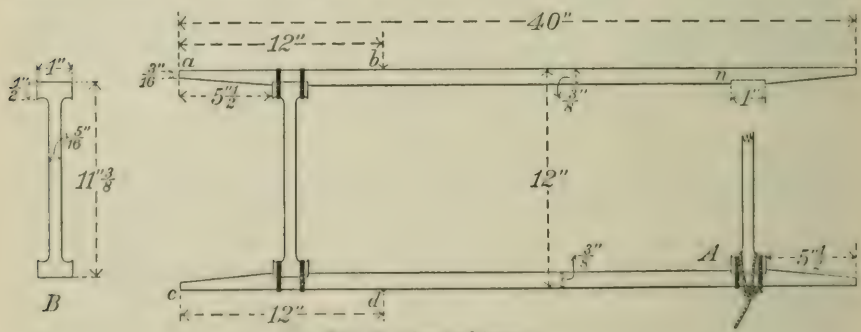

FIG. 54.—Central truss.

makers' or harness makers' twine is the best material for this purpose, but any coarse thread or fine string, thoroughly waxed, will suffice.

Fig. 55 shows the form to which the corner longitudinal spines should be dressed, the long, straight edge being slightly rounded, as shown in the end view. Notice that the notches at the opposite ends are not at the same distance from the end.

THE CLOTH, THREAD, ETC.

The covering of the kite is made of two long strips of cloth. Both edges of the strips should be hemmed, even if one edge has a selvage, and when so hemmed, the width should be just 12 inches. The total length of the strip, when stretched about as it will be on the kite, should be 96½ inches, the half inch being allowed for the lap of the goods in sewing the two ends together. It may be remarked here that it is generally better to carefully *tear* the cloth to the proper length and width, rather than try to cut it, as more accurate results will be gained by the first method. The opposite ends of each cloth strip should be carefully and evenly lapped the one-half inch and strongly sewed together with a double seam, thus forming two endless bands.

The next step is to mark the cloth bands at the places that are to be fastened to the frame. Stretch each cloth band out smooth and straight over two thin sticks run through inside the band. It is well to make the seam in the band come over or near the edge of one of the sticks. When the band is smooth and evenly stretched, draw a pencil line across the band exactly in the middle, where it turns around the edge of each stick. Let the line near the seam be marked

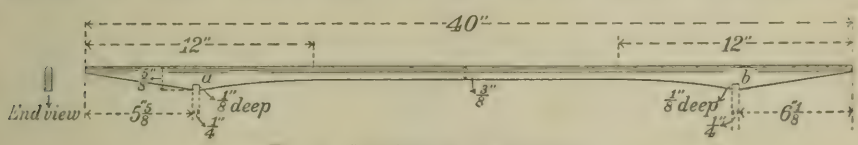

FIG. 55.—Longitudina_ corner spine.

A and the opposite line *B*. Now shift the cloth around the sticks so that the lines *A* and *B* approach each other, but do not pass. Carefully adjust the band so that when evenly stretched the line *A* is just 12 inches from *B*, and mark the cloth, as before, where it passes over the edge of each stick. Shift the cloth again still farther around the sticks; this time let the line *A* and *B* pass each other, and, when they are again separated just 12 inches and the cloth evenly stretched, draw pencil lines at the edges of the sticks as before. Time and care spent in laying out these lines accurately on the cloth, so as to divide it into equal portions *when stretched*, will be well repaid in the even flying of the kite.

The cloth bands are now ready to be tacked to the sticks. Put one of the bands over the central truss and tack the line *A* down with five or six small (2-ounce) tacks to one of the sticks; for example, as shown from *a* to *b*, fig. 54. The opposite line, *B*, must be tacked to the opposite stick from *c* to *d*. The remaining band is similarly tacked to the opposite end of the truss. Finally, the four corner longitudinal spines are passed within the bands and the appropriate lines of the cloth tacked to the sticks. The only point needing special attention at this step is to arrange the corner spines so that their

notches will stand in proper relation. Referring to fig. 55, it will be recalled that the small notch at one end of each spine is nearer the end than at the opposite end. In tacking the spines to the cloth, all that is necessary is that one pair of spines in opposite corners shall have the notches the shorter distance from the end and the notches of the other pair be at the longer distance. In other words, for example, tack short-ended spines in the *C* and *D* corners, as they appear in fig. 53; then the long ends of the remaining spines must occupy the *E* and *F* corners of fig. 53. When so arranged, one diagonal strut stepped in the notches will pass in front of and the other behind the uprights of the central truss.

All that now remains to be done is to fit up the diagonal struts. Fig. 56 shows a finished diagonal strut. It is difficult to determine beforehand the exact length these should be, because the amount the cloth bands will stretch is uncertain. The length indicated in fig. 56 is about right, if all the other dimensions specified herein are carefully adhered to. Make up a pair of the struts about a half inch too long at first, then, by trying them in the kite and cutting out the notches deeper and deeper, a perfectly satisfactory fit can be secured and the cloth braced out smooth and taut. Care must be taken to

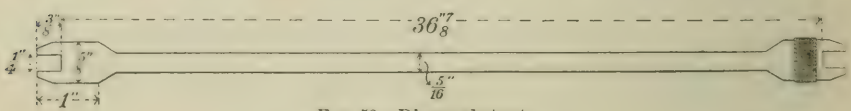

FIG. 56.—Diagonal strut.

keep the two struts of the same pair the same length. This fitting had best be done before reducing the cross section of the sticks between the ends. The enlarged ends, when finished, should have about the dimensions shown in fig. 56; then, to prevent the forks from splitting off, it is quite necessary to lash the ends just back of the notch with a serving of good, waxed thread. Instead of cutting these struts out of a solid piece, as described above, some may prefer to build up the enlargements at the end by gluing on small cleats, finally lashing the waxed thread over all as before.

It is understood, of course, that the diagonal struts are to be inserted within the cells of the kite, so that the notched ends enter the shallow notches of the corner spines, shown at *a* and *b*, fig. 55. One diagonal strut passes in front of, and the other behind, the upright of the central truss in each cell, and the three sticks are firmly bound together at the point of crossing with waxed thread.

METHODS OF BRIDLING.

Two methods of bridling the kite will be described. Cut off about 6 feet of stout cord and tie one end to the central truss at *A*, as shown in fig. 54, the cord passing through small holes pierced in the cloth

covering. The knot employed at this point is shown enlarged at *A*, fig. 57. The flying line should be tied to the free end of this cord by means of bowline knots, as shown at *B*, fig. 57. This knot is strong,

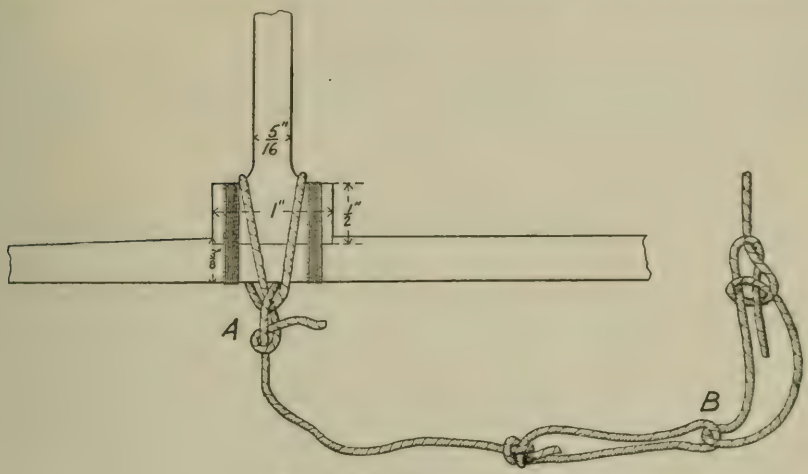

FIG. 57.—First form of bridle.

never slips, and can be easily untied, no matter how much the line may have been strained.

The one-point attachment of bridle, described above, is better suited to strong than light winds, and sometimes in lighter winds it may be

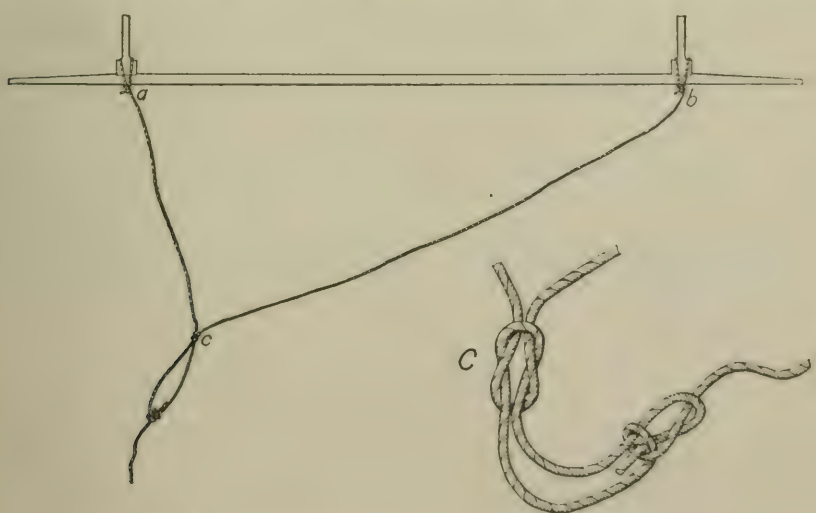

FIG. 58.—Second form of bridle; *c*, enlarged knot (loosened).

more satisfactory to employ the two-point attachment of bridle shown in fig. 58. In this the free end of the 6-foot piece of cord is shown tied to the central truss at *b*, thus forming the bridle, *a*, *b*, *c*; the

main line being attached at the point *c* by a kind of knot shown enlarged at one side. This will not slip of itself, but the point of attachment can easily be adjusted as may be desired.

To be perfectly safe, the flying line for this kite should have a tensile strength of from 50 to 60 pounds and be equally strong throughout. During light winds a finer line will answer, but strong currents are frequently encountered as the kite ascends, and a weaker line than specified above is likely to be broken.

FLYING THE KITE.

If the wind is favorable for flying, the best way to start the kite in flight is to run out 150 feet or so of twine while the kite is held by an assistant. When all is ready, the assistant may toss the kite upward a little in the direction in which it is to go. It will take care of itself afterwards. It is important the kite be cast off directly in line with the wind, otherwise it may seem to dart badly. When fairly up the kite may sweep a little from side to side, but if it ever darts or turns over, there is something radically wrong, probably due to an uneven distribution of the cloth surface, or some permanent distortion of the framework. Sometimes the weight of the wood varies, and one side is heavier than the other. This should be corrected by weighting the light side with a small strip of sheet lead, or otherwise.

If the wind is very light, a finer twine may be used in flying, and it may be necessary to run a little with a long string out, in order to get the kite into upper and more rapidly moving currents.

When the wind is very strong, drop the ball of twine on the ground so that the cord can pay out rapidly, and let the kite go up directly and quickly from the hand.

TANDEM KITES.

Several kites can be sent up on the same line. When an additional kite is to be sent up, it must be first carried out, say, 100 feet, attached to a separate line of that length, the end being tied to a loop formed in the main line. When all is ready, the kite is tossed up, as already described.

UTILIZATION OF RESIDUES FROM BEET-SUGAR MANUFACTURE IN CATTLE FEEDING.

By Guilford L. Spencer,
Assistant in Division of Chemistry.

PULP FEEDING IN EUROPE.

In visiting the sugar-beet farms of Europe, the excellent condition of the beef and dairy cattle is quite noticeable. This desirable result is in a large measure attributable to feeding the beet pulps from the sugar factories to the cattle. In addition to the pulps, a small proportion of molasses is also often fed.

It is customary in Europe, especially in Germany, to guaranty a certain proportion of pulp to each farmer who is a shareholder in the factory, as part compensation for his beets, and to pay other farmers not receiving pulp a somewhat higher price, approximately 75 cents per ton. The shareholders contract to furnish the beets from a certain area, and can depend upon receiving pulp in proportion to this acreage. The beet pulp is, moreover, in such demand that farmers not shareholders contract to plant a certain acreage to beets, and are then also supplied pulp as part compensation.

The pulp is especially prized in the sugar-producing sections for feeding milch cows. The general results of such feeding are a large flow of rich milk and the production of butter of good flavor.

RESIDUES FROM BEET-SUGAR MANUFACTURE.

In the sugar-beet industry the roots are topped in the fields prior to transportation to the factory, and the crown of the beet is removed by means of a sharp, heavy knife applied at or near the lowest leaf scar. Experience and chemical tests have demonstrated that there is a tendency for various salts to accumulate in the crown of the beet in greater quantities than in other parts of the root. Many of the salts retard the crystallization of the sugar in the manufacturing processes, and increase the production of molasses. It is for this reason that the manufacturers are very strict in their specifications relative to topping.

The tops, or crowns, may therefore be considered among the residues of the manufacture. They may be fed to cattle, but with hardly as satisfactory results as would be obtained by feeding the entire beet, owing to the large proportion of salts. In view of the necessity of

maintaining the fertility of the land, it is not usually advisable to feed the beet tops; they should be left in the fields to rot and be turned under in subsequent operations. However, where the manure from the cattle fed in part upon beet crowns and leaves is returned to the land such feeding is profitable.

In the earlier days of the beet-sugar industry in this country difficulty was experienced in some localities in persuading the farmers to leave the beet tops upon the ground instead of feeding them or hauling them to the factory, thus increasing the tare, and special inducements were necessary to convince them of the advisability of so doing.

The next important residue, and that which has been already briefly commented upon, is the beet pulp. This pulp is the residue of the beet remaining after the removal of the juice, or, according to present practice, after the removal of those parts readily soluble in water at moderate temperatures.

PROCESSES FOR EXTRACTING SUGAR FROM BEETS.

Until within the last decade three processes of extracting the sugar from the beet were in vogue, each producing characteristic pulps. These processes are termed the "hydraulic-press," the "continuous-press," and the "diffusion." In the first two processes the roots were first reduced to a fine pulp by means of rasps. In the hydraulic process this pulp was placed in sacks and submitted to heavy pressure, then moistened with water, and again pressed. This method produced very dry pulps of great feeding value and in an excellent condition for conservation. In the continuous-press process the pulp was passed between rollers, the residue saturated with water, and again pressed. This process produced a pulp of greater humidity than the hydraulic pulps, and of less feeding value. These processes have disappeared from the sugar factories, and are probably used in few, if any, of the distilleries; therefore the character of the pulps produced need receive no further consideration.

The process now employed by sugar factories in the extraction of the juice from the beet is termed "diffusion." The beets, after being thoroughly washed, are sliced into long, grooved pieces, somewhat approximating the letter V, in cross section. These slices are transferred to large iron vessels, and are treated with successive portions of hot water, heated to approximately 160° F. The vessels are closed and the water is under a few pounds' pressure during the process. After the extraction of the juice the pulp is pressed in continuous apparatus, and is then ready for delivery to farmers. The pulp in this condition is quite moist, still retaining about 89 per cent of water.

DIFFUSION PULPS.

The following may be considered an average analysis of diffusion pulps:[1]

Analysis of diffusion pulps.

Ingredients.	Fresh pulp.	Dry material.
	Per cent.	*Per cent.*
Moisture	89.09	
Nitrogenous matter	.92	8.43
Digestible carbohydrates	6.52	59.76
Indigestible carbohydrates	1.98	18.15
Fat	.09	.83
Mineral matter	1.40	12.83
Total	100	100
Solid matters	10.91	

The analyses, of which the above table gives mean results, were made by a commission of experts in France, including Messrs. Dupont, Vivien, Lucas, Duvin, and Durot. A brief résumé of feeding experiments conducted by this commission will be given further on.

A small percentage of cane sugar is included in the percentage of digestible carbohydrates given in the table. After the pulp has been stored in silos for a short time, the sugar, which does not usually exceed from 4 to 6 pounds in quantity in a ton of the fresh material, gradually disappears through fermentation, and therefore is lost, at least in part, before the pulp is fed. The nutritive ratio (per cent fat multiplied by 2.25 plus per cent digestible carbohydrates, divided by per cent proteids) of diffusion pulps approximates 1:7.2. This is a medium ratio, and agrees fairly well with the Wolf-Lehmann standard for fattening a steer. A calculation on a somewhat different basis, assigning a money value to each of the constituents of the materials, indicates that beet pulp is worth about half as much as corn silage.

The usual European practice in feeding beet pulp to beef cattle is to mix a small quantity of linseed-oil cake and chopped alfalfa with the material.

FEEDING EXPERIMENTS WITH BEET PULP.[1]

Few records, if any, of carefully controlled American experiments in feeding cattle on pulp are available; hence, those made in France by the commission already alluded to are given here.

At the time these experiments were made, the hydraulic and continuous press methods of extracting the juice from the beets were employed to a far greater extent than the diffusion process. In consequence of the increasing number of diffusion plants at this time,

[1] Bulletin No. 52, Division of Chemistry; also House Doc. No. 396, Fifty-fifth Congress, first session.

the question of the relative values of the different pulps was the subject of frequent discussion, and many disputes between the factories and the farmers were referred to the courts. The experiments were made in connection with the settlement of one of these disputes. The gentlemen who composed the commission appointed by the court rank high among the leading experts of Europe in matters relating to the beet industry, and the experiments quoted are therefore of the highest value. Data relative to press pulps are omitted, as these pulps are no longer of importance.

The following animals were used in the tests: (1) Beef cattle; (2) oxen; (3) milch cows; (4) sheep; (5) ewes. Before beginning the tests the animals were all gradually accustomed to the change from their customary ration to diffusion pulp.

(1) *Beef cattle.*—Twelve beeves each received every day, in three meals, 115 pounds of diffusion pulp, mixed with 6.6 pounds chopped alfalfa and 6.6 pounds linseed-oil cake. Their weight increased an average of 2.214 pounds per day. Taking into account the values of the increased weight of meat, and of the alfalfa and linseed-oil cake, that of the diffusion pulp is $1.316 per 1,000 kilograms, or 2,200 pounds.

(2) *Oxen.*—Four oxen received each per day 126.8 pounds of diffusion pulp, mixed with 12 pounds of alfalfa and 2.2 pounds of linseed-oil cake. These cattle decreased in weight somewhat the first fifteen days and did less work than usual, but in the second fifteen days they had entirely recovered. The trial continued two months and a half. In making a calculation similar to the one above, the value of the diffusion pulp was $0.956 per 1,000 kilograms (2,200 pounds).

(3) *Milch cows.*—The test with cows lasted thirty days. Two cows were used, one Flemish the other Dutch. Prior to the test the cattle were fed on dry alfalfa with a small quantity of press pulps from beets. The cows were each given per day 99.2 pounds of diffusion pulp with 4.4 pounds of alfalfa. The tests indicated that the pulp is of greater value as regards lactation than in the production of flesh. The effect of this ration on the product of cream, calculated, of course, in cubic centimeters, is shown in the following table:

Cows fed on diffusion pulp.

Date.	Percentage of cream to milk.	
	Cow No. 1.	Cow No. 2.
April 27	8.00	7.00
May 1	7.50	8.00
May 12	7.50	8.00
May 19	7.50	8.00

From these tests, it was inferred that the milk of the cows fed from diffusion pulp contained an average of 7.68 per cent of cream. The butter produced from this milk did not have the peculiar odor which is present in that from cows fed on press pulps.

(4) *Sheep.*—In this test twenty merino sheep were fed on diffusion pulp. The rations fed per animal and the resulting increase were as follows:

	Pounds.
Average rations per head:	
Pulp	11.88
Linseed-oil cake	.44
Chopped alfalfa	1.10
Weight of sheep:	
April 4	2,085.6
April 26	2,217.6
Total increase	132.0

The sheep eat the pulp with avidity; hence, it is unnecessary to make other additions to it. On a basis of this experiment with sheep, the value of the diffusion pulp was calculated to be $1.74 per 1,000 kilograms (2,200 pounds).

(5) *Ewes.*—The ewes were obtained from a flock from which the lambs had just been separated. In feeding the ewes, to which a somewhat larger ration was given than in the preceding experiment, the value of the pulp was calculated to be $1.206 per 1,000 kilograms (2,200 pounds).

Cost and feeding value of the pulp.—Not taking into account transportation, the commission estimated the value of the pulp per 1,000 kilograms (2,200 pounds) at $1.22, and from calculations based on a cattle food analysis, at $1.288.

From these experiments, one may draw the same conclusion relative to the feeding value of pulp as was drawn from the analytical data, namely, the material is very fattening food. The experiments in question, and many others, also indicate that pulp may be fed to dairy cattle with great success. The results with cattle doing heavy work indicate that pulp will find its best application in fattening animals for the market and in feeding milch cows, rather than as a ration for draft animals.

PULP FEEDING IN THE UNITED STATES.

While, as already stated, so far as the writer is informed, no experiments corresponding with those conducted in Europe have been made in this country, much has been accomplished in a practical way in pulp feeding. Pulp has been fed to dairy cattle in California for many years with satisfactory results. Reports from the Pecos Valley in New Mexico show the satisfactory feeding of large numbers of sheep, and a good demand for pulp.

A letter from Vice-President Thomas R. Cutler, of the Utah Beet

Sugar Company, Lehi, states that the company has been feeding pulp the past four years. This pulp is stored in silos, a little coarse salt being mixed with it at the rate of approximately 5 pounds per ton of pulp. The cattle and sheep eat the pulp greedily, cattle consuming an average of 100 pounds per day. The pulp is mixed with from 10 to 15 pounds of hay per 100 pounds for "roughness." The animals fatten rapidly, and altogether the results obtained have been very satisfactory.

The conditions which obtain in the vicinity of the Nebraska factories are somewhat different from those in the other localities mentioned. The writer recently visited a factory at Grand Island, and found there a very large pile of pulp, the accumulations of several seasons, the demand for this by-product at the factory being far from keeping pace with the manufacture. The products of the different seasons form distinct layers which may be readily separated. No effort is made to conserve the pulp. Considerable quantities of this pulp are given for the asking to farmers within easy hauling distance, and the remainder accumulates near the factory. Although the pulp is a decomposing mass to a depth of several inches, it is not offensive. On removing the decomposing portion at the surface, that part of the pulp at greater depths is of a cheese-like consistency, and may be readily removed with a shovel. The managers of the factory state that the cattle and sheep greedily devour the pulp without regard to its age, and are even fond of the portions near the surface of the heap.

Pulp is also fed to cattle at Grand Island immediately after bringing them in from the ranges. These cattle have known but little restraint, and have been accustomed to feed only upon the grasses of the prairies; nevertheless, on being given the beet pulp, they eat it without hesitation. A large owner of such cattle at Grand Island stated to the writer that he found the pulp of great feeding value, and especially valuable in changing the feed from grass to grain. He feeds the pulp in mixture with corn, and the moisture of the pulp serves to soften the grain. This feeding with pulp is necessarily discontinued when freezing weather sets in, partly on account of the waste of corn in the frozen pulp.

The factory at Grand Island has met with little success in disposing of the final molasses for feeding purposes.

Mr. G. H. Spitzli, manager of the First New York Beet Sugar Company, at Rome, conducted experiments in feeding, a summary of the results of which are given from a letter by that gentleman to the Department of Agriculture.

No very extensive experiments in feeding have been made at the Rome factory. Last year fourteen head of cattle were purchased about December 22 and fed on pulp mixed with a little cut hay and one pint of beet molasses for a period of four and one-third months,

to May 1. An ordinary bushel basket of pulp, with the molasses spread over the top, was fed three times per day. The average gain in weight of the cattle, as shown May 1, was 328 pounds. The animals were two-year olds, and grew considerably in height as well as taking on additional flesh. Mr. Spitzli also states that on a farm at Kirkland, N. Y., where blooded jersey stock is raised, the pulp is fed to milch cows with very satisfactory results.

The factory at Rome, N. Y., is this year selling the pulp at 50 cents per ton, and is finding a satisfactory market for it within hauling distance of the factory. The pulp is also being sold to several cattle raisers, who pay 50 cents per ton freight on it in addition to the factory price. From present indications, the supply at 50 cents per ton will not meet the demand next season.

It is evident that pulp will be in greatest demand at factories located as that at Rome, N. Y., at least for the next few years of the beet-sugar industry in the United States. In Nebraska and in States where similar conditions obtain and cattle foods are of low cost, the demand for pulp will increase but slowly. The largest demand will be in the dairy districts, and, other conditions being equal, the greatest expansion of the beet-sugar industry may be looked for in the great dairying States.

MOLASSES AS A FOOD FOR CATTLE.

The next residue of feeding value is the final molasses. In the processes of manufacture the juice is purified, evaporated to a dense sirup, and a part of the sugar then removed by successive crystallizations. After each crystallization and removal of sugar, the proportion of the saline matters and other impurities to the sugar increases, and after a time no more sugar will crystallize in this residue, which is termed molasses. This molasses then contains approximately 50 per cent of sugar and a large proportion of saline and other substances. Notwithstanding the feeding value of the molasses, due to its sugar content, it can not be fed in large quantities on account of the action of the saline matters present. The feeding of molasses is now practiced only as mentioned in connection with the experiments at Rome, N. Y., and in prepared-food mixtures.

Several of the American factories employ a saccharate process and precipitate the sugar from molasses as a lime compound, which finally decomposes, leaving a very pure sugar solution. Other factories sell the molasses to the distillers, and others find it a drug on the market and difficult to dispose of; hence, the desirability of devising satisfactory methods of feeding this by-product.

In view of probable future and extended investigations by the Chemist of the Department on the feeding value of molasses, further discussion of the question at this time is needless.

VALUE OF BEET-SUGAR INDUSTRY TO THE FARMER.

This brief discussion of the feeding value of the residues from the manufacture of beet sugar indicates the great value a large extension of the industry would be to the American farmers. It would not only give them a means of further diversifying their crops, but would afford a valuable and cheap food in the cattle industry and materially increase the prosperity of the agricultural interests.

BIRDS AS WEED DESTROYERS.

By Sylvester D. Judd, Ph. D.
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INTRODUCTION.

The problem of weed destruction is perennial in every land where agriculture is practiced. Indeed, so serious is it, that soil culture may be said to be an everlasting war against weeds. For a thorough understanding of the weed problem, it is necessary not only to define a weed, and to study its relation to crops, but to ascertain what are the agents, natural or artificial, which act as weed destroyers.

A weed is a plant out of place. Certain plants seem to have formed a habit of constantly getting out of place, and installing themselves in cultivated ground. Whether actually among crops or in adjacent waste land, from which they can spread to cultivated soil, they are always a menace. In the garden they occupy the room allotted to useful plants and appropriate their light, water, and food, so that any check on these noxious plants, a million of which can spring up on a single acre, will not only lessen nature's chance of populating the soil with these worse than useless species, but will enable the farmer to attain greater success with cultivated crops. The hoe and the cultivator will do much to eradicate them, but some will always succeed in ripening a multitude of seeds to sprout the following season. Certain garden weeds produce an incredible number of seeds. A single plant of one of these species may mature as many as a hundred thousand seeds in a season, and if unchecked would produce in the spring of the third year ten billion plants.

SEED-EATING BIRDS.

Fortunately certain agents are at work to check this harvest, and perhaps the most efficient among them are seed-eating birds. Each fall and winter they flock in myriads to agricultural districts and live upon the ripened seed of weeds. Since they attack weeds in the most critical stage of life, the seed period, it follows that their services must be of enormous practical value. The benefits are greatest in the case of hoed crops, since here are found the largest number of annual weeds, which, of course, are killed by frost and must depend for perpetuation solely upon seeds. The principal weeds which birds

prevent from seeding are ragweed, pigeon grass, smartweed, bindweed, crab grass, lamb's-quarters, and pigweed. (See fig. 59.) It is sometimes asserted that no thrifty farmer will allow these noxious species to ripen seed, but such prevention is practically impossible, because even if all the edges of fields and all waste ground could be cleared, weed patches along ditches, roads, and hedgerows would still remain to disseminate seed to cultivated land. It is in just these places that birds congregate in greatest numbers.

FIG. 59.—Four common weeds, the seeds of which are eaten by birds: *a*, amaranth; *b*, crab grass; *c*, ragweed; *d*, pigeon grass.

Some birds eat more or less weed seed throughout the year even when insects are most abundant. But their good work practically extends from early autumn until late spring, and is perhaps most noticeable in winter, when the ground is white with snow. During cold weather most of the birds about the farm feed extensively upon seed, and gorge themselves until their stomachs and gullets become completely distended. It is not at all uncommon for a crow blackbird to eat from 30 to 50 seeds of smartweed or bindweed, or a field sparrow 100 seeds of crab grass, at a single meal. In the stomach of a Nuttall's sparrow were found 300 seeds of amaranth (see fig. 60), and in another 300 seeds of lamb's-quarters; a tree sparrow had consumed 700 seeds of pigeon grass, while a snowflake from Shrewsbury, Mass., which had been breakfasting in a garden in February, had picked up 1,000 seeds of pigweed. The birds most actively engaged in consuming weed seed are sparrows and finches, including more than a score of species,[1] horned larks, blackbirds, cowbirds, meadow larks, doves, and quail.

[1] These species include the tree, song, field, chipping, grasshopper, fox, Nuttall's, golden-crowned, white-crowned, and white-throated sparrows, juncos, snowflakes, goldfinches, pine siskin, redpolls, towhees, and grosbeaks.

SPARROWS AND FINCHES.

Sparrows are the most abundant and widely distributed of the smaller birds inhabiting the rural districts of the United States. Their intimate association with agricultural interests has suggested the importance of a careful inquiry as to their food habits, and such an investigation based on field observations and an examination of the contents of stomachs in the laboratory is now being made by the Biological Survey. Sparrows have been collected in practically all the States, the District of Columbia, and Canada, and some 4,000 stomachs have already been examined. The results show that during the colder half of the year the food of these birds consists almost entirely of the seeds of weeds.

FIG. 60. Weed seeds commonly eaten by birds: *a*, bindweed; *b*, lamb's-quarters; *c*, purslane; *d*, amaranth; *e*, spotted spurge; *f*, ragweed; *g*, pigeon grass; *h*, dandelion.

Sparrows generally seem to be regarded with favor, but the English sparrow drives away native birds and does so much damage to grain and fruit that it is considered a pest. The native sparrows might also be suspected of injuring crops; but though they frequently sample grain in stubble fields they have not, as yet, been found guilty of committing serious depredations. In order to compare the grain-eating propensities of the various species, specimens were collected in a field a few miles south of Washington, D. C., before and after the wheat was cut. Of nineteen native birds, representing song, field, chipping, and grasshopper sparrows, only two had eaten grain, and these had taken only one kernel each, while every one of the five English sparrows was gorged with wheat. But with all his faults, the English sparrow does some good by assisting in the work of weed-seed destruction. Flocks of thousands of these birds may be seen every autumn on the lawns of the Department of Agriculture, feeding on crab grass (*Panicum sanguinale*) and yard grass (*Eleusine indica*), two weeds which crowd out good turf-making grasses. The English sparrow also deserves credit for destroying seed of the dandelion (*Taraxacum taraxacum*), which is a prolific weed throughout the United States, especially in lawns, cemeteries, and pastures.

In 1894 English sparrows were observed by the writer destroying dandelion seeds in Cambridge, Mass., and during the last three years in the public parks of Washington, D. C. In the latter city

the birds eat these seeds from the middle of March until the middle of August, but chiefly in April and the first half of May, when the lawns are literally yellow with flowers. After the yellow petal-like corollas have disappeared the flower presents an elongated, green, egg-shaped body with a downy tuft at the upper end, and in this stage it is most frequently attacked by the English sparrow. The bird removes several long scales of the inner involucre by a clean cut close to the receptacle or base of the head, thus exposing the plumed seeds, or akenes. He seizes a mouthful of these akenes and then lops off the plumes with his bill and swallows the seeds. In many cases, especially when hungry, he does not take the trouble to remove the plumes. Generally a score of seeds are dropped in tearing open a head, and usually a few are left clinging to the edge of the receptacle. The mutilation caused by the birds' beaks can be detected until the flower stalk dries and falls.

FIG. 61.—Song sparrow (*Melospiza fasciata*).

In order to determine how much damage was done to dandelions on the lawns of the Department of Agriculture, every flower stalk was picked from a rectangular space 6 feet 2 inches long by 3 feet 3 inches wide. This was on April 29, 1898. Of the 413 stalks collected, 358 showed unmistakable marks of the sparrow's bill. On the next day 293 stalks were gathered from a circle 2 feet in diameter on the other side of the lawn, and 275, or 93 per cent, proved to be mutilated. These and similar observations seem to show that at least three-fourths of the dandelions which bloom in April and May on the Department lawns are mutilated by birds.

In the destruction of dandelion seeds the English sparrow is aided by several native birds, chiefly the song sparrow (*Melospiza fasciata*), chipping sparrow (*Spizella socialis*), white-throated sparrow (*Zonotrichia albicollis*), and goldfinch (*Astragalinus tristis*). So far as observed the native birds usually do not cut open dandelions, but feed upon those left by the English sparrow. The song sparrow, however, is capable of getting out seeds alone, for one which was kept in captivity manipulated dandelions in precisely the same way as the English sparrow. The song sparrow (fig. 61) and the chipping sparrow make a practice of feeding from the short-stemmed heads that have already

FOUR COMMON SEED-EATING BIRDS.

1, Junco; 2, White-throated Sparrow; 3, Fox Sparrow; 4, Tree Sparrow.

been opened, but even here the chipping sparrow has difficulty in pulling out the seeds, and often simply picks up those which have been dropped. Goldfinches frequently pursue an entirely different course, although they also pick seeds from the green involucres torn open by English sparrows. On May 3, 1898, a dozen goldfinches were observed for a couple of hours on the Department lawns. First they hopped along the ground; then one bird flew to a dandelion stalk 6 inches high, alighted crosswise, and moving toward the downy ball until it bent the whole stem to the ground, ate seed after seed (fig. 62).

FIG. 62.—Goldfinch (*Astragalinus tristis*).

Besides the lawn weeds already mentioned, such as dandelions, crab grass, and yard grass, several others, including pigeon grass, knotweed, sedge, oxalis, and chickweed furnish food for birds. These plants are also troublesome in other places besides lawns. Knotweed (*Polygonum aviculare*) litters up paths and roads or grows in spots where turf is broken, chickweed (*Alsine media*) occurs in plowed ground, and pigeon grass (*Chætocloa glauca* and *C. viridis*), which is considered one of the worst weeds in Minnesota, is found among many crops. The seeds of these plants are eaten by the song sparrow, chipping sparrow, field sparrow, junco, English sparrow, tree sparrow, Gambel's sparrow, and white-throated and white-crowned sparrows.

Among the weeds which are troublesome in fields, especially among hoed crops, may be mentioned ragweed (*Ambrosia artemisiæfolia*), several species of the genus *Polygonum*, including bindweed (*P. convolvulus*), smartweed (*P. lapathefolium*), and knotweed (*P. aviculare*), pigweed (*Amarantus retroflexus* and other species), nut grass and other sedges (*Cyperaceæ*), crab grass (*Panicum sanguinale*), pigeon grass (*Chætocloa viridis* and *glauca*), lamb's-quarters (*Chenopodium album*), and chickweed (*Alsine media*). Every one of these weeds is an annual, not living over the winter, and their seeds constitute fully three-fourths of the food of a score of native sparrows during the colder half of the year. Prof. F. E. L. Beal, who has carefully studied this subject in the Upper Mississippi Valley, has estimated the amount of weed seed eaten by the tree sparrow (*Spizella*

monticola), junco (*Junco hyemalis*), and other sparrows that swarm down from Canada in the fall and feed in the rank growth of weeds bordering roadsides and cultivated fields. He examined the stomachs of many tree sparrows and found them entirely filled with weed seed, and concluded that each bird consumed at least a quarter of an ounce daily. Upon this basis, after making a fair allowance of the number of birds to the square mile, he calculated that in the State of Iowa alone the tree sparrow annually destroys about 1,750,000 pounds, or about 875 tons, of weed seed during its winter sojourn.

Besides tree sparrows and juncos, the most important gregarious sparrows that destroy weeds in the Mississippi Valley and on the Great Plains are the fox sparrow (*Passerella iliaca*), snowflake (*Passerina nivalis*), the white-crowned sparrow (*Zonotrichia leucophrys*), Harris's sparrow (*Zonotrichia querula*), and longspurs (*Calcarius lapponicus*, *C. ornatus*, *C. pictus*, and *Rhyncophanes mccownii*). Farther south are found lark finches (*Chondestes grammacus* and *Chondestes grammacus strigatus*), while on the Pacific slope occur Nuttall's sparrow (*Zonotrichia l. nuttalli*), the golden-crowned sparrow (*Zonotrichia coronata*) and Townsend's sparrow (*Passerella iliaca unalaschcensis*). East of the Alleghenies the most active weed eaters are the tree sparrow, fox sparrow, junco, white-throated sparrow, song sparrow, field sparrow, and chipping sparrow. (See Pl. XV.)

On a farm in Maryland, just outside the District of Columbia, tree sparrows, fox sparrows, whitethroats, song sparrows, and juncos fairly swarmed during December in the briers of the ditches between the cornfields. They came into the open fields to feed upon weed seed, and worked hardest where the smartweed formed a tangle on low ground. Later in the season the place was carefully examined. In one cornfield near a ditch the smartweed formed a thicket over 3 feet high, and the ground beneath was literally black with seeds. Examination showed that these seeds had been cracked open and the meat removed. In a rectangular space of 18 square inches were found 1,130 half seeds and only 2 whole seeds. Even as late as May 13 the birds were still feeding on the seeds of these and other weeds in the fields; in fact, out of a collection of 16 sparrows, 12, mainly song, chipping, and field sparrows, had been eating old weed seed. A search was made for seeds of various weeds; but so thoroughly had the work been done that only half a dozen seeds could be found. The birds had taken practically all the seed that was not covered; in fact, the song sparrow and several others scratch up much buried seed.

Most of the song sparrows, practically all the field, chipping, vesper, and grasshopper sparrows, dickcissels, lark finches, and Harris's sparrows of the central portion of the United States spend the winter in the South, while their places are taken in the North by snowflakes, juncos, clay-colored longspurs, fox sparrows, and white-throated and white-crowned sparrows. All these birds have much the same food

habits, but they differ in the quantity and kind of seed which they eat. Thus, the tree sparrows, or "winter chippies," snowflakes, and longspurs feed largely upon seeds of grasses, especially those of pigeon grass, crab grass, and allied species, while the white-throated sparrow in the Eastern States, Nuttall's sparrow in the Pacific-coast region, and the white-crowned sparrow so abundant in the central part of the United States, are particularly fond of amaranth and lamb's-quarters. In January the whitethroat depends upon ragweed and various species of *Polygonum*, such as bindweed, knotweed, and smartweed, for more than half of its food; the white-crowned and fox sparrows take nearly as much as the whitethroat, while juncos destroy a still greater amount of ragweed.

FIG. 63.—Dickcissel (*Spiza americana*).

The chippy and song sparrow are perhaps the best known of all the native sparrows of the United States. When not living in hedgerows or bushes about buildings the song sparrow inhabits the shrubbery along water courses. It seeks its food on the ground, generally among bushes or weeds, and has a peculiar mouse-like way of running through the grass. Seeds of weeds, especially smartweed, bindweed, and other species of the genus *Polygonum*, pigeon grass, pigweed, lamb's-quarters, and ragweed, and also some crab grass, form four-fifths of the food of this species during the colder half of the year. Ninety-five out of a hundred of the birds collected during March and

April had eaten weed seed, and many stomachs contained from 50 to 200 seeds each.

The chipping sparrow is a familiar little bird, readily recognized by its reddish cap, cicada-like note, and habit of lining its nest with horsehair. It eats the seeds of such troublesome grasses as pigeon grass, crab grass, and closely allied species, and during September and October these and other weed seeds make up three-fourths of its food.

The field sparrow (*Spizella pusilla*) is closely related to the chipping sparrow, but may be distinguished by its reddish bill. It is thoroughly commonplace in appearance, and in habits is much shyer than the chipping sparrow, which is often called a dooryard bird. Field sparrows are very abundant about the farm, and their food consists of practically the same seeds as those eaten by its relative.

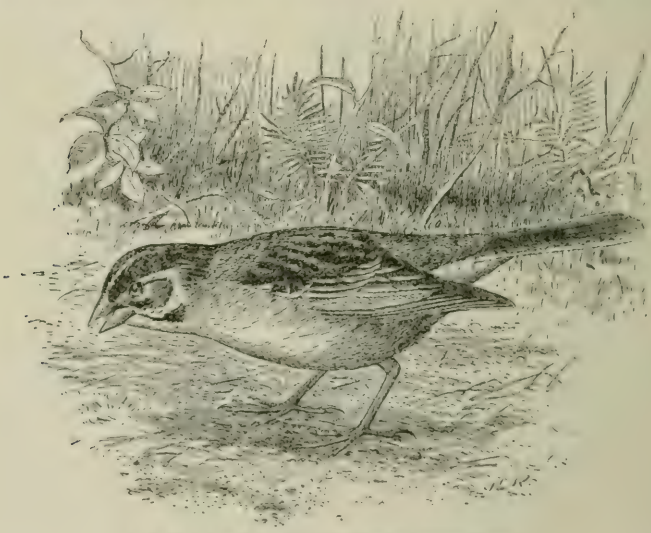

FIG. 64.—Lark finch (*Chondestes grammacus*).

The grasshopper sparrow (*Ammodramus savannarum passerinus*), so called from its dry, monotonous note, is even more a bird of the fields than the field sparrow. It is one of the few species that eats the seeds of rib grass (*Plantago lanceolata*). The dickcissel (*Spiza americana*, fig. 63) of the Central States, which also has an insect-like note, is larger than the grasshopper sparrow, and its plumage is conspicuously marked with bright yellow, black, and gray, somewhat like that of a meadow lark. The lark finch (*Chondestes grammacus*, fig. 64) is also a large sparrow of striking appearance. Its head is striped with black, and from this fact it is known in certain sections as "snake bird." It is particularly fond of the seeds of leguminous plants. The vesper sparrow (*Pooecetes gramineus*), celebrated for its twilight chanting, is as much a bird of the open grassy fields

as the lark finch or dickcissel. When disturbed it flits up from the ground, spreading its white-splashed tail, and alights but a short distance away to resume its work. However varied in dress or habit, all the native sparrows are alike in subsisting largely upon seeds of noxious plants.

The goldfinch (*Astragalinus tristis*, fig. 62), or wild canary, is as useful as it is beautiful, and as a weed destroyer has few equals. It confines its attention very largely to one family of plants, the Compositæ, and is especially fond of thistles, wild lettuce, wild sunflower, and ragweed. It is so often seen on thistles, both Canada and bull thistles, that it is commonly known as the thistle bird. Near Washington, D. C., a flock of a dozen birds was seen during the latter part of August feeding on sunflowers that had escaped from cultivation, and in the Central and Western States the goldfinches do much good by eating the seeds of wild sunflowers and other closely related weeds. They have also been seen feeding upon wild lettuce (*Lactuca spicata*), and probably eat prickly lettuce (*Lactuca scariola*), which has proved the most rapidly spreading weed ever introduced into this country, but as yet no actual observations as to the latter food habit have been made. Stomachs collected in August were filled with seeds of Compositæ, mostly sunflowers (various species of *Helianthus*) and thistles (*Carduus lanceolatus* and other species).

At Burlington, Iowa, during July and August, Mr. Paul Bartsch found goldfinches feeding exclusively upon the bull thistle (*Carduus lanceolatus*). He was able to approach within a few feet of several birds while thus engaged, and noticed that the seeds or akenes were bitten off and swallowed, while the plumes or pappus floated away. When there was no wind, the pappus often failed to fly away, and clung to the birds, almost burying them with down. A dozen of the birds were killed and their gizzards and gullets were found literally crammed with thistle seeds. At Sing Sing, N. Y., goldfinches have been seen eating the seeds of the Scotch thistle (*Onopordon acanthium*) and boneset (*Eupatorium perfoliatum*). Cone flowers (*Rudbeckia hirta*), prairie sunflowers (*Gaillardia*), evening primroses, catnip, elephant's foot (*Elephantopus* sp.), and mullein also form part of their food, and late in the season they turn their attention to ragweed and consume great quantities of the seeds of this troublesome species. In winter and spring large flocks feed to some extent upon the seeds of conifers and catkin-bearing trees, such as the sycamore and birch. In destroying the seeds of the gray birch (*Betula populifolia*) on the edge of grass lands they do some good, for this tree has a habit of seeding adjacent pastures, which then grow up into a thicket of young saplings.

The pine siskin (*Spinus pinus*) and the redpoll linnet (*Acanthis linaria*) are two drab-gray birds related to the goldfinch, which feed largely upon seeds of conifers, sycamores, birches, and alders, but also descend to the ground to eat weed seed. In winter they feed upon sow thistles (*Sonchus oleraceus*), field asters (*Aster* sp.), and goldenrods (*Solidago* sp.). The redpoll linnet is known to destroy mullein

seeds (*Verbascum thapsus*), and the pine siskin is often seen consuming quantities of seeds of chickweed (*Alsine media*), lamb's-quarters (*Chenopodium album*), and ragweed (*Ambrosia artemisiæfolia*).

The common Eastern towhee, or chewink (*Pipilo erythrophthalmus*), and the green and the brown towhees of the far West are great scratchers, and there is little doubt but that they find many seeds that other birds fail to secure. Unfortunately, their food habits have not been sufficiently studied to furnish any detailed account of their value as weed destroyers.

The grosbeaks likewise have been insufficiently studied. The evening grosbeak (*Coccothraustes vespertinus*) and the rose-breasted grosbeak (*Zamelodia ludoviciana*) are known to eat seeds of ragweed, and the blue grosbeak (*Guiraca cærulea*) feeds upon a variety of weed seeds. The cardinal grosbeak (*Cardinalis cardinalis*), or redbird of the South, is abundant along hedgerows and briery tangles adjoining farms, and during the winter months does good work by feeding upon the seeds of such noxious plants as ragweed, pigeon grass, bindweed, and smartweed.

HORNED LARKS.

Horned larks (*Otocoris* sp.) occur either as residents or winter visitants throughout the greater part of the United States. They are strictly terrestrial, and inhabit either open fields, or grassy, gravelly, or sandy plains. In midwinter they may be found in flocks on plowed fields, where the land is lying fallow, picking up seeds of weeds, which if left would germinate and cause trouble the following season. When thus employed, the larks select mainly the same seeds as the cardinal grosbeak, but occasionally they also eat buttonweed (*Diodia teres*) and sorrel (*Rumex acetosella*).

BLACKBIRDS AND THEIR ALLIES.

The several species of blackbirds, although subsisting quite extensively upon weed seed, do considerable damage to crops. This is particularly noticeable in the Mississippi Valley, where redwings (*Agelaius phœniceus*), yellow-heads (*Xanthocephalus xanthocephalus*), and crow blackbirds (*Quiscalus quiscula*) flock to the grainfields by the million. The ravages in the rice fields of the South by the bobolink, or reedbird (*Dolichonyx oryzivorus*), in company with the redwings, are even more serious. The rusty grackles (*Scolecophagus carolinus*), Brewer's blackbird (*Scolecophagus cyanocephalus*), and the cowbird (*Molothrus ater*) are less injurious. All these birds are fond of pigeon grass, paspalum, crab grass, pigweed, knotweed, and ragweed, and the cowbird also eats the seeds of wild sunflowers, gromwell (*Lithospermum* sp.), sorrel, mustard (*Brassica nigra*), chickweed, and thistle. More than 10 per cent of the food of the crow blackbird, and more than 75 per cent of that of the redwing, during the colder half of the year, consists of weed seed.

The meadow lark (*Sturnella magna*) has long been placed on the border line of game birds, but it is a mistake to class any bird as game when its usefulness and beauty so far surpass its value as food.

The farmer can not afford to dispense with the services of the meadow lark, for it busies itself all summer eating grasshoppers and noxious insects, and when autumn comes varies its diet with ragweed, pigeon grass, and other weeds, until in December these noxious plants comprise 25 per cent of its food.

GAME BIRDS.

The ruffed grouse (*Bonasa umbellus*) of the Eastern woodlands sometimes eats small quantities of weed seed, while the prairie hen (*Tympanuchus americanus*), seeking its food in the open or near cultivated fields in the great agricultural region of the Central United States, does still more service. In the West and Southwest the California valley quails (*Lophortyx californicus* and *L. californicus vallicola*) and Gambel's quail (*Lophortyx gambelii*) consume weed seeds, but they also commit wholesale depredations on fruit. The Eastern quail, or bobwhite (*Colinus virginianus*), on the contrary, seldom if ever causes the fruit grower any trouble, but does much good by destroying weed seed in fields where grain has been cut and a rank growth of weeds has taken its place. Seeds of rib grass, tickfoil, and berries of nightshade (*Solanum* sp.) are sometimes eaten, and pigeon grass and smartweed are frequently consumed in large quantities. The amount of grain found in the few stomachs thus far examined is surprisingly small, while the proportion of weed seed is astonishingly large, in some cases crops and gizzards being literally gorged with hundreds of seeds of ragweed.

FIG. 65.—Mourning dove (*Zenaidura macroura*).

The mourning dove (*Zenaidura macroura*, fig. 65) is abundant

throughout much of the United States, and is especially common in stubble fields and waste places grown up to weeds. It is preeminently a seed eater, and although at times turning its attention to grain it nevertheless consumes an enormous amount of weed seed. The crop of one dove secured in a rye field in Warner, Tenn., contained 7,500 seeds of *Oxalis stricta*. Just outside the District of Columbia the bird has been seen feeding in fields overgrown with pigeon grass and ragweed, and especially in old cornfields, where smartweed and bindweed formed tangles of sufficient extent to injure the crop. In the Eastern States it has a peculiar habit of picking up pokeweed seeds and crushing them in its muscular stomach. Several weeds belonging to the genera *Lithospermum*, *Oxalis*, and *Euphorbia* are also utilized as food to a somewhat lesser extent. In California the dove feeds upon the seeds of a leguminous weed, known as turkey mullein (*Eremocarpus setigerus*). The habit is so well known in some localities that a botanist upon inquiring how he could collect some seeds of this plant was advised to shoot a few doves and open their crops. The ground dove (*Columbigallina passerina terrestris*) of the Southern States is very similar to the mourning dove in food habits, and probably does almost as much good in eradicating weeds.

SUMMARY.

No less than fifty different birds act as weed destroyers, and the noxious plants which they help to eradicate number more than threescore species. Some of these plants are much more in favor than others, while several are almost universally sought after. During the colder half of the year food is furnished for many species of birds by well-known and widely distributed weeds.

The blackbirds, the bobolink, the dove, and the English sparrow, in spite of grain-eating proclivities, do much good by consuming large quantities of weed seed.

Shore larks and grosbeaks also render considerable service, while the meadow lark is even more beneficial. Goldfinches destroy weeds which are not touched by other birds, confining their attacks chiefly to one group of plants (the Compositæ), many of the members of which are serious pests.

But the birds which accomplish most as weed destroyers are the score or more of native sparrows that flock to the weed patches in early autumn and remain until late spring. During cold weather they require an abundance of food to keep their bodies warm, and it is their habit to keep their stomachs and gullets heaping full. Often one of these birds is found to have eaten 300 seeds of pigeon grass or 500 seeds of lamb's-quarters or pigweed. Because of their gregarious and terrestrial habits, they are efficient consumers of seeds of ragweed, pigeon grass, crab grass, bindweed, purslane, smartweed, and pigweed. In short, these birds are little weeders whose work is seldom noted, but always felt.

INSECTS INJURIOUS TO BEANS AND PEAS.

By F. H. Chittenden,
Assistant Entomologist.

INTRODUCTION.

Beans, peas, cowpeas, and other edible legumes are subject to injury by certain species of beetles, commonly known as weevils, which deposit their eggs upon or within the pods on the growing plants in the field or garden and develop within the seed. Four forms of these weevils, members of the genus Bruchus of the family Bruchidæ, which inhabit the United States, are very serious drawbacks to the culture of these crops in many portions of the country. The specific enemy of the pea is the pea weevil, and of the bean, the common bean weevil, both of sufficiently wide distribution and abundance to hold the highest rank among injurious insects. Cowpeas are attacked by two species of these beetles, known, respectively, as the four-spotted bean weevil and the cowpea weevil. These latter are of considerable importance economically in the Southern States and in tropical climates, as well as in northern localities in which cowpeas are grown or to which they are from time to time shipped in seed from the South and from abroad.

As with the insects that live upon stored cereals, the inroads of the larvæ of these weevils in leguminous seeds cause great waste, and particularly is this true of beans that are kept in store for any considerable time. In former times popular opinion held that the germination of leguminous food seed was not impaired by the action of the larval beetle in eating out its interior, but this belief was erroneous, as will be shown in the discussion of the nature of the damage by the pea weevil.

It is not probable that any serious trouble follows the consumption by human beings of the immature weevils in green peas or beans, but the use for food of badly infested dry seed filled with the dead bodies and excrement of the beetles would very naturally be attended with unpleasant consequences. Kirby and Spence narrate that "in the year 1780 an alarm was spread in some parts of France that people had been poisoned by eating worm-eaten peas, and they were forbidden by authority to be exposed in the market."

When the crop is made and harvested, and even before, the insects

which have undergone their successive changes from larva and pupa within and at the expense of the seed, gnaw their way out and make their appearance, often in great numbers, in the garden or in the bags, barrels, and other receptacles in which the seed has been stored. Then for the first time the farmer, merchant, or housekeeper becomes aware of their presence.

All of the above-mentioned species of insects live within the infested seed throughout the winter, and all but one of them (the pea weevil) continue to breed for successive generations in the stored material. In addition there are other weevils which injure seed in a similar manner in foreign countries and whose introduction into the United States in seed material is to be guarded against.

In the fields the growing pods are invaded by the boll worm and the larva of the pea moth, and the foliage is preyed upon by numerous insects. None, however, save in exceptional years and in limited districts, is of as much importance as the species which develop within the matured seed. Of foliage feeders, the bean leaf-beetle and bean ladybird, blister beetles, cutworms, and other caterpillars are deserving of special mention. Several forms of plant-bugs, leaf-hoppers, and plant-lice also exhaust the plants by sapping their juices.

All of the species considered in the present paper that inhabit the Eastern United States have been under observation by the writer in the vicinity of Washington, D. C.

THE PEA WEEVIL.

(*Bruchus pisorum* Linn.)

GENERAL APPEARANCE AND METHOD OF WORK.

Seed peas are often found with a single round hole in them due to the attack of the pea weevil, or, as it is sometimes incorrectly called, the "pea bug." This is the largest of the pea- and bean-feeding weevils found in this country, measuring about a fifth of an inch (5mm.) in length and half that in width. Its ground color is black, but it is thickly covered with brown pubescence, variegated with black and white markings arranged as shown in fig. 66, *a*. The sides of the thorax are notched or toothed, and the abdomen, which projects beyond the elytra or wing-covers, is coated with whitish pubescence and marked by two black spots. The hind femora or thighs are thickened and each bears two prominent teeth.

HISTORY AND ORIGIN.

This weevil has long been known as an enemy to the pea. About the middle of the last century the celebrated Swedish traveler and naturalist Pehr Kalm gave an account of it and its ravages in America, stating, in 1748, that at that time the culture of the pea had been abandoned in Pennsylvania, New Jersey, and southern New York on account of this insect.

Most writers on economic entomology have agreed that this species, presumably because it was first found in peas in North America, is indigenous to this country, from whence it has been introduced into southern and middle Europe. There are reasons for believing, however, that it came originally, with so many other injurious insects which live upon cultivated seeds, from the Orient.[1] This species now occurs over nearly the entire globe, wherever peas are cultivated. It is scarcely known, however, in the colder countries of northern Europe, and does comparatively little damage in the colder parts of Canada; hence, it happens that seed peas for planting in the United States are largely imported from Canada or are bought from seed-dealers who obtain them from our more Northern States. What was true in Kalm's time in New Jersey, when peas could not be sown on account of the insects which consumed them, may almost be said at present of many localities in the United States.

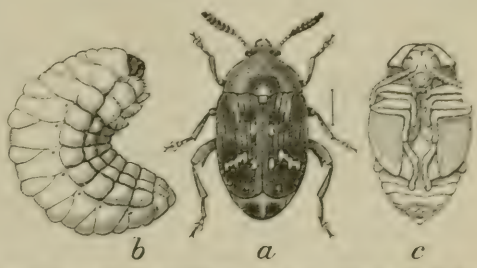

FIG. 66. *Bruchus pisorum*: *a*, adult beetle; *b*, larva; *c*, pupa—all greatly enlarged (original).

NATURE OF INJURY.

It is no uncommon sight to see every pea in a pod infested with this weevil; and although nearly every one is familiar with the appearance of "buggy" peas, it is not generally known that in eating green peas we often eat also a larva or "worm" with nearly every pea. The only external evidence of infestation in a green pea is a minute dot on its surface, but in dry seed the cell inhabited by the insect is visible under the skin, while later the beetles may be seen with their heads poking through holes which they have made in the skin.

Until recently the belief was more or less prevalent that the larva working within the seed, by some wonderful instinct, avoided the germ or embryo, and that weevil-infested peas were therefore of equal value for seed to uninfested ones, but this is incorrect. Many "weeviled" seed will germinate, but as they are deficient in plant food the resulting plant is apt to be weakly and nonproductive. Of 500 peas tested by Prof. E. A. Popenoe in Kansas in 1890 only one-fourth germinated, and the partial destruction of the cotyledons rendered the future growth of these doubtful, while an examination of 275 injured peas showed only 69 in which the germ was not wholly

[1] Two reasons for this belief may be mentioned: It belongs to a group of the genus Bruchus, having the sides of the thorax toothed, and not represented by any native species; furthermore, peas are not native to North America, and no other food plant is known for this weevil.

or partially destroyed. Of a lot of seed tested in Canada by Dr. James Fletcher, Dominion entomologist, 17 per cent grew, but only 2 per cent made strong looking plants producing seed, all the others being stunted and weak. Another lot tested in which the radicle had been injured by the weevil in escaping from the seed did not grow at all.

LIFE HISTORY AND DEVELOPMENT.

The beetles appear on the vines when the peas are in blossom and the eggs[1] are deposited singly upon the surface of the pods, being attached by a peculiar viscid secretion which turns white in drying.

The minute, newly hatched, or post-embryonic larva[2] bores through the pod opposite a pea, which it enters and casts its skin, after which it appears as a larva of the ordinary Bruchid type. Within the developing pea the larva feeds and grows apace, and when fully matured presents the appearance indicated at *b* of fig. 66. It is somewhat maggot-like in general aspect, nearly cylindrical, fleshy, strongly wrinkled and perfectly white throughout except in the region of its minute mouth-parts, where it is brown. The larva in this stage has been described as apodous, or footless, but this is an error, as it has three pairs of very apparent legs. The full-grown larva measures in its natural curved position about a fourth of an inch (6 mm.) and is nearly twice as long as its diameter. It now eats a circular hole in the pea, leaving only the thin outer membrane as a covering, after which it lines the interior of the pea with a thin layer of paste, excluding its excrement, and within the cell thus formed it changes to pupa.

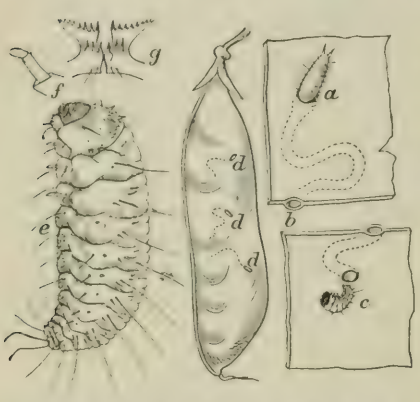

FIG. 67.—*Bruchus pisorum:* *a*, egg on pod; *b*, cross section of opening of larval mine; *c*, young larva and opening on inside of pod by which it had entered, enlarged; *d*, *d*, *d*, eggs on pod, slightly enlarged; *e*, embryonic larva, greatly enlarged; *f*, leg of same; *g*, prothoracic spinous processes, more enlarged (reengraved from Insect Life).

The pupa is white and delicate like the larva and shows the notched sides of the thorax (fig. 66, *c*). In this stage the insect remains for a

[1] The egg is about one-twentieth of an inch in length (1.5 mm.), yellow in color, three times as long as wide, pointed at one end and blunt at the other. Eggs are shown, natural size, *in situ* on the pod in fig. 67 at *d*, and magnified at *a*.

[2] At this stage the larvae are of the nearly cylindrical form shown by fig. 67, *e*. They are provided with three pairs of short temporary or false legs, each composed of only three apparent joints (see *f*). Upon the thorax there is a series of six strong retrorse spines, bordering which are two plates, strongly toothed along their outer border (see *g*). Both plates and legs are evanescent, but they assist the larva in obtaining entrance to the pea.

period dependent upon atmospheric conditions, a week or several days longer. Individuals that were kept under observation at the Department developed in seventeen days in the hottest July weather, and in nine days in seasonable weather in August. The periods of the other stages of this insect, the egg and the larva, do not appear to have been observed.

The first adults of the new generation that have been observed in the vicinity of the District of Columbia appeared on the 21st of July, but other individuals developed as late as the middle of August. A very considerable proportion of the beetles leave the seed in the latter part of the summer and in the autumn in this latitude, but farther north the beetles are said to remain in their cells usually until the succeeding spring, when many are planted with the seed. In its adult condition this species passes the winter. It develops only a single generation annually. As it does not breed in dry peas, the new generation for another year is dependent on such beetles as are contained in planted seed or which escape from the storeroom.

PREDACEOUS ENEMIES.

Among natural enemies, the Baltimore oriole, Harris tells us, splits open the green pods for the sake of the larvæ within the peas, and the crow blackbird is said to devour great numbers of the beetles in the spring, but the introduction of the English sparrow leaves few of these birds near our gardens, and no other natural checks in the shape of predaceous or parasitic insects are known for this weevil.

REMEDIES.

Holding over seed.—A simple and effective remedy, and one that has been in operation for fifty years or more, consists merely in keeping seed peas in a close receptacle, such as a tight bag or box, over one season before planting. The beetles which issue die without being able to lay their eggs in the field. The primary injury to the seed has been effected by the larva the first summer and after the weevil develops, always during the first autumn in the writer's experience, further damage practically ceases.

Late planting.—Comparative immunity from pea weevil attack is claimed by growers in some localities by simply planting late, and the writer is disposed to the belief that in some localities, at least—as for example, in the neighborhood of Washington, where two crops could be grown on the same beds—late planting is all that is necessary to secure sound seed stock.

Fumigation with bisulphide of carbon.—When it is desired to plant the first season after gathering the seed, bags in which peas have been kept tightly closed should be placed in a tight box or vessel and disinfected with bisulphide of carbon, at the rate of an ounce or two to 100 pounds of seed. This method will kill the weevils without

destroying the germinative power of the seed, and its effectiveness is in proportion to the tightness of the receptacle. Benzine and naphtha or gasoline will serve the same purpose. In the use of all these remedies care should be observed, on account of their inflammability, not to treat material in the immediate vicinity of fire, such as a lighted lamp or cigar.

In many portions of this country where peas are extensively grown, seedsmen and other large growers have a building especially constructed for fumigation and made as nearly air-tight as possible. This building is filled with bags of peas and the bisulphide is then evaporated in shallow pans containing about a fourth of a pound each and distributed about on the bags. This liquid rapidly volatilizes, and, being heavier than air, descends and permeates the infested mass, destroying all insects which it may contain.

Peas are usually subjected to this treatment for forty-eight hours when they are desired for planting; but if for food, they may be freely exposed until the fumes of the chemical shall have passed entirely away. In the fumigation of a reasonably close room or building it is customary to evaporate a pound or a pound and a half of the bisulphide for every thousand cubic feet of space. If smaller quantities of seed are fumigated, one ounce is evaporated to a hundred pounds of infested material, and in still smaller quantities a tablespoonful is used for each cubic foot. In comparatively empty rooms, and in such as do not admit of being tightly closed, two or three times the above quantity of the chemical is sometimes necessary. The effects of fumigation are best in warm weather, when the insects are active.

Throwing seed into water.—The custom of throwing seed into water just before planting is of some value if employed with discretion. One has but to try it for himself to demonstrate that what is true of one kind of seed will not apply to another. The smallest and lightest varieties of pea will float when infested or damaged, while large, heavy seed affected by this weevil will sink to the bottom. Sound seed only should be used for planting, and injured peas, unless used as food for swine or fowls, should be burned.

Warm storage.—Some growers report good success in the storage of peas in tight receptacles in rooms where they are kept warm all winter. The beetles are induced to leave the peas prematurely, particularly if the seed be occassionally stirred or otherwise agitated, and die before the seed is wanted for planting. This remedy is useful in southern latitudes, where the bulk of the beetles escape in the autumn, but is stated not to be so successful farther north where the adult insects usually remain in the seed until the spring.

Heat is of value in destroying insects in stored material, and it has been found by experiment that a temperature of 145° F. will kill the

weevils in the seed without injury to the germinative property of the seed. A similar remedy consists in soaking infested seed for one minute in boiling water. A longer time is apt to injure it for planting.

No efficient preventive of injury by this weevil is known, but cooperation in the treatment of infested seed and in clean culture would render further remedy unnecessary.

THE COMMON BEAN WEEVIL.

(*Bruchus obtectus* Say.)

The most formidable enemy to the culture of beans in the United States as well as in many other countries, is the common bean weevil (*Bruchus obtectus* Say). In the nature of its attack it differs from the pea weevil in that it not only oviposits and develops in the pods in the field but continues to breed for successive generations in seed, after harvest and storage, until the seed is useless for planting or as food for man or stock.

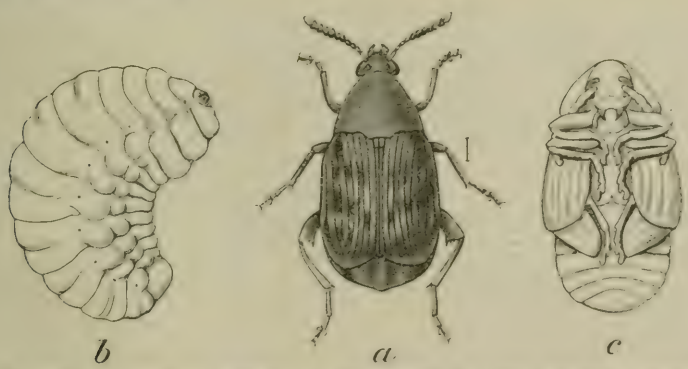

FIG. 68.—*Bruchus obtectus: a*, beetle; *b*, larva; *c*, pupa—all greatly enlarged (original).

As with peas, the market gardens of the North provide the dry seed for consumption and for planting in the Southern States. In the country about Washington it is next to impossible to procure a crop of beans uninfested by this weevil; hence, the stores of the city are supplied mainly from the North, New York State furnishing the greatest quantities.

DESCRIPTION AND DISTRIBUTION.

The adult of this bean weevil is smaller than the preceding species. It varies considerably in size, but its length will average about an eighth of an inch (3 mm.). It is thickly coated with fine brown-gray and olive pubescence which gives the body that color. The wing-covers are mottled, as shown in fig. 68, *a*. From the pea weevil this species may also be known by the different shaped thorax and the two small teeth in addition to the large tooth with which the thighs are armed. In fig. 69, *a*, the beetle is represented in profile with its head bent under in its natural resting position.

The history of this species begins with its description by the pioneer Western naturalist Thomas Say, in July, 1831. The first economic or biologic account of the insect appeared just thirty years later, but strangely enough it was not until the year 1870 that it attracted any marked attention by its injuries to crops.

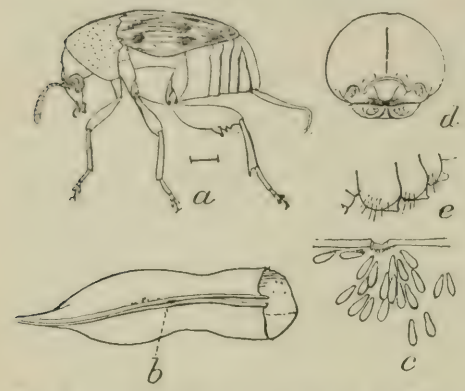

FIG. 69.—*Bruchus obtectus:* *a*, beetle in profile; *b*, section of bean pod, showing slit for deposition of egg; *c*, portion of interior of pod, showing egg mass inserted through slit; *d*, head of post-embryonic larva, front view; *e*, portion of thoracic joints of mature larva, showing legs—all except *b* much enlarged (*a-d* reengraved from Riley, *c* original).

Until recently this species, like the preceding, was generally believed to be indigenous to this country, which will account for its name, American bean weevil. M. A. Fauvel, the distinguished French coleopterist, has expressed the opinion that this species is neotropical, and owes its origin to Central or South America; the question may rest here until some good reason can be shown for a contrary belief. It is certainly not native to the United States, and if introduced from the Eastern Hemisphere probably became acclimated in tropical America before establishing itself in the North. There are several species of edible Phaseolus, or wild bean, native there, and the fact of the original specimens from which the species was described having come from Louisiana, probably from the vicinity of some seaport, lends color to this hypothesis. The species has spread by the distribution of infested seed rather than by flight, which will explain its next recorded appearance in Rhode Island in 1860, in New York two or three years later, and, in the next decade, in New Jersey, Pennsylvania, Illinois, Kansas, Missouri, and elsewhere. By 1873 it was recognized as the most abundant species of Bruchus over the region east of the Rocky Mountains. The distribution of the bean weevil is now world-wide. It occurs in nearly every State and Territory of the Union, and in the Antilles and

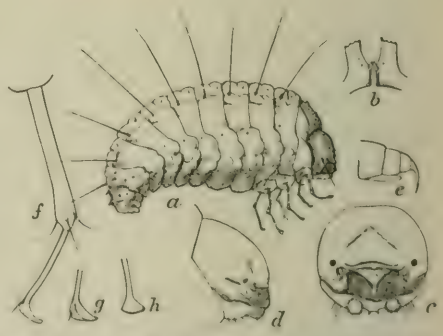

FIG. 70.—*Bruchus obtectus:* *a*, post-embryonic larva; *b*, prothoracic crest; *c*, head, from front, *d*, from side; *e*, antenna; *f*, thoracic leg; *g*, rear view of tarsus; *h*, front view of same—*a* greatly enlarged, *b-h* still more enlarged (reengraved from Insect Life).

Mexico, and is generally diffused through Central and South America, in the latter country from Venezuela to Buenos Ayres. It is also known in southern Europe in the Mediterranean region, in Persia, Indo-China, Algeria and South Africa, Madeira, the Azores, and the Canary Islands.

LIFE HISTORY AND HABITS.

Oviposition, as has been stated, takes place primarily in the field, the eggs[1] being deposited upon or inserted in the pod through a hole made by the jaws of the female and through openings, such as are caused by its drying and splitting. A group of eggs is shown in outline in fig. 69, *c*, and the slit made by the beetle for their insertion on the ventral suture of a pod will be seen at *b*, fig. 69. In shelled beans the eggs are dropped loosely in the bag or other receptacle in which they are stored, or are placed in holes made by the weevils in their exit from the seed. Less seldom they are attached to the outer surface of the seed.

Immediately after entering a bean the larva[2] undergoes its first molt, losing its long legs, hairs, and thoracic plates, and when full fed takes on the appearance shown in fig. 68, *b*, which represents an individual just before transformation to pupa. In this advanced condition the legs show only as pads, but a day or two earlier they have more the character of legs, although, of course, rudimentary (see fig. 69, *e*). Before transforming to pupa the larva leaves the cell in which it has fed and forms an oval pupal chamber with smooth compact walls. Within this it transforms to pupa (fig. 68, *c*), in which stage it may be distinguished from the pea weevil by lacking the notches on the sides of the thorax.

Experiment has demonstrated that the eggs show a variation in period of hatching from five days in the hottest weather to twenty days in a cool exposure, and the larval stage requires from eleven to forty-two, and the pupal stage from five to eighteen days, making for the entire life cycle a period varying from twenty-one to eighty days, according to season and locality. There are probably produced annually an average of six generations in latitudes such as the District of Columbia and a less number in more northern localities.

Unlike the pea weevil, a large number of individuals will develop in a bean, as many as twenty-eight having been found within a single seed. It will thus readily be seen that the first outdoor generation or any single indoor generation is capable of exhausting seed and completely ruining it for food or planting or any other practical purpose.

[1] The eggs, as would naturally be expected from the smaller size of the beetle, are not so large as those of the pea weevil, measuring only a fiftieth of an inch (0.55–.7 mm.), which is two and a half times their diameter. They are cylindrical ovate and of the color of ground glass, caused by close granulation.

[2] The post-embryonic larva differs from that of other bean and pea weevils by its larger temporary legs and by other characters, which are shown in fig. 70.

except, perhaps, as hog feed. This was conclusively proven in the autumn of 1897 in the case of both the first outdoor and an indoor generation observed in the city of Washington.

The beetles begin to issue from beans in the field in a climate like that of the District of Columbia and adjacent parts of Maryland and Virginia as early as October, when in the natural course of events the eggs for a new brood would be deposited in such pods as had cracked open so as to expose the seeds within.

It is perhaps superfluous to state that this beetle prefers the bean as a host plant, but it will also breed in cowpeas in the field as well as in store, and in confinement, at least, develops in dried peas, lentils, and chick-peas. Whether the insect would attack these legumes in the field in the presence of an abundant supply of its more favored food plants remains to be seen.

It is no more true of seed infested by this species than of that attacked by the pea weevil that germination is not impaired by the work of the weevil in the bean. It has been proved experimentally by Professor Popenoe that weeviled beans should not be planted. In a test made at Manhattan, Kans., only 50 per cent of the infested seed used germinated, and only 30 per cent could by any possibility have passed the germinating stage, and these, owing to more or less extensive injury to the seed leaves, would probably have produced plants of low vigor and correspondingly low productiveness.

Two species of parasitic Chalcidid flies, *Eupelmus cyaniceps* Ashm. and *Bruchobius laticollis* Ashm., are valuable as destroyers of this beetle.

REMEDIES.

No efficient means are known for the prevention of the attacks of the bean weevil in the field; hence, we must place our chief reliance upon the thorough destruction of the insects in the dried seed.

From the fact that this species continues to breed for upward of a year in dried seed, it is obvious that neither the expedient of holding over seed for a year before planting nor that of planting late for seed stock would be productive of good, as in the case of the pea weevil. Recourse must therefore be had to fumigation or to heat, and the earlier the seed is treated after it has been gathered the better the result.

Just before it is planted seed infested with this bean weevil should be lightly thrown into water. Badly injured seed will float, and may then be picked out or poured off and destroyed. Sound seed only should be reserved for planting.

THE COWPEA WEEVIL.

(*Bruchus chinensis* Linn.)

Cowpeas, while subject to attack by the preceding species, are far more liable to be infested by two other beetles, the cowpea weevil and

the four-spotted bean weevil, both of which appear to be specific enemies of this plant, and which injure its seed in the same manner as the common bean weevil. Like that species they begin work in the garden and field and continue to breed in the stored seed, until they entirely spoil it as food for stock, and seriously impair its germinating power. Both species are generally distributed and injurious in the South, and are widening their range with the increasing use of their food plant as a soil renovator and as forage.

These two species of weevil resemble each other after a manner superficially, in appearance as in habit, but they differ to some extent in various details of their life economy as well as in structure and distribution.

GENERAL APPEARANCE, ORIGIN, AND DISTRIBUTION.

The cowpea weevil may be readily distinguished from the four-spotted species by the two large, elevated ivory-like lobes at the base of the thorax and by the strongly pectinate antennæ of the male (see fig. 71, *a*).[1]

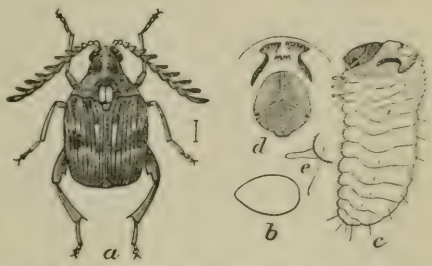

FIG. 71.—*Bruchus chinensis:* *a*, adult male; *b*, egg; *c*, post-embryonic larva; *d*, front view of head of same; *e*, thoracic leg of same—*a* much enlarged, *b–e* more enlarged (original).

This is undoubtedly an Old World species and an ancient enemy of edible pulse.

Linnæus described this species in 1758, giving it its specific name from its known habitat at that time. On this head he wrote "*Habitat in Pisis omnis generis, e China allatis*," and we may safely conclude that China was the original home of this species. Like the common bean weevil, it is now widely known through its distribution by commerce, being particularly abundant in tropical countries. Its recorded distribution abroad includes Europe; China, Japan, and the East Indies in Asia; Egypt, Sierra Leone, Barbary, Algeria, and the Cape of Good Hope in Africa; Puerto Rico, Panama, Brazil, and Chile in tropical America. It has been for some time thoroughly acclimated throughout the Southern States of the Union, and from present knowledge it is fairly certain that it is capable of establishing itself wherever its food plant will grow. Recent observation shows that the species is a permanent inhabitant of the District of Columbia, and of Maryland and Virginia in the immediate vicinity. Westward it occurs as far north as Iowa.

[1] The ground color is dull red, sometimes more or less blackish, variegated with yellow and gray or white pubescence. The pattern of the elytra varies, that shown in the illustration being the prevailing form of specimens reared in the District of Columbia. The darkest spots at the sides are not round and conspicuous as in the four-spotted bean weevil, and the apical spots are sometimes wanting, while often black is the prevailing color of the dorsal surface.

The cowpea is credited with having first been cultivated in this country in the early days of the eighteenth century, but there is no available earlier record of the occurrence of the insect here than 1853.[1]

LIFE HISTORY AND DEVELOPMENT.

The cowpea weevil does not differ very strikingly in its life habits and economy from the common bean weevil. A careful study of the biology of each, however, has been rewarded by the development of certain points of difference, which may be briefly summarized.

The egg[2] when freshly laid is clear and translucent, but becomes grayish white with age. The eggs are deposited on the outside of the growing pods in the field and upon the dried seeds, and are attached by a glutinous substance which covers the egg and extends somewhat around it. The larvæ[3] hatch from them in four, five, or more days, depending upon the season and other circumstances, and burrow into the pods to the developing seed, which they penetrate. In two or three weeks in midsummer weather they have attained full growth, when they present much the same appearance as the larvæ of the previously mentioned weevils. The pupa state lasts from about four or five days in warm weather to considerably longer in cooler weather, when the beetle form is assumed. The beetle gnaws its way out of the seed, in the same manner as do the other species of Bruchus, by cutting a round flap through the skin of the pod. The first brood which develops in the field attains maturity at least by the third week of September, and perhaps earlier, if we may judge by the appearance of the exit holes in the pods and the further fact that certain varieties of cowpea mature sooner than this.

The beetles continue to develop in the dried and stored seed for several generations, in fact, until the seed becomes completely ruined for any practical purpose and unfit even for the sustenance of this insect. In a very short time decomposition sets in, inviting swarms of mites, and the beetles are forced to other quarters in their struggle for existence.

In a fairly warm indoor temperature six or seven broods probably develop annually in a latitude like that of Washington, D. C.

It is yet early to say with positiveness which varieties of seed are most subject to infestation by this insect. The "Unknown" cowpea seems to be a favorite seed, but the insect is also injurious to all other

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[1] F. E. Melsheimer, Cat. Col. U. S. 1853, p. 99, mentioned as *scutellaris* Fab., synonym of *sinuatus* Sch.

[2] The egg, shown in outline at fig. 71, *b*, is ovate, about six-tenths of a millimeter in length and two-thirds as wide, convex exteriorly and flattened interiorly at the point of attachment.

[3] The newly-hatched larva (fig. 71, *c*) resembles somewhat that of the pea weevil. It is of course smaller, the minute temporary legs (see *c*) are apparently not jointed, and the prothoracic plate (*d*) bears blunt, rounded teeth instead of acute spines.

varieties, to "adsuki" beans (*Phaseolus radiatus*), pigeon peas (*Cajanus indica*), common peas, lentils, and chick-peas (*Cicer arietinum*), and to the Ceylonese seeds known in their native home as "kolu" and "muneta." Table beans of different varieties also serve as food for this species.

It has been noticed of this weevil that material infested by it undergoes a marked elevation in temperature, particularly at times when the beetles are undergoing transformation and issuing from the seed. In one instance the temperature of a small sack of seed infested by the cowpea weevil was found to be 25° F. higher than the surrounding atmosphere.

This weevil is sometimes attacked while in an immature condition by two or more Chalcidid parasites, and quite frequently falls a prey to the omnivorous mite *Pediculoides* (*Heteropus*) *ventricosus* Newp., which destroys it in all stages.

REMEDIES.

The similarity of the life habits of this and the common bean weevil renders it amenable to the same remedies, bisulphide of carbon or heat.

THE FOUR-SPOTTED BEAN WEEVIL.

(*Bruchus quadrimaculatus* Fab.)

DISTRIBUTION AND HISTORY.

The four-spotted bean weevil is the more slender species and differs from the cowpea weevil by many characters.[1] What appears to be the commonest form of coloration is illustrated at fig. 72, *a*.

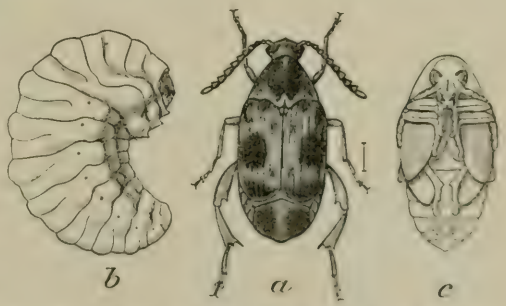

FIG. 72.—*Bruchus 4-maculatus*: *a*, beetle; *b*, larva; *c*, pupa—all enlarged (original).

This species is undoubtedly exotic, but its origin and the time of its introduction are obscure. Olivier, in his "Histoire naturelle des Insectes" (Vol. IV, No. 79, p. 19), published in 1795, notes its occurrence in "Carolina, where it lives in peas." The original description of the species appeared three years earlier, and was from specimens from Santa Cruz, West Indies. Other earlier records are also American,

[1] The ground color is black, with black, gray, and white pubescence. The antennæ are serrate and not pectinate in the male. The basal lobe of the thorax is marked with white pubescence only. The elytra are longer, and the gray and white pubescence is so arranged as to leave four large black spots, whence the species derives its name. These markings are variable and often lacking.

including Brazil and Mexico; but it is probable that the insect, like its preferred food plant, the cowpea, is from the tropical Orient.

Its distribution extends throughout the South, and in all probability wherever cowpeas grow. It is evidently acclimated as far north as Iowa. Abroad it is recorded from Venezuela, Brazil, Mexico, British Honduras, the West Indies, East Indies, Sierra Leone, Ethiopia, southern France, Italy, and elsewhere.

Since Olivier's note on the food plant of this species there was a lapse of nearly a century before any attention was drawn to it in its economic or biologic aspect in this country. In 1893 it was mentioned as having been found at the first Atlanta Cotton Exposition in 1885, infesting "black-eyed table beans" from Texas. At the Columbian Exposition in 1893 it was breeding in great numbers in beans and cowpeas in the exhibits of Brazil and Venezuela, most of the exhibited seeds being badly decomposed toward the latter days of the exposition. In succeeding years complaints were received from various sources. The cowpea is the favorite food, the "black-eye" variety seeming to be preferred. Peas and beans of various sorts are also attacked.

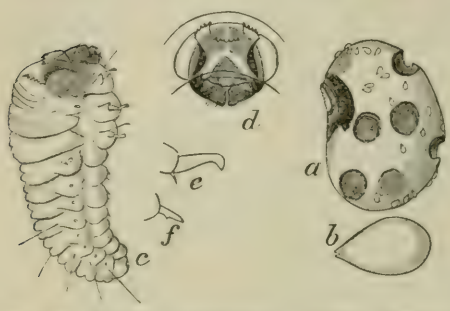

FIG. 73.—*Bruchus l-maculatus:* *a*, cowpea, showing holes made by weevils in their escape from seed, also eggs deposited on surface; *b*, egg in outline; *c*, post-embryonic larva; *d*, head of same; *e*, prothoracic leg; *f*, spine above spiracle of first abdominal segment—*a* twice natural size, *b*, *c* greatly enlarged, *d*, *e*, *f* more enlarged (original).

The writer has noticed of this species more than of any other insect that attacks stored products that decomposition sets in in the material infested at a very early period, and that this is more noticeable in cowpeas than in any other seed.

Repeated experiments, conducted at various times with different lots of cowpeas infested with this species, tend to show that it breeds with greater facility in fresh and slightly moist seed, such as is often furnished by the development of a brood of its own kind, than in dry seed, and it is therefore advisable to keep seed in a perfectly dry atmosphere.

In its life economy this weevil very nearly resembles the two preceding species.[1]

[1] The egg closely resembles that of the cowpea weevil, but it is perceptibly larger and proportionately wider, more broadly rounded anteriorly and more narrowed posteriorly, being apically pointed, with the extreme apex produced. The eggs are shown as deposited on an infested cowpea at fig. 73, *a*, and more enlarged at *b*. The newly-hatched larva, shown in profile at *c*, resembles that of the cowpea weevil, but the thorax (*d*) is armed on the lower portion of the plate

REMEDIES.

The remedies to be employed against this species are the same as for the common bean weevil.

FOREIGN BEAN AND LENTIL WEEVILS.

In foreign countries there are other species of bean- and pea-feeding weevils related to the four species previously noted from their injuriousness here, three of which are of sufficient importance in their native or adopted homes to merit brief mention in this connection. These foreign weevils have been imported into the United States numbers of times, but, so far as at present known, none have yet become acclimated with us. In all probability their introduction will be effected sooner or later, in spite of the reported failures of such individuals as have been brought here to survive and procreate.

THE EUROPEAN BEAN WEEVIL (*Bruchus rufimanus* Boh.).– The most important of the foreign weevils is the one above mentioned. It is common and destructive in Europe and in North Africa. In these countries it takes the place of our common *B. obtectus*, and although it feeds on peas as well as various sorts of beans, appears to favor the broad or Windsor varieties.

This species is very closely related to the pea weevil, being of the same size and of similar appearance. It can, however, be readily distinguished by its much narrower thorax and fainter markings, particularly the large spots on the pygidium, which are only weakly indicated.

The importation in 1870 into New York or New Jersey of a lot of "pea pods" from Switzerland infested by this weevil first brought the species to public notice and led to general belief that it was actually introduced here. It was doubtless brought to this country in seed before that date, as it has been many times since.

The writer found it in nearly every one of many samples of Windsor beans exhibited at the Columbian Exposition in 1893. During the same year the species was found in peas at College Station, Tex.

In its life history it does not appear to differ materially from the congeneric pea weevil. Like that species, it oviposits on the growing pods in the field, and the beetle matures in the early autumn and winters over usually in the seed. As with its congener also it produces only a single generation a year, but the large size of the beans

with three acutely pointed teeth on each side, and the teeth on the upper portion are also pointed. The legs (*c*) are apparently two-jointed. The fully matured larva is shown in fig. 72 at *b*, and the pupa at *c*. This species, like the preceding, is subject to the attacks of the mite *Pediculoides ventricosus* Newp., which destroys it in its various stages and often in great numbers. Two species of Chalcidid parasites, *Bruchobius laticollis* Ashm. and *Aplastomorpha prattii* Ashm., MSS., also assist in its destruction.

which it most often inhabits enables several beetles to live within a seed.

THE LENTIL WEEVIL (*Bruchus lentis* Boh.).—This weevil, as its name indicates, is the specific enmey of the seed of the lentil and does considerable injury to that legume. It belongs to the same group as the European bean weevil and the pea weevil, and is probably, like them, indigenous to the Eastern Hemisphere, where it ranges through middle and southern Europe, Egypt, and Syria. The adult beetle resembles in miniature the latter species, measuring only an eighth of an inch.

The lentil weevil was first brought to public notice in this country in 1880, when it occurred in imported lentils at Buffalo, N. Y. In 1893 it was found by the writer in various exhibits of lentils at the Columbian Exposition; in 1894, in lentils received from Boston, Mass., at this Department, and again the following year in a lot of the same seed received from Egypt and designed for distribution in this country. Beetles in this last lot were numerous, alive, and active in the middle of February, but the entire consignment was thoroughly fumigated before being distributed. Lentils are sparingly grown in some parts of this country, but the weevil, so far as is known, has not yet been introduced. Its permanent introduction, however, would appear to be assured, as this seed, which is already under cultivation in limited areas, becomes better known and appreciated, and will be accomplished by the increased importation of foreign seed for food and for planting, unless proper means are employed to prevent it by inspection and fumigation.

FIG. 74.—*Spermophagus pectoralis:* weevil at right, much enlarged; Mexican bean at left showing: below, holes made by beetle in egress; above, a group of eggs on surface, three times natural size (original).

THE MEXICAN BEAN WEEVIL (*Spermophagus pectoralis* Shp.).—The third foreign weevil that will be mentioned is shown in fig. 74. It is an inhabitant of South and Central America and breeds in the seed of beans and cowpeas. Its eggs, also illustrated, are round in outline. The species oviposits freely upon stored seed, and there is, therefore, every indication that it breeds like our common bean weevil for successive generations in the same material. It occurred in great numbers at the Columbian Exposition, but the infested material was all fumigated or destroyed under the writer's direction, and thus its possible introduction from that source prevented. The bean weevil is congeneric with five described species (Zabrotes) indigenous to the United States, one of which occurs as far north as Maryland, and although it is a tropical form, its introduction in time into the Southern States would not appear improbable.

BLISTER BEETLES.

Several of the many species of Meloidæ, or blister beetles, that are so destructive in gardens, particularly in the Southwest, are very injurious to beans, peas, and other leguminous crop plants. These insects are gregarious, and it is their habit, in their seasons of abundance, to congregate in great numbers, when, as they feed most voraciously (apparently consuming many times as much as they are able to assimilate) they injure a crop beyond recovery in a few days.

THE ASH-GRAY BLISTER BEETLE (*Macrobasis unicolor* Kby.).—The most troublesome blister-beetle enemy of legumens in the East is the one here figured. This beetle is elongate in form, rather soft-bodied, and of a uniform ash-gray color, produced by a dense covering of minute hairs of this shade. The female is illustrated at fig. 75 and at the left is shown a male antenna. It inhabits the entire Eastern United States from Canada, New England, and South Dakota to Florida and Texas, extending westward to Kansas and Nebraska.

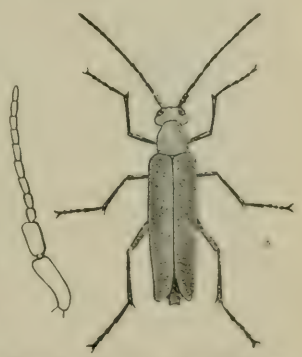

FIG. 75.—*Macrobasis unicolor:* female beetle at right, twice natural size; male antenna at left, greatly enlarged (original).

This species does severe injury to beans and peas by devouring the leaves, and the past year it was found upon cowpeas and soy beans at Washington. Of other legumens it attacks clover, locust and honey locust, and numerous wild plants, such as lupines, astragalus, and wild indigo. It is quite a serious enemy of the potato, and has been reported by Department correspondents to do damage to tomatoes, sweet potatoes, anemones, and chrysanthemums.

The beetles are actively destructive for a month or more. In the latitude of the District of Columbia they make their appearance about the middle of June and farther north from one to four weeks later.

In their life history blister beetles differ greatly from other Coleoptera in that they undergo a more complicated series of metamorphoses. The class to which this species belongs feeds upon the eggs of locusts or grasshoppers. The blister-beetle eggs are laid on plants or upon the ground. From each hatches a small long-legged larva, called a "triungulin," which runs actively about in search of a grasshopper egg-pod, which it enters and feeds upon. After a time it casts its skin and assumes what is called the "carabidoid" larval stage, and when it next molts, it resembles a white grub, the "scarabæidoid" larval stage. When a larva has finished its quota of locusts' eggs, it undergoes a third molt and forms within its own skin what is known as the "coarctate" larval stage or "pseudopupa," and in this condition usually passes the winter. In the spring the fourth and ultimate

larval molt takes place, and with the fifth molt the insect enters upon the true pupal stage, and in due time transforms to a beetle.

Blister beetles are not an unmixed evil, since they do some good in their larval stage to compensate in a measure for the harm they occasion to our crops; for the habit of the larvæ of feeding upon grasshopper eggs renders them of very material aid in keeping these pernicious insects in check. This is especially true of the Western States, where both blister beetles and grasshoppers abound. But the benefit derived from the insect while in its larval stage is really more than counterbalanced by the loss it occasions in fields and gardens; hence, insecticides or other measures should be employed to destroy the beetles when they occur in harmful numbers.

Remedies.—Paris green is one of the best remedies for blister beetles when they occur on potatoes and most other crops. It may be applied dry, mixed with from 10 to 20 parts of flour, plaster, or air-slaked lime, or in the form of a spray, also mixed with lime or Bordeaux mixture, at the rate of a quarter of a pound of the poison to 40 gallons of the diluent. But, unfortunately, in the use of an arsenite upon beans there is difficulty in obtaining a dry mixture or solution sufficiently strong for the destruction of the insects which will not endanger the plants by burning or scalding. The addition of lime mitigates this to a certain extent. Repeated applications are sometimes necessary, since the poisoned beetles are replaced by others.

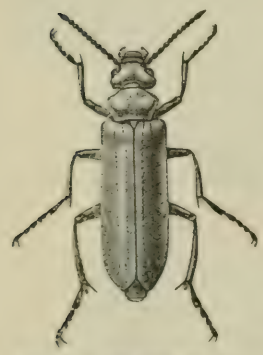

FIG. 76.—*Cantharis nuttalli*: female beetle, one-third larger than natural size (original).

A remedy which is employed with success in the Western States consists in sending a line of men and boys through infested fields to drive the beetles, by short flights and running, before them until they alight in windrows of hay, straw, or other dry vegetable material which have previously been prepared along the leeward side of the field. When the beetles have taken refuge in such a windrow, it is fired and the beetles are burned.

After what has been said concerning the voracity of these beetles it is almost superfluous to add that whatever remedy is employed should be applied at the outset of attack in order to be of substantial value.

NUTTALL'S BLISTER BEETLE (*Cantharis nuttalli* Say).—This species is to the bean industry in the Northwest what the ash-gray blister beetle is in the Eastern States. The beetle (fig. 76) is a large and beautiful insect, variable both in color and size. It is bright metallic green, the head and thorax have usually a coppery luster, and the wing-covers are often purple. In measurement it varies from a little over half to nearly an inch. Its habitat extends from the Mississippi River to the Rocky Mountains, and it is particularly abundant in South

Dakota, Minnesota, Colorado, Montana, western Nebraska, and the Northwest Territories of Canada. It is a near relative of the Spanish fly, the *Cantharis vesicatoria* or cantharides of commerce, has the same blistering properties, and might be put to the same use. In fact, all the members of this family possess a vesicating principle, and the native representatives, nearly two hundred species in number, could all be used as cantharides.

The life history of this blister beetle is unknown, but it is probably similar to that of the preceding species. The beetles make their first appearance about July 1, ravenously devour the blossoms and tender leaves of beans and other garden vegetables, and, if report speaks truly, they are capable of destroying a crop in a day. Fortunately this species is sporadic in its attack, its appearance in destructive numbers following years of excessive locust or grasshopper abundance. Were it otherwise, growers of beans in the territory which it inhabits might be obliged entirely to abandon the cultivation of this crop.

Remedies.—From the rapidity with which this insect works, it is obvious that poisons are of little value. We must, therefore, resort to mechanical measures for its destruction, and in the employment of these promptness and thoroughness are the essentials. The beetles may be destroyed by one of three methods: (1) By driving them into windrows of dry straw or similar material and burning them; (2) by sweeping them into a net, such as is used by insect collectors, and throwing the captured insects into a fire; (3) by beating the beetles into specially prepared pans of water on which there is a thin scum of coal oil.

THE BEAN LADYBIRD.

(*Epilachna corrupta* Muls.)[1]

This species, which is called also the spotted bean beetle, has been known as injurious only a few years, and its field of operation is limited both as regards the number of crop plants affected and the territory over which it ranges.

This beetle is one of three species of the ladybird family (Coccinellidæ) known to live by choice on vegetable matter, the other species being predaceous and subsisting largely upon plant-lice and soft-bodied larvæ. It is nearly hemispherical, in outline broadly oval, and its length is a little more than a fourth of an inch. Its color is light yellowish brown, and each wing-cover bears four black spots (see fig. 77, *b*).

This species was originally described from Mexico. In 1864 it was recorded from the United States, but it was not until 1883 that anything appears to have been published concerning its habits. In this year it did serious injury to wax beans in Colorado. In later years

[1] This name, according to Rev. H. S. Gorham, must give way to *E. varivestis* Muls. (See Biol. Centr.-Am., Col., Vol. VII, p. 242.)

similar instances of injury were reported from New Mexico. Its distribution comprises also Arizona and western Kansas.

The insect is described as being the worst enemy to the bean crop in the West, its work being compared to that of the Colorado potato beetle, and in some localities it is stated to frequently destroy entire crops. It devours in both larval and adult stages all parts of a bean plant, leaves, flowers, and green pods. The female beetle deposits her yellowish-brown eggs in large clusters on the under surface of bean leaves (fig. 77, *d*), and the larvæ feed chiefly upon the lower sides of

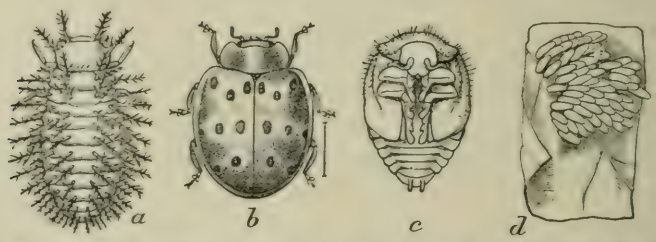

FIG. 77.—*Epilachna corrupta: a*, larva; *b*, beetle; *c*, pupa; *d*, egg mass—all about three times natural size (original).

the leaves. The full-grown larva shown in the illustration at *a* is of about the same length as the beetle, in color yellow, and covered with stout branched spines. When fully matured, it attaches itself to a leaf by its posterior end and transforms to pupa (*c*). The beetle, where observed in New Mexico, makes its appearance from the latter part of June to the middle of July, and the new brood of beetles is to be found in September and October. The winter is passed in the adult stage, and only a single generation has been observed in a year.

The eggs are preyed upon by two predaceous ladybirds, *Hippodamia convergens* Guer. and *Coccinella transversoguttata* Fab. The beetle when disturbed has a habit, possessed in common by other ladybirds, of drawing up its legs so that a small drop of yellow liquid, having a disagreeable odor, exudes from each kneejoint, and it is probable that this enables it to secure for itself comparative immunity from the attacks of birds and other enemies.

REMEDIES.

Paris green suggests itself as the most useful insecticide for this species, but unless great care be taken in its application, certain varieties of beans are liable to be killed by the scorching of their leaves. It should be applied as an underspray at the first appearance of the beetles. Kerosene emulsion applied also as an underspray gives still better results, as it is not open to the same objection of poisoning the plants as in the case of the arsenites. Hand-picking of the beetles

and their eggs upon their earliest appearance is a measure of prevention that would compensate for the time and labor on small kitchen gardens.

THE BEAN LEAF-BEETLE.

(*Cerotoma trifurcata* Forst.)

An insect of considerable importance in the Gulf States, and of somewhat minor import farther northward in the vicinity of Maryland and Virginia, is the bean leaf-beetle (*Cerotoma trifurcata* Forst.). This species first became known as an enemy to beans in 1875, from its injuries in Shawnee County, Kans. In later years it attracted attention successively in portions of New Jersey, Louisiana, Indiana, Delaware, Ohio, Maryland, and Virginia, and during the year 1897 was particularly numerous and troublesome in the last two States. Injury is due to the adult beetle, which eats large round holes in the growing leaves of beans and cowpeas, and certain other leguminous plants, including cultivated beggarweed or tickseed (*Desmodium tortuosum*), a plant which is grown to some extent in the South for forage and as a soil renewer. The larvæ also do their share of damage by feeding on the roots and upon the main stems of the plants just below the surface of the ground.

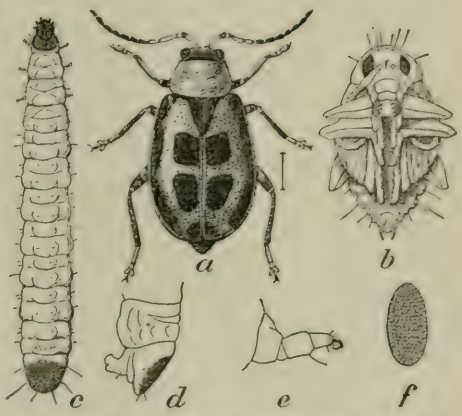

FIG. 78.—*Cerotoma trifurcata:* *a*, adult beetle; *b*, pupa; *c*, larva; *d*, side view of anal segment of larva; *e*, leg of same; *f*, egg—*a*, *b*, *c* enlarged about six times, *d*, *e*, *f* more enlarged (author's illustration).

The adult beetle is a member of the family Chrysomelidæ and resembles in several particulars the cucumber beetles (Diabrotica). It measures from a seventh to a fifth of an inch (3.5–5 mm.) in length, and is nearly twice as long as wide. It varies greatly in color, from pale yellowish or buff to dull greasy red, with black markings, arranged, in what appears to be the typical form, as in fig. 78, *a*. Individuals often occur, however, in which the elytral marking is almost if not entirely wanting.

This species is native to North America and found from Canada southward to the Gulf States and westward to Kansas and Minnesota. It ranges from the Transition to the Lower Austral life zones, being most abundant and injurious in the last.

The bean leaf-beetle feeds both on cowpeas and beans, and of the latter the low-growing, or dwarf, varieties are usually most injured, since their period of growth is shorter, while the pole beans put out new leaves after injury has ceased. The beetles when abundant strip

the leaves to their veins and midribs. Ordinarily they would seldom attract attention, as they feed and rest during the greater portion of the day almost exclusively on the under side of the leaves. Before the cultivation of beans in the United States, this beetle fed upon its wild food plants, of which tick trefoil (Meibomia), bush-clover (Lespedeza), and hog peanut (Falcata) are known. The beetles are rather sluggish and seldom seen in flight, nor are they easily disturbed, and hence may be readily captured by hand. When alarmed, they drop to the ground, but soon reascend to the plant.

In the extreme South the beetles appear as early as April, and farther northward as late as June. The minute orange-colored eggs (shown much enlarged at fig. 78, *f*) are laid around the stem of the insects' food plant, just below the surface, and in clusters of from six to ten or more, and the larvæ when hatched eat around the stem and feed also upon the roots. The eggs hatch in from five to eight days, and the larvæ attain full growth in from four to six or seven weeks. The full-grown larva is shown in fig. 78, *c*, enlarged about six times. It is nearly cylindrical in form, milk-white in color, with darker head and anal segment. It measures about three-tenths of an inch in length (7–8 mm.), and is about an eighth as wide as long. The pupa, shown at *b*, fig. 78, is white like the larva and delicate in texture. The pupa state lasts from five to eight days, these periods varying with the conditions of heat, dryness, or moisture. The entire life cycle requires from six to nine weeks. The periods indicated are for the latitude of the District of Columbia. In the most northern range of the species there is probably only one generation a year. In Maryland and Virginia there are evidently two, the former developing during July, the latter in September. In the Gulf States there is probably a third generation, as the beetles are numerous there as late as October.

REMEDIES.

The sluggishness of the beetles indicates hand-picking as of value in small gardens early in the season. Pyrethrum is said to be useful in checking its depredations, but the chief reliance would be in spraying with one of the arsenicals, where the insect is sufficiently numerous to justify a poisonous insecticide. This remedy should be employed on the first appearance of the insects in order to stop them at the outset and to avoid possible poisoning of the bean pods if these are to be eaten green. An important measure is clean culture and the careful weeding out of wild food plants, such as tick trefoil and bush-clover, in the neighborhood of cultivated crops.

OTHER INJURIOUS BEETLES.

Several other species of beetles of omnivorous habits in their adult condition attack leguminous food plants. Prominent among these are the banded flea-beetle (*Systena taeniata* Say) and the pale-striped

flea-beetle (*S. blanda* Mels.[1]), species of common occurrence on beans. In 1894 the former was reported to have been very destructive in Ohio, where large fields were seriously damaged. These beetles are often met with in gardens and attack a variety of plants, such as beets, melons, carrots, and potatoes, but fortunately they are only sporadically injurious.

Beans may be protected against these insects by a dusting of air-slaked lime, which will force them to feed upon their wild food plants, which consist chiefly of common garden weeds. Bordeaux mixture applied as a spray is of value as a repellent against flea-beetles, and will doubtless prove effective against the present species. If the beetles are present in great abundance, Paris green should be added to the spraying mixture.

In the neighborhood of the District of Columbia the twelve-spotted cucumber beetle (*Diabrotica 12-punctata* Ol.) attacks the foliage of beans and other edible legumes in the same manner as does the bean leaf-beetle, sometimes also injuring the pods.

THE BOLL WORM OR CORN-EAR WORM.

(*Heliothis armiger* Hbn.)

The maturing pods of beans, peas, and cowpeas are often found bored full of holes and the seed within devoured. The insect most often concerned in damage of this nature is *Heliothis armiger* Hbn., better known as an enemy of cotton, corn, and tomatoes, whence it has received the vernacular names cotton boll worm, corn-ear worm, and tomato fruit worm. It is a species of wide distribution and destructiveness, but whether it is indigenous to this country or imported is not known.

In addition to the crops mentioned, this species feeds upon and injures tobacco, pumpkin, squash, melons, red pepper, okra, and other vegetables, and among garden flowers it attacks gladiolus, geranium, mallow, and mignonette. In Europe it is injurious to chick-peas and lucern. In feeding upon beans and cowpeas it devours a seed or two and then comes out and enters another pod. A single larva is capable of ruining several pods. One that was kept under observation destroyed a pod in a day. Even if only a single hole is made the damage is apt to be considerable, as the pod is likely to become more or less decomposed and access is afforded to other insects and to rain. The same is true of the injuries by this insect to other fruits.

The adult of the boll worm is a Noctuid moth. Its general color is ocher yellow, more or less variegated with blackish markings, and arranged as in fig. 79, *a*. It measures about an inch and a half across its expanded fore-wings.

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[1] The latter is considered by some authorities a variety of the former.

The larva or caterpillar varies greatly in color, different shades of pink, purple, and green being the prevailing ground tints. One of the dark striped forms is shown at *b* and a light, nearly immaculate form at *c*. Individuals that have fed more or less freely exposed to sunlight are darker and brighter colored than such as have lived hidden from view within bean pods, ears of corn, or tomatoes.

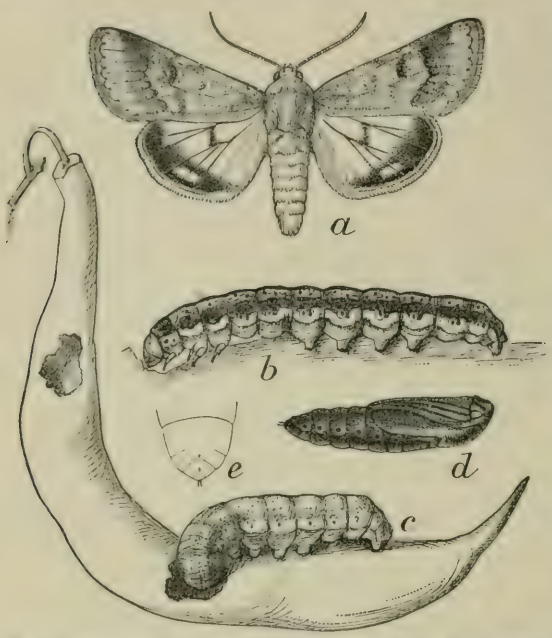


FIG. 79.—*Heliothis armiger:* *a*, moth; *b*, dark larva; *c*, lighter larva entering pod; *d*, pupa; *e*, last segment of same, ventral view—all somewhat enlarged (original).

The eggs of the boll worm are laid at twilight upon any portion of a plant and they hatch in from two days to a week. The caterpillar attains its full development in from two to four weeks, when it enters the ground and transforms to a light mahogany-colored chrysalis (see fig. 79, *d*). The duration of this stage is from one week to a month. The average life cycle from egg to adult is between five and six weeks in the South, and the number of annual generations varies probably from about two or three in the northern range of the species to four or five in the cotton States.

REMEDIES.

The habit of the boll worm larva of feeding in concealment renders it practically impossible to kill it with poisons. When it occurs on cotton a trap crop of corn is employed with profit, and it is possible that recourse might be had to similar measures when the insect occurs in peas and beans. Thorough applications of Paris green, either in the form of a spray or dry in powder, will doubtless kill the younger caterpillars, but string beans treated in this manner should be rinsed in water before cooking or before sending them to market. Late fall plowing is of value in ridding infested fields of the boll worm, but there is no practical remedy known for this insect when it occurs in corn ears or tomatoes.

THE PEA MOTH.

(*Semasia nigricana* Steph.)

For a number of years past the larva of the pea moth has done injury to peas in the Dominion of Canada, where the cultivation of this crop is an important industry. It especially affects late crops, damaging the ripening peas in the pods. This is a comparatively new importation from the Old World, where it has been known for many years as an enemy of the pea. It is as yet practically unknown in the United States, but the pea growers of New York and New England and other Northern States should be warned against it.

No remedy appears to be known for this species beyond early fall plowing and the destruction of the infested vines.

CUTWORMS AND OTHER CATERPILLARS.

CUTWORMS.—Numerous leaf-feeding caterpillars feed upon the foliage of leguminous garden plants, of which cutworms of several species are among the most important, often causing extensive damage to young plants by cutting them off, and to older plants by severing their leaves and tender shoots. One of our common forms often found on beans and peas is shown in fig. 80. It is called the Western striped cutworm (*Feltia subgothica* Haw.), and is widely distributed and injurious. Other species troublesome to peas are the clover cutworm (*Mamestra trifolii* Rott.) and the zebra caterpillar (*M. picta* Harr.).

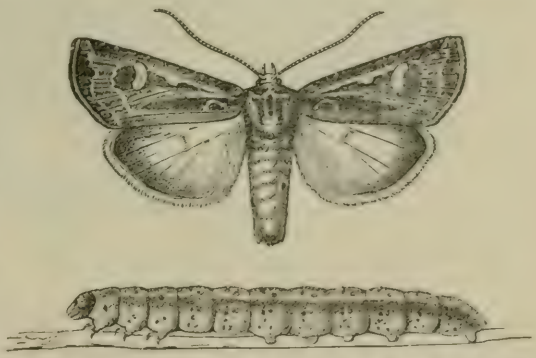


FIG. 80.—*Feltia subgothica:* mature moth above, larva below—somewhat enlarged (original).

The best cutworm remedy is a bait composed of bunches of clover, grass, or weeds, poisoned by dipping them into a solution of arsenic or Paris green, or of a mash of bran poisoned in a similar manner and scattered about at the bases of the vines.

THE YELLOW BEAR (*Spilosoma virginica* Fab.).—A large hairy caterpillar called yellow bear or woolly bear sometimes does considerable harm to peas and beans. It is one of the commonest of garden pests, and appears to thrive equally well upon any sort of herbaceous plant, from garden vegetables, fruits, and flowers to weeds and grasses. It infests alike fields of corn and cotton, orchards, and vineyards, and sometimes defoliates forest and shade trees.

The adult, known as the ermine moth, but commonly called "the

miller" (fig. 81, *a*), has a wing expanse of from 1½ to 1¾ inches, is white in color, with a black discal spot on the fore-wings and two on the hind-wings. The yellow eggs are deposited in large clusters on the under sides of leaves. The caterpillar when full grown measures about 2 inches, and varies in color from pale cream (*c*) to dark red or brown (*b*). Transformation to pupa takes place in a loose cocoon constructed from its own hairs (see *d* and *e*). In this state it remains for from twelve days to a month. There are evidently two generations annually in a climate such as that of Maryland and Virginia,

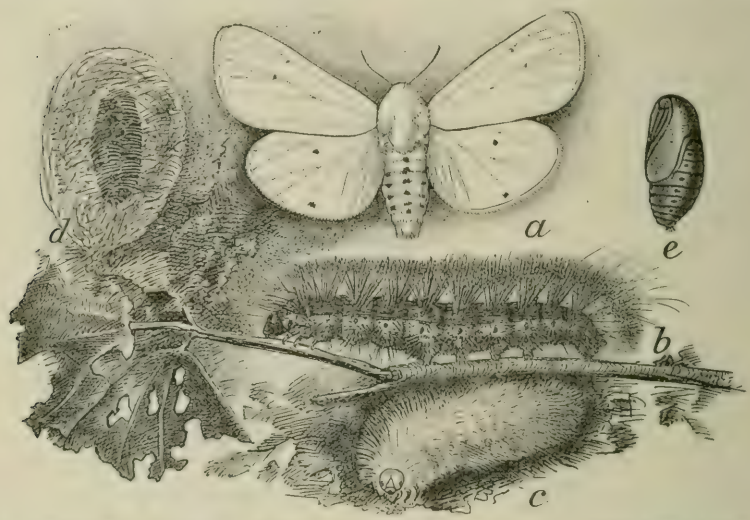


FIG. 81.—*Spilosoma virginica:* *a*, female moth; *b*, full-grown larva; *c*, light form of larva, not quite mature; *d*, cocoon; *e*, pupa—all slightly enlarged (original).

the first appearing about June, the second wintering over as pupa and issuing in the spring. The moth is nocturnal and seldom seen during the daytime.

REMEDIES.

The caterpillars may be killed with the arsenites, and the best time for their destruction is just after they have hatched from the egg clusters, when they are feeding together. When more mature, their presence is indicated by the large holes they make in the leaves of the plants which they infest, and they may then be picked off from the under side of the leaves, where they feed by preference, and crushed. This means of reducing them may be employed with benefit, as they are capable of doing an immense amount of injury in a very short time.

THE SALT-MARSH CATERPILLAR (*Leucaretia acraea* Dru.).—A larva very similar to the above, and known as the salt-marsh caterpillar from its ravages in forage crops grown in the salt marshes of the New England States, is sometimes injurious to peas and beans. It is

amenable at such times to the same remedies as advised against the yellow bear.

THE BEAN LEAF-ROLLER (*Eudamus proteus* Linn).—A caterpillar known as the bean leaf-roller or "roller-worm" is injurious in the Gulf States to leguminous plants, particularly beans, as also cultivated "beggarweed." It is the larva of a butterfly called the swallow-tailed skipper. The ground color of the larva is yellowish, its head being darker and marked with two orange spots near the mandibles. The head is prominent and separated from the body by the narrow neck, a character which will serve to distinguish it from any other common caterpillar on garden crops.

This caterpillar may be successfully controlled by a spraying with Paris green on its first appearance.

PLANT-LICE, PLANT-BUGS, AND LEAF-HOPPERS.

Several species of plant-lice, plant-bugs, and leaf-hoppers weaken the vitality of pea, cowpea, and bean plants by sucking their juices.

FIG. 82.—*Halticus uhleri:* *a*, brachypterous female; *b*, full-winged female; *c*, male; *d*, head of male in outline—*a*, *b*, *c* much enlarged, *d* more enlarged (author's illustration).

Of the plant-lice, *Aphis gossypii* Glov., *A. rumicis* Linn., and *Siphonophora erigeronensis* Thos. (?) have been the most abundant forms on these legumes in the neighborhood of the District of Columbia in recent years.

Of the leaf-hoppers that infest these plants, *Empoasca fabæ* Harr.

has long been known as injurious to beans. Two related species, *E. mali* LeB. and *E. flavescens* Fab., have recently been observed to have similar habits.

The plant-bug best known as an enemy of beans is *Halticus uhleri* Giard (fig. 82), which has been reported as doing damage in Kansas and Ohio, living in great numbers on the under sides of the leaves, puncturing them so as to cause the death of the tissues in small irregular white patches. This same species was quite injurious on hothouse chrysanthemums in the city of Washington recently, and somewhat troublesome on beans in Maryland in the vicinity of Washington. This insect in its brachypterous or short-winged form greatly resembles the black flea-beetle of the genus Epitrix, alike in appearance, in the nature of its work, and in its saltatory power. It may be called the garden flea-hopper.

The standard remedy for plant-lice, leaf-hoppers, and plant-bugs is kerosene emulsion, and, as the pea- and bean-infesting species feed chiefly on the under sides of the leaves of these plants, an underspraying is necessary.

WORK IN VEGETABLE PHYSIOLOGY AND PATHOLOGY.

By Albert F. Woods,
Acting Chief of Division of Vegetable Physiology and Pathology

INTRODUCTION.

It will be readily understood by those who have read the paper on the work of the Division of Vegetable Physiology and Pathology in the Yearbook for 1897 that most of the problems investigated by the Division require years for complete mastery. Much of the work done and advance made during the year were necessarily of a technical nature. This is particularly true of the work of plant breeding, where the problems of heredity and changes produced by crossing and intercrossing must be carefully worked out and understood. Hybrids must be made in large numbers, selected, crossed, and intercrossed for several years before the desired result is obtained. In the case of diseases, the life history of parasites causing them and the physiological relations of these parasites to their hosts must be studied until throughly known and understood. It is upon this knowledge that all preventive measures and treatments are based and the conditions for the greatest productiveness and value of a crop determined. The method of treating a disease recommended one year may be materially changed the next in favor of a cheaper or more effective remedy suggested by the discovery of some new fact. The work is not completed until the method is known by which the cost and labor of producing any crop and overcoming its diseases are reduced to a minimum and the plants are made to yield the largest profit. This paper must, however, be limited to a brief presentation of the more practical results of the work of the year.

THE GRAIN SMUTS.

It is estimated that oat smut alone destroys each year in the United States over $18,000,000 worth of grain. The other grains, especially wheat, rye, and barley, also suffer severely from smut diseases; the amount, however, has not been estimated. A careful review of all the work done on this subject up to the present time was made during the year. As the different kinds of smut require different treatment, each kind was carefully described and illustrated, so that it can be distinguished by the farmer, and the latest and best methods of preventing it given. The results were published in Farmers' Bulletin No. 75.

THE GRAIN RUSTS.

The aggregate loss to the United States from grain rusts is estimated to be greater than from all other diseases of these crops. A three years' test for rust resistance of over nine hundred good varieties of wheat obtained from every wheat country of importance in the world was closed during 1897. The results showed more conclusively than ever before that varieties from southern and eastern Russia are by far the best adapted to the greater portion of the wheat regions of the United States. They are the most resistant to drought and cold, and, on the whole, to rust also; are more certain in yield, though not yielding heavily, and produce a very high quality of grain.

The principal varieties found to be the most resistant to orange leaf rust in any part of the country, if sown in good time, are the winter wheats Turkey, Mennonite, Pringles No. 5, Rieti, and Odessa, and the spring wheats, Haynes Blue Stem and Saskatchewan Fife.

Durum and Poulard wheats are very resistant to leaf rust, but so far have been used chiefly for macaroni. A few of the most important of these wheats are Arnautka, Taganrog, Belotourka, Medeah, and Hybrid de Galland. The work has made clear the extremely important point that the leaf rusts, which have been the ones mainly studied hitherto, are not nearly so destructive as the black stem rusts of wheat and oats. More attention must therefore be given to these latter forms. In addition to confirming still further that the orange leaf rust of wheat (*Puccinia rubigo-vera tritici*) lives over winter in this country in the uredo, or summer stage, the same has now been proved true of the corresponding form on rye (*P. rubigo-vera secalis*). The spores start first on self-sown grain, and from this the regular fall-sown crop may be infected. All farms should therefore be kept constantly free from self-sown wheat and rye.

The black stem rust of wheat occurs also on *Hordeum jubatum* (squirrel-tail grass), but does not winter its uredo in this country so far as known. We have proved beyond doubt now that *Dactylis glomerata* (orchard grass) and *Arrhenatherum elatius* (oat grass) act as hosts of the black stem rust of oats (*P. graminis avenæ*). Oats may therefore be readily infected with this destructive rust by being sown near these two grasses; other grasses are strongly suspected.

The rusts of *Agrostis alba vulgaris* (redtop) and several species of Elymus and Agropyrum are not equivalent to any of the cereal rusts, as has been supposed. For the first time in America it has been proved that the Æcidium, or cluster-cup rust, of Rhamnus (buckthorn), in this case *R. lanceolata*, is connected with the crown rust (*Puccinia coronata*) of oats and of *Phalaris caroliniana* (Carolina canary grass). A full presentation of the work will shortly be published.

BLACK ROT OF CABBAGE.

One of the most important diseases of truck and garden crops studied during the year was the black rot of cabbage. The disease also attacks turnips, cauliflowers, wild mustards, and other related plants. With cabbage it causes dwarfing, one-sided growth of the heads, or the entire absence of heads. The leaves turn yellow from the edges inward and finally fall off. The woody layer of the stem is black or brown. The trouble was found to be due to a yellow bacterium, which gains entrance to the tissues of the plant mainly through the water pores on the edges of the leaves or through injuries produced by insects. The disease has been found doing serious damage in many of the important cabbage-growing districts of the Eastern and Central States and as far west as Iowa and Nebraska. Its known distribution now includes sixteen States, and it will likely be found in many more. Where the disease has a start the loss is from 30 to 75 per cent of the crop. Losses from this cause around Racine, Wis., alone during the last three years have been estimated at over $100,000. The disease is spread mainly by transplanting plants from soils contaminated with the germ to new soils, which in turn become infected, and to some extent also by leaf-eating insects and slugs.

The best preventive measures that can at present be suggested are to avoid planting on land where the disease has appeared, and to use especial caution in regard to the seed bed. Avoid the use of manures contaminated with cabbage refuse, and keep up constant warfare against the cabbage butterfly and the harlequin cabbage bug. A full description of the disease and preventive measures were published in Farmers' Bulletin No. 68.

VARIOUS IMPORTANT DISEASES.

On the Pacific coast a new and destructive disease of bulbs was investigated, its bacterial nature established, the mode of infection learned, and a practical means of prevention recommended. A new bacterial disease of walnuts, the cause and treatment of which have been worked out within the past two years, has been under investigation in both the laboratory and field. Several new facts of importance were learned, such as the common way in which the organism causing the disease passes the winter, the manner of rapid spring infection of the trees, and the chemical action of the germ upon the tissues.

Much additional work has been done on apple canker and peach leaf curl, two of the most serious diseases affecting these fruits. The methods of treatment recommended have proved highly successful, and when put into general use will save several millions of dollars annually to the growers of these crops. An obscure disease causing the death of buds and twigs of Japan plum, and thought to be a physiological trouble, was finally traced to a peach bud mite. A circular on the subject has been prepared and will be published in

cooperation with the Division of Entomology. Two kinds of root rot of peach and plum were found to be doing serious damage in the South.

During the work on sooty mold, a fungous disease of the orange and lemon which follows attacks of the mealy wing, or white fly, it was discovered that the mealy wings are themselves affected by two fungous diseases. Experiments made during the year have proved that the diseases of the mealy wing can be spread artificially, and may thus be used as a means of combating this much-dreaded pest. Experiments in spreading these friendly fungi will be carried on in cooperation with the Division of Entomology.

Among greenhouse crops the leaf-spot disease of violets was carefully worked out and proved to be due to a fungus, a new species of Alternaria. The best means of preventing the disease were found to be rigid selection of vigorous stock for planting, careful attention to cultivation and watering, and avoiding the use of tobacco for fumigating against insects, tobacco having been found to injure the leaves, making them more susceptible to infection by the fungus. In this connection, a method of using hydrocyanic-acid gas for fumigating violets and a number of other greenhouse crops was carefully worked out, and the results will appear in a circular to be issued by the Division of Entomology. It causes no injury to the leaves or flowers, and thus reduces to a minimum the danger of spot from fumigation. In the selection experiments carried on in connection with this work the productiveness of the plants has been raised 50 per cent, besides making them more resistant to disease. A widely distributed disease of carnations known as Bacteriosis, and hitherto supposed to be due to bacteria, was thoroughly investigated, and it was found that bacteria do not cause the disease, but that the plants react to the attacks of aphides, thrips, and other insects. In such cases all the characteristics of the malady in question are produced. The problem of preventing this disease is thus greatly simplified.

Much progress has also been made in the study of other diseases of violets, carnations, hyacinths, tomatoes, cucumbers, and other forcing-house crops.

PLANT BREEDING.

The year has marked a great advance in the work done in plant breeding. A paper on "Hybrids and their utilization in plant breeding," published in the Yearbook for 1897, presents very clearly the possibilities of great improvement in our cultivated plants by this means. It is beginning to be pretty generally understood that a great many diseases of plants are due to a lack of power on the part of the latter to completely adapt themselves to their surroundings and maintain a well-balanced vigor and resistance to unfavorable conditions and parasitic enemies. The lack of complete adaptation to surroundings is sometimes very slight, but nevertheless sufficient to make the difference between a profitable and unprofitable crop.

GRAPES.

The disease known as coulure, or falling of the flowers and young fruit of the finest raisin grapes of California, is a good case in point. An investigation of the disease showed that the dropping of the flowers and fruit is due mainly to unfavorable climatic conditions at or about the time when the first crop of grapes is in bloom. The varieties most susceptible are the Muscat of Alexandria and Muscatel Gordo Blanco, the finest and most highly prized raisin grapes in existence. Although they are tender varieties, they do well in California except for this disease. As a result of investigations it was ascertained that if the first bloom could be delayed until the weather became fine or if the plants were protected from cold or unfavorable atmospheric changes the injury would not occur. The problem, then, was to delay the flowering of the vines or increase their hardiness, so that they might escape the bad weather at flowering time or be able to stand it without injury. To overcome this weakness the two varieties mentioned have been crossed with Malaga, an exceedingly thrifty grower, very hardy, resistant to disease, and an excellent raisin grape, though not equal to the Muscat or Muscatel Gordo Blanco. About twenty thousand crosses were made. The new seedlings are now several years old. When they come to maturity those having the hardiness of the Malaga and the fruiting qualities of the finer varieties will be selected. In this way it is believed that coulure and a number of other diseases due to the lack of hardiness can be overcome, and many millions of dollars saved annually to the grape growers of the Pacific coast.

HARDY ORANGES.

A similar problem to the one just discussed, and one of the greatest importance to citrus culture, is to secure a hardy orange that will successfully resist the severe freezes that cause such great destruction in Florida, California, and Louisiana. The experiments so far made, especially during the past year, show conclusively that the common orange may be successfully hybridized with the so-called trifoliate orange, a hardy sort, of poor quality, which can be grown as far north as Philadelphia. About one hundred and fifty of these hybrids have been produced and are now growing in the greenhouses of the Department. Many of them show by their foliage that they are intermediate in character between their parents. The results which have been obtained with other fruits by similar means justify the conclusion that it is possible, by making a sufficient number of crosses, to obtain a variety having to a large degree the fruit characters of the common orange and the hardiness of the trifoliate. The same method may also be successful in obtaining hardy varieties of the lemon, lime, and other subtropical fruits.

Another important problem in citrus culture which has received attention during the past year is to secure a common orange of good

quality with the loose, easily removable rind of the tangerine orange, and also to secure sorts resistant to blight and other diseases.

From the crosses made in 1893 sixty-four hybrid orange trees are now growing in south Florida. Buds of each have been inserted on mature trees, and will probably fruit next year. Crosses made in 1897 have yielded eight hundred and eighty-three hybrid trees, now growing in the Department greenhouses. In the spring of 1898 four hundred and ninety-seven more citrus crosses were made.

PINEAPPLES.

One of the most important problems in pineapple culture is to secure sorts with large fruits, of good quality and good shippers, and resistant to disease, especially pineapple blight. With this in view, six hundred and ninety-three crosses were made last year. The seeds obtained from these gave two hundred and fifty-nine seedlings, most of them of remarkable vigor. They are now growing in the Department greenhouses. Four hundred and sixty-five more crosses were made this spring.

PEARS.

In pear growing it is very important to obtain sorts preserving the great vegetative vigor and disease resistance of the Oriental with the high quality of fruit of the European varieties. One hundred and sixteen crosses have been made with this in view, resulting in fifty-three fruits, from which a large number of seedlings is expected.

WHEAT.

Similar lines of work are also under way in breeding wheats for resistance to rust, for greater productiveness, and for other desirable qualities. The remarkable results obtained abroad with cereals suggest the great improvements that may be confidently expected from careful breeding.

It is not possible to present in this paper the work accomplished in the breeding and selection experiments with a number of other crops. Sufficient has been given, however, to show the nature of the work and the promise it gives of securing fruits and grains of high quality and productiveness, resistant to disease, hardier, and better adapted to the conditions under which they must be cultivated. That these expectations are well founded is shown by the remarkable results already obtained where careful work has been done. Many experiment station workers and others have entered into active cooperation with the Division along these lines, and such united effort should result in greatly increasing the value and productiveness of our agricultural crops.

MILLETS.

By Thomas A. Williams,
Assistant in Division of Agrostology.

INTRODUCTION.

The term "millet" is used in a general way to designate certain cereal and forage grasses, the seeds of which are usually small as compared with other cereals, such as oats, wheat, and barley. In some parts of the world certain of the sorghums are included under this name, while in this country several grasses of quite different character are locally called millets.

Millets are important both as forage plants and as a source of food for man. In nearly all parts of the world they take a prominent place among forage crops, and it is estimated that they feed about one-third of the inhabitants of the globe. Between 35,000,000 and 40,000,000 acres of millets are grown annually in India, and Japan alone uses about 35,000,000 bushels of seed each year for human food. Corea, China, and other Asiatic countries also use enormous quantities for this purpose.

PLACE OF MILLETS ON THE FARM.

On the whole, it is doubtful if there are many sections in this country where millets should be made a primary crop. Their place is rather that of a supplementary one—a "catch crop," when the corn has been "hailed out;" a substitute for corn where that crop is not easily grown; a crop to be grown on a piece of land that might otherwise lie idle; a readily available crop for use in short rotations; an excellent thing to grow on foul land to get rid of weeds, giving practically the same results as fallowing, or summer cultivation, and in addition a crop of forage; a supplement to the regular or permanent pastures and meadows. It is in such ways that the millets are most valuable on the average farm, and such is the place they should be given in American agriculture.

GROUPS OF THE CULTIVATED VARIETIES.

In this paper the discussion is limited principally to varieties of recognized merit already on the market, leaving new and untried sorts until such a time as experimentation will have demonstrated their value for general cultivation. It is not desirable to consider at length the relative merits of the various trade names used by seedsmen in

placing their millets on the market. As far as possible these names have been grouped as synonyms under the most generally accepted titles of the various standard varieties.

But little has been done in the really scientific development of varieties. In a few instances careful selection has been practiced, but as a rule the so-called new varieties on the market are only local variations of well-known sorts. During recent years a number of the experiment stations have been paying special attention to the introduction and testing of foreign millets, and the Department of Agriculture has distributed seed of a number of foreign sorts to the various State experiment stations and to private individuals in different parts of the country. Out of the many kinds thus introduced and tested some are giving promise of value for cultivation, and there is no doubt that others could be crossed with some of the standard varieties in such a manner as to materially increase their value.

With one or two exceptions the millets grown in the United States belong to the genera Chætochloa and Panicum, and may be arranged into three groups. In the first group are those belonging to the genus Chætochloa (formerly Setaria), with a compact, bristly, foxtail-like head, closely related botanically to the common foxtail grasses of the fields and waste places; this group, which may be termed the foxtail millets, includes such varieties as Common Millet, Hungarian, and others originating from the various species of Chætochloa, chiefly *C. italica* and its var. *germanica*. A second group is composed of varieties derived from the common barnyard grass (*Panicum crus-galli*) and its allies (*P. colonum*, *P. frumentaceum*, etc.), distinguished by the dense paniculate heads so characteristic of barnyard grass; although extensively cultivated in parts of the Old World, the millets of this group, which may be designated the barnyard millets, have only recently come into prominence in American agriculture. The third group comprises millets with bushy heads, the seeds being produced at the ends of the comparatively long branches; this group includes the "common" millet of the Old World and the varieties derived from the same species (*Panicum miliaceum*), regarded by many as the true millets, as they undoubtedly are in fact; in the United States they are most generally known as the broom-corn millets, which title has been adopted in this paper.

Foxtail Millets.

ORIGIN AND EXTENT OF CULTIVATION.

The foxtail millets (*Chætochloa italica* and var. *germanica*) are by far the most important group of millets grown in this country—probably in the whole world. There is a difference of opinion as to the nativity of this species. Some writers regard it as a native of southern Europe; but although it has been cultivated there from the remotest period, there seems to be no good evidence of its being a

native. Writers on Chinese economic plants give this as one of the five plants sown each year by the Emperor in a public ceremony, in accordance with the command given by Chin-nong, 2700 B. C. These plants are all regarded by the Chinese as natives of that country. The species seems to occur in the wild state in Japan. De Candolle, the leading authority on the "Origin of cultivated plants," after an extended discussion of all the evidence obtainable, concludes as follows:

> The sum of historic, philological, and botanical data makes me think that the species existed before all cultivation, thousands of years ago, in China, Japan, and the Indian archipelago. Its cultivation must have early spread toward the West, since we know Sanskrit names, but it does not seem to have been known in Syria, Arabia, and Greece, and it is probably through Russia and Austria that it early arrived among the lake dwellers of the stone age in Switzerland.

According to Hackel, the common weedy grass known as Green Foxtail (*Chætochloa viridis*) is to be regarded as the probable original form of the cultivated foxtail millets.

In some of their many varieties foxtail millets have long held an important place among the plants cultivated over large portions of Europe, Asia, Africa, and America. There is much doubt as to the exact time and manner of the introduction of these millets into this country. The opinion prevails that the variety known as Common Millet was the first to be introduced, probably near the close of the last century. Hungarian grass was certainly grown in this country as early as 1830, and was probably introduced[1] some time before that date. Both the German and Japanese millets are of later introduction.

At the present time these millets are more or less extensively grown throughout temperate Europe, a large part of India, China, Japan, northern Africa, the United States, and Canada. In the United States their cultivation is most general in the middle West, although they are grown more or less throughout the country. In parts of the South they are replaced to some extent by sorghum, while in the North the broom-corn millets are sometimes grown in their stead, and of recent years the barnyard millets are gaining favor in some sections. Among the leading millet-growing States are Iowa, Missouri, Kansas, Texas, Nebraska, the Dakotas, Minnesota, Illinois, and Tennessee.

In this country the foxtail millets are grown almost exclusively for forage, but in other parts of the world they are used for human food; in early times, they were probably much more extensively used for this purpose than at present. Seed of this species has been found in such abundance in the remains of the lake dwellings of Switzerland as to indicate that it was in common use during the stone age in central and southern Europe. Long before the Christian era, at least as early as 2700 B. C., it formed one of the chief sources of food in China; and is still extensively used for this purpose, not only

[1] Bul. 117, Mich. Agr. Exp. Sta., pp. 23, 24 (1894).

in China, but also in Corea, Japan, the East Indies, and Trans-Caucasia. Church[1] says it is grown in India chiefly as an "intermediate or subordinate" crop, and is largely used as human food in certain parts of the country. He further says, "It is generally regarded as nutritious and digestible, but in some places it is considered to be rather heating." It is usually prepared by parching or boiling, and is eaten alone, or may be mixed with milk and sugar, forming a mixture known among the natives as "sir." At the present time it is widely grown for forage in foreign countries, particularly in central Europe and in parts of India.

HABIT AND CONDITIONS OF GROWTH.

The foxtail millets delight in rich, warm, loamy soils, and will not thrive in soils that are poor and thin. This is particularly the case with the coarser varieties like German Millet. Common Millet and Hungarian usually give better results under adverse conditions of soil and climate than the other varieties commonly grown in this country. The foxtail millets are strong, rapid growers, and draw nourishment largely from the surface soil. The great mass of strong, fibrous roots have a beneficial effect on the physical condition of the soil, particularly in the case of lands recently brought under the plow. A crop of millet on new "breaking" aids materially in subduing the land and in preparing it for the succeeding crop. In many localities, notably in the West, millet is an excellent crop to precede corn. In the South the foxtail millets are regarded as well adapted to the upland soils of the cotton regions, Common Millet being best for the light soils and German Millet for low, heavy soils.

The foxtail millets not only endure excessive heat and sunlight well, but make very rapid growth if the supply of moisture is not too limited. They are, however, very susceptible to cold, particularly when the plants are young. The length of time required to reach maturity varies a great deal, according to the variety and the soil and climatic conditions, the commonly grown varieties ordinarily being ready to cut for hay in from fifty to eighty days from date of sowing, and maturing seed in from ten to fifteen or twenty days later. Under very favorable circumstances some of the varieties may be in condition to cut for forage within a month or six weeks from time of seeding.

VARIETIES.

The various foxtail millets commonly found on the market in the United States may be grouped under the following standard varieties:

(1) Common Millet (*Chætochloa italica*).
(2) German Millet (*Chætochloa italica*).
(3) Golden Wonder Millet (*Chætochloa italica*).
(4) Hungarian Millet (*Chætochloa italica* var. *germanica*).

[1] Food Grains of India, p. 55.

Several seed firms are also offering "Japanese millets;" but different sorts are offered under practically the same name, and sometimes the seed sent out is apparently only that of one of the common varieties, so that it is scarcely possible to make a suitable classification at the present time. The two Japanese sorts which have received widest distribution are mentioned in the pages following in connection with certain standard sorts with which they seem most closely associated.

Seed of the Corean millets has not yet been placed on the general market, but as some of the forms give promise of much value for cultivation in this country they are given a place in this discussion.

Common Millet. (Pl. XVI, fig. 1.)

Synonyms: Small Millet (Texas), Californian Millet (Salzer, Vilmorin), Dakota Millet (in part, of some seedsmen), Early Harvest Millet or Missouri Millet (at least in part), American Millet (in part).

Stems slender, several to many from the same root, usually simple or unbranched, about 3 feet in height; leaves of medium width (one-fourth to one-half inch), rather soft; heads nodding, small to medium-sized (usually 3 to 6 inches in length), slender, composed of small subdivisions, which are compactly arranged toward the tapering apex, but become loose below, giving the head an irregular appearance at the base; beards of medium length, often tinged with purple or brown at maturity; chaff pale or yellowish; "seed" large, yellow, oval.

Common Millet was one of the first varieties to be introduced and to come into general cultivation in the United States, but there seems to be no record of the exact date of its introduction. At the present time it is the most widely cultivated of the foxtail millets in this country. It is the hardiest of the commonly grown varieties, enduring drought the best and giving better returns on poor soils. By most feeders the hay from this variety is preferred to that from others on account of its finer quality, there being less loss in feeding it. Although German Millet will usually out-yield Common Millet under favorable conditions of soil and moisture, the latter will, one year with another, afford more forage of a finer quality in most localities in the Northern States.

Common Millet is one of the earliest of the foxtail millets, and is the most constant in its characters. Although this variety seems to have been long known in Europe, its cultivation is by no means so general there as in the United States; indeed, the variety seems to have reached its perfection in this country, and is being taken back to the old country under such names as "American Millet," "Californian Millet" (Moha Vert de Californie, Vilmorin), etc.

As a rule, seed sold in our markets under the name of Common Millet is true to name. Occasionally seed of this variety is sold as German Millet, and much of the "Dakota Millet" is nothing but Common Millet, although most of it is probably an early strain of German Millet, as stated elsewhere.

By some Early Harvest or Missouri Millet (Pl. XVI, fig. 2) is regarded as a distinct variety, mainly because of its earliness and short, compact heads. Professor Crozier inclines to this opinion and regards Hungarian as the probable ancestor, although the introducers claim the variety to be a cross between Golden Wonder and Broom-corn millets, which can scarcely be the case. Professor Chilcott regards it as only a variation of Common Millet. Plants from seed obtained under this name from the introducers in 1897 are almost exactly like Common Millet from the same source, and plainly belong to that variety.

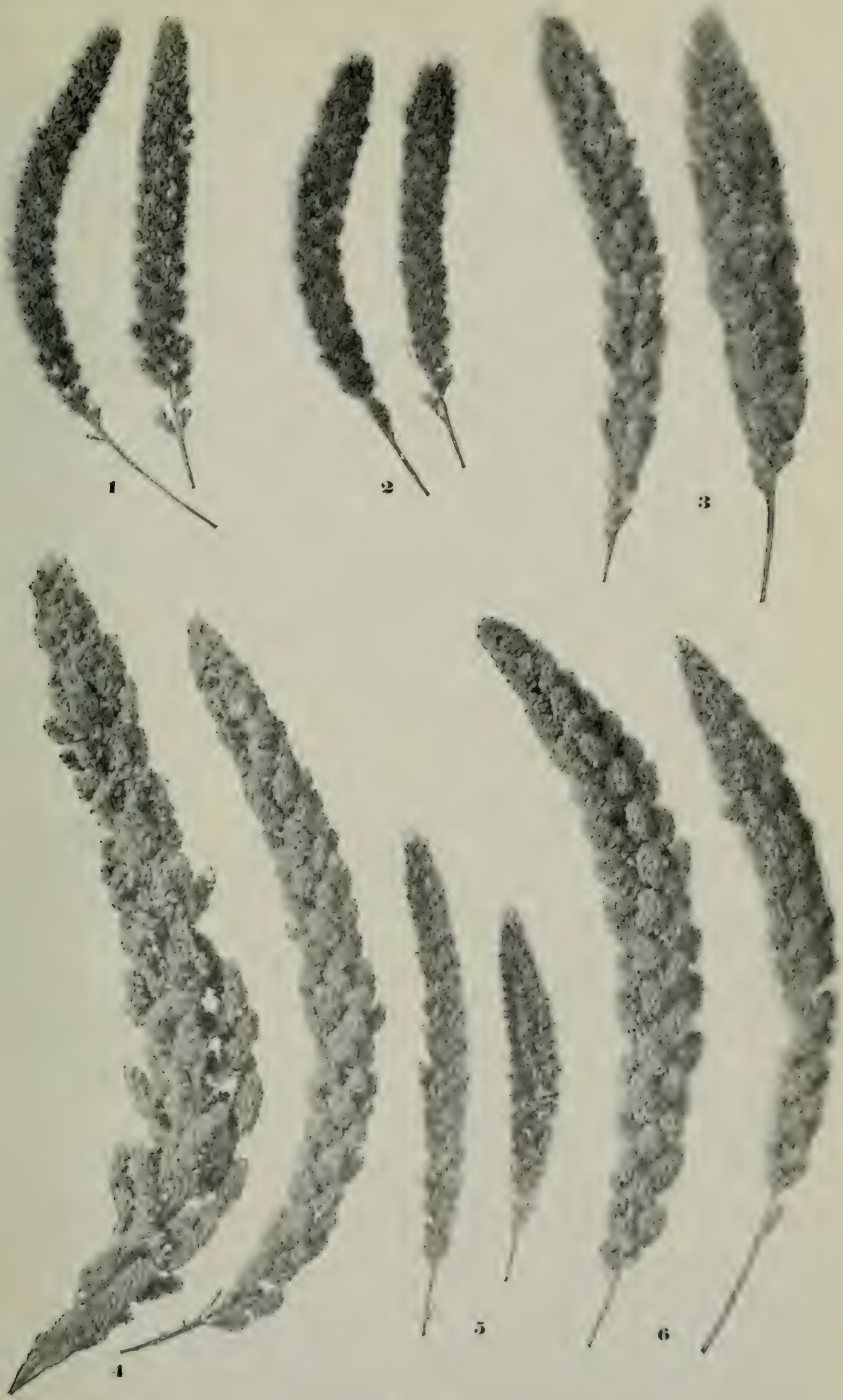
FIG. 83.—German Millet: *a* and *b*, two views of the spikelet with its cluster of three "beards;" *c*, "seed."

German Millet. (Pl. XVI, fig. 3, and Pl. XVII, fig. 3; and fig. 83.)

Synonyms: Southern Millet, American Millet (in part), Golden Millet, Mammoth Millet, Bengal Grass, Dakota Millet (for the most part).

Stems robust, usually single, unbranched, often reaching 4 or 5 feet in height; leaves broad, rather stiff and harsh; heads large (about 6 to 8 inches long by an inch or more wide), usually nodding, the subdivisions hardly as conspicuous as in Golden Wonder Millet and more closely crowded, rounded at the ends or tapering somewhat, particularly toward the base; beards conspicuous, usually with a purplish tinge; "seed" small, rounded, yellow or golden.

This variety has been in general cultivation in the South since the early seventies, but was introduced into the United States many years earlier. Professor Crozier regards the East Indies as the most probable source of its introduction into the United States, and remarks that "the name Bengal Grass, by which it was first known in this country, suggests such an origin." Flint, on the contrary, makes the statement that it was first brought to the United States from Europe. However this may be, it seems that the seed used in Tennessee, where this variety first came into real prominence, was brought from France in the early sixties, and since that time this has been the leading millet sown in the South.



MILLETS.

1, Common Millet; 2, Early Harvest Millet; 3, German Millet; 4, Golden Wonder Millet; 5, Hungarian Millet; 6, Japanese Foxtail Millet.

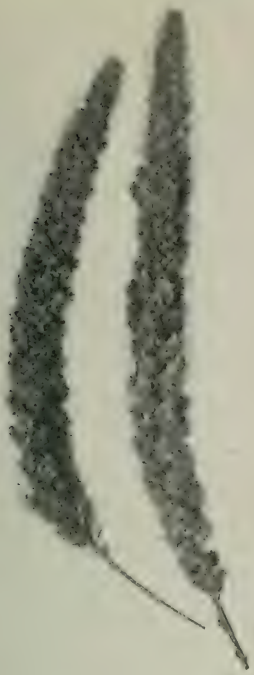


FIG. 1.—NEW SIBERIAN MILLET.

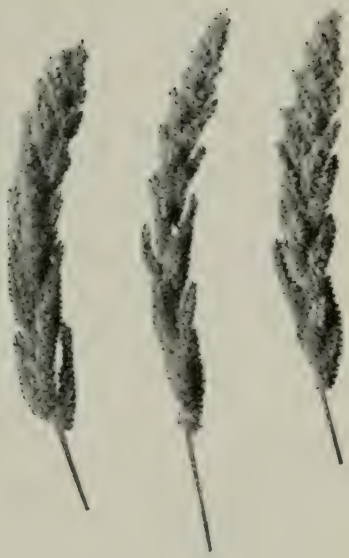


FIG. 2.—JAPANESE BARNYARD MILLET.

FIG. 3.—GERMAN MILLET GROWING IN THE GRASS GARDEN OF THE DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

German Millet makes a heavy yield of forage under favorable conditions, but does not stand drought as well as the smaller varieties, such as Common Millet and Hungarian. The hay is coarser and less highly valued than that from the smaller millets, but when the forage can be fed in the green state this will be found to be an excellent variety to grow, on account of the heavy yield.

German Millet is the latest of the varieties commonly grown here, and is exceedingly variable in its appearance and habit of growth. It is very seldom that one sees a field that is uniform in character. Many, perhaps most, of the heads may be typical of the variety, but usually there will be many others scarcely to be distinguished from Common Millet or other standard varieties. Typical German Millet brought from the South soon becomes very much modified when grown in the North. Thus, in a northern strain of German Millet sold as "Dakota Millet" or "Dakota-grown German Millet" the "seed" is larger and more oval in shape than in the typical southern form; the plants are earlier and hardier, and the yield of forage is usually better, at least in northern localities.

Some of the so-called Japanese millets now on the market belong to the German Millet type, as, for example, "Breck's Japanese Millet," which is scarcely distinguishable from the common southern German Millet.

Golden Wonder Millet. (Pl. XVI, fig. 4.)

Synonyms: Sometimes confused with the so-called Golden (German) millets.

Stems robust, usually single, unbranched, sometimes reaching 5 or 6 feet in height; leaves broad and coarse but of rather soft texture; heads large (6 to 14 inches long and one-half to 1½ inches wide), drooping, with large, closely flowered subdivisions, tapering at both ends, but more conspicuously above; beards inconspicuous; chaff yellowish, rarely purplish; "seed" small, yellowish, rounded. Plant pale green in color, the head becoming yellow or sometimes purplish as it approaches maturity.

According to Professor Crozier,[1] "this variety originated in Minnesota in 1884 and was first offered to the public four years later." Its introducers claimed it to be "an artificial cross produced by one of their growers between Hungarian grass and German Millet." It shows undoubted relationship to German Millet in its large head, coarse leaves, and robust, simple stems, but there is no evidence of Hungarian parentage in any of its prominent characters. While such a cross is no doubt possible, it would seem that Hungarian characters would enter more strongly into those of the offspring.

In yield of seed Golden Wonder leads all the other varieties of foxtail millets. The forage is coarse, like that from German Millet, and the yield heavy under favorable conditions, but Golden Wonder is even more susceptible to drought than German Millet, and is therefore less generally grown than any other of the well-established

[1] Bul. 117, Mich. Agr. Exp. Sta., p. 41 (1894).

varieties. At the present time it is most extensively cultivated in the States along the upper Mississippi and lower Missouri valleys. Much of the seed sold under this title is untrue to name. German Millet is perhaps oftener sold as Golden Wonder than any other variety.

There is an Italian variety of millet sold by Vilmorin, of Paris, which is very much like Golden Wonder in size, appearance, and time of ripening, and also a Japanese variety sold by Gregory & Son which is perhaps scarcely to be distinguished from it, although when grown under similar conditions the heads of the Japanese form are usually rather smaller and more symmetrical, more closely flowered, and the "seeds" are rounder and of a deeper yellow.

Hungarian Millet. (Pl. XVI, fig. 5.)

Synonyms: Hungarian Honey, Hungarian Grass, German Millet (in the Old World and in small part in this country).

Stems rather slender, clustered, branching, 3 to 4 feet high; leaves abundant, rather narrow, upright, typically bright green; heads erect or nodding slightly at maturity, small to medium sized (3 to 6 inches long), compactly flowered, tapering quite regularly at both ends; beards prominent, usually purplish or brownish; chaff tinged more or less with purple; "seed" large, oval, varying from yellowish to purple brown, and variously mottled. In the more typical plants the percentage of dark seed is high. There is an opinion prevailing among seedsmen and others that dark-colored seed is more likely to be better matured than the lighter colored and that it will develop into stronger plants.

Hungarian seems to have been first brought into the United States soon after the introduction of Common Millet. According to Professor Crozier,[1] the time of its (Hungarian) first introduction into the United States is unknown, but as early as 1830, and probably much earlier, it was in cultivation here. It did not gain much prominence as a forage crop, however, until about 1855–56, or a couple of years after the seed was introduced from France and distributed by the Patent Office. It was sent out under the name of "Moha de Hongrie," which had been given to it by the French, and our own common names of Hungarian Grass and Hungarian Millet probably came from that.

This millet first came into general cultivation in the Middle West. In Iowa it won favor at once, and as early as 1856 was a most valuable forage crop, particularly on recently broken land. At the present time it is more widely grown in the North than in the South. By most farmers it is placed next to Common Millet as a hay crop, the quality being regarded as better than German Millet.

Hungarian does not resist drought as well as Common Millet, but with favorable conditions of soil and moisture it will usually give a somewhat heavier yield. One reason why Hungarian has not found more favor with farmers generally is that it shows a greater tendency than other common varieties to persist in the soil when allowed to

[1] Bul. 117, Mich. Agr. Exp. Sta., p. 26 (1894).

mature seed before harvesting. In portions of the Missouri Valley region, as in eastern Nebraska and Iowa, this millet received a great deal of attention from farmers during the seventies, and fine crops of hay and seed were obtained, but its tendency to "volunteer" brought it into more or less disfavor, and it is now less commonly grown than either Common Millet or German Millet. It seldom becomes troublesome, however, except on light, sandy soils or land recently brought into cultivation. On moist, heavy soils or in regions where there is a great deal of wet weather during the fall and winter months it is not likely to make much volunteer growth.

A millet has been recently placed on the market by a Northwestern seed firm under the name of "New Siberian Millet" (Pl. XVII, fig. 1), which, although regarded by some as but a form of Hungarian, seems to possess characters which, if constant, will entitle it to rank as a distinct cultivated variety. At the South Dakota experiment station it was regarded as the best millet grown during the season of 1897. The plants are larger than Common Millet, with a habit of growth, beard, and chaff much like Hungarian; heads drooping, larger than in either Common Millet or Hungarian, tapering at both ends, with rather conspicuous, closely flowered subdivisions; "seed" of about the same size and shape as Common Millet and Hungarian, orange colored.

Japanese Foxtail Millets. (Pl. XVI, fig. 6.)

Under the name of "Japanese Millet" several different kinds of foxtail millets are being grown in various parts of the country. Some of these are apparently identical with varieties already grown in this country, and others are so closely allied that further study is necessary before they can be given a place either as distinct varieties or as forms of better known sorts. As illustrating this point, such cases may be cited as "Breck's Japanese Millet," mentioned under the discussion of German Millet, and Gregory's "Japanese Millet," noted under the head of Golden Wonder Millet. Several sorts imported from Japan by Professor Brooks seem more distinct as cultivated varieties, and will no doubt soon be given appropriate trade names.

As a rule these Japanese millets are comparatively large forms, giving heavy yields of seed or forage under favorable conditions, but with little ability to withstand drought, succumbing quicker than any of the commonly grown sorts. Some of them, however, have given good results in certain localities, and it is not unlikely that they may ultimately prove to be desirable for general cultivation, or valuable sorts may be developed from them by selection and crossing.

Corean Foxtail Millets.

Several millets recently introduced from Corea have been grown at some of the State experiment stations and on the experimental grounds of the Department of Agriculture at Washington, D. C. These varieties are seemingly quite different from those already

grown in this country, and deserve further experimentation. Two of the varieties seem particularly hardy in the District of Columbia. Both have clustered, branching stems. In one (fig. 84) the head is slender, nearly cylindrical, erect or somewhat nodding; beards very long and conspicuous; chaff green or purplish; "seed" green or purplish, with quite conspicuous transverse wrinkles, rather pointed at the ends, medium sized. In the other the head is larger, quite erect at first, but nodding slightly after a time, conspicuously bearded, tapering at each end, composed of narrow, rather conspicuous subdivisions; chaff green or purple; "seed" much as in the preceding, but less often dark colored, and possibly averaging narrower and slightly smaller.

FIG. 84.—Corean Foxtail Millet.

Both these varieties "volunteer" quite readily, the larger perhaps showing the greater tendency to do so.

BARNYARD MILLETS.

ORIGIN AND EXTENT OF CULTIVATION.

The term "Barnyard Millet" was first applied to the cultivated varieties of the cosmopolitan barnyard grass (*Panicum crus-galli*) by Prof. W. P. Brooks in 1896.[1] In the present paper the application has been extended so as to include not only all the varieties derived from *Panicum crus-galli* but also those belonging to *Panicum colonum*, *P. frumentaceum*, and other species of Panicum with the same type of inflorescence and habit of growth.

The true barnyard grass is very widely distributed and varies exceedingly in its botanical characters. It occurs throughout the United States in fields and waste places, usually as a coarse-growing plant, with broad leaves and widely spreading stems, producing large irregular "heads" of flowers and seeds. There is much variation

[1] Eighth Ann. Rep. Mass. (Hatch) Agr. Exp. Sta., p. 31.

in the habit of growth, however, some of the forms having upright stems which branch but little. There is also much variation in the color of the "heads" and in the bearded character of the chaff (glumes), the color varying from green to purple-brown and the glumes strongly bearded or with the beards nearly or quite wanting (var. *muticum*).

In many parts of the Old World barnyard grass is not only grown for forage but also as food for man. Thus, in India, under the name of "bharti," it is grown as a forage crop and is also often harvested as a grain, the seed being used as food by the poorer classes in the same way as that of "Shama" Millet (*Panicum colonum*) and of "Sanwa" Millet (*P. frumentaceum*), both of which are extensively grown for this purpose in parts of Asia. Speaking of the cultivation of *Panicum frumentaceum* in Japan, where it is known as "Hie," Professor Georgeson says "this is a very common crop in all parts of Japan, especially in the hilly districts, where there is no suitable rice land, or where water is not available for irrigation. It is grown entirely for its seed, which when thrashed out and cleaned is ground and used for food, being eaten mostly as a porridge."[1]

VARIETIES.

True Barnyard Millets. (Pl. XVII, fig. 2; and fig. 85.)

These are undoubtedly the most valuable varieties of this group for cultivation in this country. The varieties that give best results under cultivation are those with upright habit of growth, a close "head," and a tendency to produce a large quantity of leaves. Of the varieties at present grown in the United States, one of the recently imported Japanese sorts is probably the most promising. It is a coarse-growing form with a heavy leafage and compact beardless heads (Pl. XVII, fig. 2). This variety has been thoroughly tested by Professor Brooks at the Massachusetts experiment station, and is highly recommended by him as a forage crop. It matures a crop of hay in about two and one-half months.

There are several valuable varieties in various parts of our own country, the most notable being those found in prairie regions of the West and Northwest and the "Ankee" grass (fig. 85) of the Southwest. In the artesian-well region of the Dakotas there are wild forms of barnyard grass that seem particularly well adapted to the conditions that prevail in the vicinity of the flowing wells, especially where the soil has been watered too freely. In many places considerable areas about the ponds and along the ditches are covered each season with a growth from 3 to 6 feet high. Similar areas may be seen elsewhere in the West and Northwest in irrigated regions, and they are yearly becoming more common. In the Southwestern part of the United

[1] Bul. 117, Mich. Agr. Exp. Sta., p. 47.

States there is a large, thrifty form of this grass, which makes a very fine growth in lowlands and swampy places during the wet season. It is known to the Mohave Indians as "Ankee," and its seed is said to be extensively used by them as food.

On the experimental grounds of the Department of Agriculture at Washington, D. C., "Ankee" makes a magnificent growth, reaching a height of 7 feet or more and maintaining a very characteristic upright habit of growth. It has also made luxuriant growth on the grounds of the station at Knoxville, Tenn., and at the Cornell, New York, Massachusetts (Hatch), and Michigan stations. It is one of the most promising of the inland forms of the species, and should be given an extended trial, particularly in sections where high temperatures prevail.

FIG. 85.—"Ankee" Millet: *a* and *b*, two views of the spikelet; *c* and *d*, two views of the "seed."

Professor Brooks, of the Massachusetts station, considers "Ankee" inferior to Japanese Barnyard Millet for a fodder crop for that locality on account of its lateness and the coarseness of the forage. "Ankee" grass is considerably later than the common forms of the species. Professor Brooks reported that plants from seed sown on May 4 failed to reach maturity, and at the Michigan station the same was found to be true of plants sown on May 20. This variety requires four months or more to mature seed.

In addition to the above-mentioned inland forms, there are coastal forms growing in brackish marshes and meadows along the seacoast, possessing much value for forage. One of these is quite different in appearance from all other forms of barnyard grass, and is probably specifically distinct. The lower leaf sheaths are very hairy and the "heads" are conspicuously bearded. The plants attain a height of from 3 to 6 feet. This grass may well be given a trial on saline soil in inland regions.

Barnyard Millet does not endure drought well, being more susceptible than the common sorts, and it can not be profitably grown on

poor soils. On the rich prairies of the West and Northwest heavy yields may be obtained where the supply of moisture is sufficient, as when under irrigation. It seems to thrive better on the alkali soil so common in some parts of the West than either Common or German Millet. In some parts of the South, particularly in the lower Mississippi Valley, it makes a fine yield of hay, sometimes affording two cuttings a season, and, although an annual, it continues to occupy the land year after year through the great readiness with which it reseeds itself. In these localities it furnishes a large proportion of the volunteer hay crop and is also used for soiling.

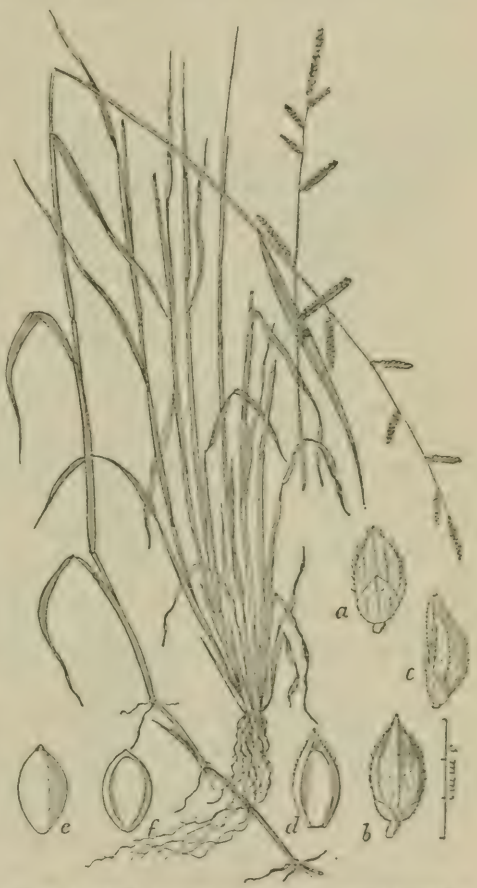


FIG. 86.—Shama Millet: *a, b, c, d*, different views of the spikelet and glumes, or chaff; *e, f*, two views of the "seed."

Under average conditions of moisture and fertility of the soil, Barnyard Millet is one of the most productive of the annual hay grasses. At the Massachusetts (Hatch) experiment station Professor Brooks has obtained a yield of 12 to 18 tons of fresh or 4 to 6 tons of cured forage per acre. He finds that under the conditions prevailing for the past few years this millet has outyielded all others grown on the station grounds. He suggests that by seeding early in May and cutting as soon as the plants come into bloom a second crop may be obtained and the yield of forage per acre be materially increased. The yield of seed from this millet compares favorably with that of other varieties, usually ranging from 40 to 60 bushels per acre. The seed is not as heavy as that of the broomcorn and foxtail millets, weighing but 35 pounds per bushel.

Shama Millet or Jungle Rice. (Fig. 86.)

Shama Millet (*Panicum colonum*) is a grass with much the appearance of Barnyard Millet, but is smaller in every way, with a simpler inflorescence or "head." It is common in the tropical and subtropical

regions of the Old World, where it is a native, and is widely introduced into the other warm regions of the globe. In the United States it occurs chiefly in waste places along roadsides and ditches, mostly in the South. It is quite abundant in parts of the Southwest and also in Mexico.

In India Shama Millet is one of the most valuable forage crops, and the seeds are used for human food. According to Church[1] "this millet is a poor food; it is used in some places by a considerable number of laborers as a usual article of diet." Duthie[2] says a food preparation called "khir" is made by boiling the grain in milk, and is eaten by the Hindoos on fast days. He also mentions another method of preparing the seed in which it is ground and made into a paste and eaten with milk. The seeds of this grass are also said to be used by the Indians in Mexico and the Southwestern United States. In many of the tropical regions it is regarded as a valuable forage plant, and is often extensively grown for this purpose. Both Duthie and Church give it a prominent place among the fodder-producing plants of India, in the northern part of which it is in common use.

In the Southeastern United States this grass thrives on rich, moist soil and, in places, affords considerable forage of excellent quality, but little effort has been made to cultivate it. Several attempts to grow it in the North have met with poor success. At the Cornell experiment station it made a fair showing, "resembling poor specimens of Barnyard Millet, reaching about a foot in height."

Sanwa Millet.

Sanwa Millet (*Panicum frumentaceum*) is very closely allied to the true barnyard grass, and, like it, is a coarse-growing plant, under favorable conditions yielding a large amount of herbage. Although extensively grown in other parts of the world, notably in southern and eastern Asia, but little attention has been given to it in the United States, and the few experiments made with it have not given encouraging results, except, perhaps, in the South. Professor Church,[3] in speaking of the cultivation and value of this grass in India, says "Sanwa is the quickest growing of all the millets; the harvest may take place within six weeks of the sowing. When it is sown in April or May, it is cut in June and July; the June sowing is ready in August," and, further, "Sanwa does not take a high place among the millets. It is either boiled as rice or boiled with milk and eaten with sugar, or it is parched." The stems and leaves are used for forage. In Japan the grass is said to make an excellent growth and afford large yields, though it is not grown for forage to any extent.

[1] Food Grains of India, p. 50.
[2] Dict. Econ. Prod. Ind., 6(I)7.
[3] Food Grains of India, p. 49.

The various attempts to grow this millet in the United States have met with only limited success. At the Louisiana experiment station it is reported as doing "excellently," but its cultivation does not seem to have been undertaken to any great extent there. At the United States grass station, Knoxville, Tenn., the millet has made a fairly good showing. Plants from seed sown on May 7 reached a height of 3 feet by the middle of July and matured seed by August 23. The yield and quality of forage was good. It proved a failure at the Kansas experiment station owing to the hot, dry summers. Further experimentation may prove it to be of some value for some sections of the South.

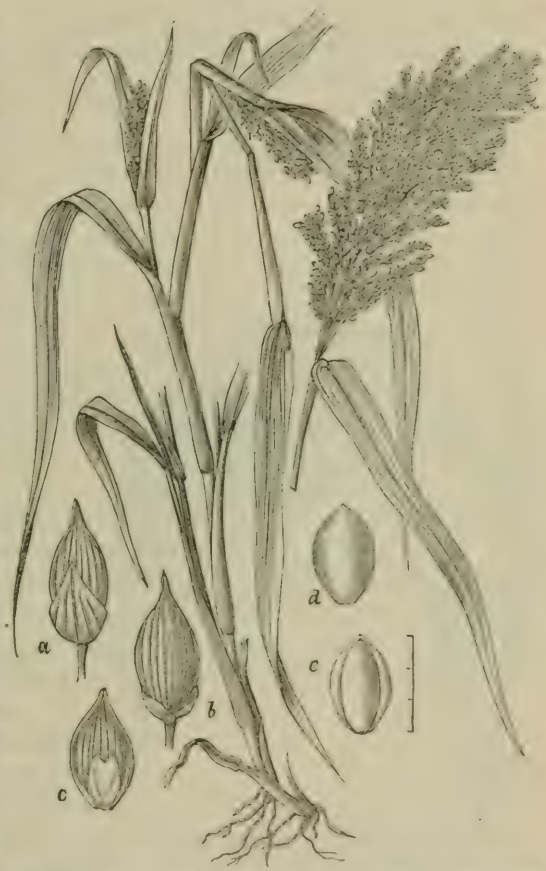


FIG. 87.—Broom-corn Millet: *a*, *b*, and *c*, views of the spikelet and glumes, or chaff; *d* and *e*, two views of the "seed."

BROOM-CORN MILLETS.

ORIGIN AND EXTENT OF CULTIVATION.

In the United States the term "Broom-corn Millet" is at the present time generally applied to this Old-World grass (*Panicum miliaceum*, fig. 87). It is the "common millet" of Europe, where it has been cultivated for centuries. A "millet," regarded by most authorities as this species, is mentioned by nearly all the early writers on cultivated plants, such, for example, as Theophrastus, Hippocrates, and others, and seems to have been extensively used as a grain in remote times. According to Heer it was much used by the Swiss lake dwellers of the stone age, and De Candolle, on the authority of Regazzoni, says it has also been found in the remains of the lake dwellings of the Varese in Italy.

The nativity of this millet is very uncertain. Although it grows spontaneously throughout southern Europe and many parts of Asia and Africa, there are apparently no really authentic cases of its having been found in a wild state. All the early records speak of it as

being cultivated. Some writers, notably Linnæus, regard India as the original home of this millet; but De Candolle does not consider the records as at all conclusive and thinks that "its Egypto-Arabian origin is very probable."

Church, in his "Food grains of India," says "it was early introduced and is largely cultivated in many parts of India."

It is also extensively grown in China and Japan as well as throughout southern Europe and elsewhere in the Mediterranean regions and north to central Europe. Although introduced into the United States many years ago, it has never been extensively grown over any large extent of territory, and at the present time is much less generally grown than the foxtail millets. It has not met with favor in the South, but in the Northwest is valued highly because of its ability to mature a crop of seed in the short dry season so often prevailing in that region, thus serving to some extent as a substitute for corn.

FIG. 88.—Japanese Broom-corn Millet.

VARIETIES.

The different cultivated varieties of Broom-corn Millet vary more or less in habit of growth and character of the panicle or "head," but the chief distinction lies in the color assumed by the mature seed. Three rather distinct types may be recognized, white, yellow, and red. These may intergrade more or less. The red sometimes becomes a very dark brown or almost black, and the "Millet noir ou gris" (black or gray millet) sold by Vilmorin, of Paris, France, gets its dark-gray appearance through the seed being marked with dark stripes on a lighter ground color.

The general color of the growing plant varies considerably in the different varieties. Plants from the yellow-seeded varieties are usually light green in color, while those from the red-seeded sorts are more often tinged with red, usually in proportion as the seed is light or dark red. Thus, plants of a very dark-red-seeded Japanese variety grown the past season maintained a decided reddish-purple tinge throughout the entire period of growth, the color being most pronounced in the young plants, fading out as they became older, and

deepening again in the panicle as the plants approached maturity. However, some of the white-seeded varieties may often become more or less tinged, as in the case of the variety sold as White French Millet. By far the greater number of the varieties offered in the market by seedsmen in this country and the varieties most widely grown for forage belong to the group with yellowish seed. Such varieties are the Manitoba, Californian Beauty, French, Turkish, and Broom-corn, or Hog millets. There seems to be little if any difference between these so-called varieties, either in appearance or value. Of the white-seeded sorts the most frequently grown are "White French," "Chinese," or "Chinese White," and "Japanese White." The white-seeded varieties seem to be more robust growers, as a usual thing, than either the yellow or the red-seeded ones, the most productive being the Japanese White. There are but two of the darker or red-seeded varieties that have come into much prominence in this country. They are the "Red French" and "Japanese Red" (fig. 88).

The large coarse-growing varieties are valuable for soiling and may be used advantageously in the silo where corn and the heavier-yielding silage crops can not be successfully grown or when for any reason these crops are destroyed. The forage does not appear to have the laxative and diuretic action upon the animals eating it produced by the foxtail millets, and there are no harsh, irritating beards. However, objections have been made to it on account of the abundant growth of stiff hairs on the leaves and stems. The yield of forage is, on the average, less than may be obtained from the other millets, but on account of the relatively short season required for its development Broom-corn Millet may often produce a crop when the others would not. The yield of seed is large in proportion to the size of the plant, 50 to 60 bushels per acre being frequently reported from the Northwest.

CULTURE OF MILLETS.

PREPARATION OF THE SOIL.

For this crop a fertile, mellow soil is preferable. Loams with but little clay and not too much sand give the best results. Heavy clay soils require considerable working in order to get them into proper condition. For spring sowing the land may be plowed in the same manner and at about the same time, or perhaps a little later, as for a crop of corn.

Millets draw their nourishment largely from the surface soil; hence, the supply of plant food should be concentrated in the upper layers of the soil and should be in forms readily available to the plant. If the surface soil does not already contain sufficient available plant food, this should be supplied in the form of barnyard manure or commercial fertilizers; those containing large percentages of nitrogen, phosphoric acid, and potash in readily available forms are most

valuable. Among such are muriate of potash, ground bone, cottonseed meal, and tankage. The barnyard manure may be scattered on the land and plowed under, but the others had best be sown on the land after it has been plowed and worked into the soil with a harrow. The amount and the exact character of the fertilizer required will, of course, depend upon the kind and condition of the soil. In most instances a mixture of muriate of potash, nitrate of soda, and ground bone or superphosphate will be found beneficial, and on some soils lime may be used to advantage. A light dressing of barnyard manure supplemented by a light application of some such mixture as the above will usually give good results in the East, while on the rich prairies of the West little, if any, fertilizing will be found necessary. In case the land is cloddy, as frequently happens when much clay is present, the harrow or roller should be used to reduce the surface to a smooth condition. This is necessary, because it is of prime importance that the seed bed should be in condition to insure prompt germination and an even development of the grass; it also facilitates the harvesting operations.

In the West it is the common practice to delay the preparation of the land for millet until near the close of corn planting. This allows the first growth of weeds to get well started, and the thorough plowing required in preparing the land leaves it so well cleaned that the millet easily keeps ahead of the weeds. If the land is very foul, the crop may be cut early, before the second growth of weeds goes to seed, and the land plowed again. Used in this way, millet is one of the best crops that can be grown for the purpose of ridding the land of weeds.

When millet is sown late in the season as a catch crop or as a second crop after rye or some other early maturing crop has been harvested, it is not always expedient to go to so much trouble in preparing the land. The seed may be sown on the freshly plowed stubble; or, if the land is quite loose and mellow, as is the case in parts of the West, the stubble may be "disked" or gone over with cultivator to kill the weeds and the seed sown and harrowed in. This "disking" or cultivating is the most common practice when millet is used as a catch crop after the main crop of corn or small grain has been "hailed" out, as is not infrequently the case in the middle West. Another quite common practice is to sow on newly broken ground, either without any other preparation than simply breaking up the sod, or, as is more often the case, the "breaking" is torn up with a "disk" or heavy iron-toothed harrow.

SEEDING.

When millet is handled as a primary crop, seeding is generally done during the latter part of May or early in June in the North, and of course correspondingly earlier in the South; or, if the moisture

conditions are favorable, it may be delayed as late as August 1 in the latter region, the general rule being to sow millet as soon as the corn is planted. The foxtail and broom-corn millets and some of the barnyard millets are quite sensitive to cold, and hence seeding should be postponed until the ground has become thoroughly warm and danger from protracted cold is past. It should, however, take place before the dry period of the summer begins. A succession of crops for soiling or silage can easily be obtained by sowing at periods of two or three weeks from May 10 to late in July.

The seed may be sown broadcast or with a grain drill. Ordinarily, there is but little if any choice between the two methods when the crop is to be cut for hay, except that the drilled seed gives an evener stand and a little less seed is required. For a crop of grain or for soiling or ensilage drilling will generally give better results. On some soils it is a good plan, when growing for seed, to plant in drills far enough apart to allow cultivation to prevent packing of the soil and loss of moisture, particularly when barnyard millet is planted.

The common practice is to sow from one-half to three-fourths of a bushel of seed of foxtail or broom-corn millets, or one-fourth to one-half of a bushel of barnyard millet per acre for a crop of hay and somewhat less for a crop of grain. Rich, well-prepared land will require less seed than that which is poor and thin; and it is not necessary to use quite so much seed when the crop is to be ensiled or fed in the fresh state as when it is intended for hay. Thin seeding is likely to result in coarse-stalked plants, which are not desirable for hay. Some of the varieties may require a smaller quantity of seed than others on account of the greater tendency of the plants to "stool;" but as the amount of "stooling" depends so much upon soil and climatic conditions, it is not usually safe to allow very much for it.

HARVESTING.

Cutting foxtail millets for hay should never be delayed until the seed has begun to ripen, particularly if it is to be fed to horses. On the other hand, it is best not to cut too early, as the hay is liable to have a more or less laxative effect upon the animals eating it. However, it is better cut early than late. The hay may be safely cut any time during the period from complete "heading out" to late bloom. Professor Chilcott, of the South Dakota experiment station, who has had much experience in growing and feeding this crop, says:[1] "The best time to cut millet for hay is when a majority of the heads have distinctly appeared." The tough, fibrous nature of the stems and the stiff beards on the heads of millet that has been allowed to approach too close to maturity detract much from the palatability of the hay, and, although something is gained from the seeds in the way of

[1] Bul. 51, S. Dak. Agr. Exp. Sta., p. 18 (1897).

nutriment, enough is lost in palatability and increased fiber to more than make up for it. Moreover, the earlier cut hay is a much safer food for all kinds of stock. On account of the succulency of the stems and leaves the curing takes place rather slowly, and the seeds may make a great deal of development after the plants are cut; hence, if cutting is delayed until after the seeds are well formed, they will often develop sufficiently during the process of curing to germinate. Cutting for soiling or for the silo can be done a little later than for hay, but should take place before the seed has begun to ripen.

For soiling or for early hay, barnyard millets may be cut as soon as the grass "heads out," or even before. The best quality of forage will be obtained by cutting during the blooming period, and when the crop is to be cured for hay this is the best time for harvesting. For silage the crop may be cut any time between "heading out" and the formation of the seed, preferably when most of the plants are in late bloom. The quality of the forage seems to deteriorate more rapidly with age than in the foxtail millets; hence, it is more imperative that cutting should be done while the plants are at their best.

On account of the greater succulency of the stems, barnyard millet is more difficult to cure than either the broom-corn or the foxtail millets, but when properly cured the quality of the hay is better than that of the other millets, and in some localities the yield is said to be greater.

One of the best methods of preserving this crop is by the use of the silo. Those who have tried this method have obtained excellent results. A fine quality of ensilage may be made by using barnyard millet and a leguminous crop like soy beans or clover.

The broom-corn millets are not difficult to cure, and the same methods may be employed as for any coarse grass. What has been said regarding the time for cutting barnyard millet for various purposes applies as well to the millets of this group. The forage deteriorates rapidly upon reaching maturity, and hence cutting should not be delayed too long.

The common practice is to use a horse mower or a scythe when cutting for hay or soiling. In localities where curing takes place rapidly and there is little or no rain during haying time, the self-rake and the self-binder have been used with good results. The bunches left by the self-rake are allowed to lie without further attention until cured; or possibly, in the case of a heavy yield, they may be turned over once or twice to facilitate drying. When the self-binder is used the bundles are loosely made, and are set up "two and two" in long shocks extending north and south, so that the bundles may get the full benefit of the sunshine. It is not often that this method can be employed in cutting for hay, but when practicable it saves much labor and leaves the hay in condition to be stored easily and well. Another

way of using the self-binder is to allow the millet to be dropped unbound to the ground, the bunches then being handled as when the self-rake is used.

One of the best methods of curing the hay is to allow the grass to lie in the swath until partially dry, then gather into cocks and let stand until thoroughly cured, after the manner of curing alfalfa and clover. Hay cured in this way is of better quality than that allowed to lie in the swath exposed to the sun until dry.

Millets may be harvested for the seed in the same manner as small grain of any sort. One of the best ways is to cut with a self-binder, place the bundles "two and two" in long, narrow shocks, with the long diameter north and south, let stand until dry, and thrash from the shocks. This method is quite generally practiced where the millets are most extensively grown for seed. It is possible that seed of a better quality may be obtained by stacking the millet before thrashing; but whether or not the gain would be sufficient to pay for the expense of stacking is doubtful. The crop should not be allowed to become too ripe before cutting, for the seed falls out badly during the process of curing and thrashing. Probably the best time for harvesting for a crop of seed is when the seed is in a "stiff dough."

USES AND FEEDING VALUE.

Millet is fed principally as a hay and soiling crop. As will be seen from the chemical analyses,[1] the forage ranks well with that of other grasses in the nutritive content, and its palatability is about that of the average for the coarser sorts. For digestibility, millet forage compares favorably with that from other coarse grasses.

Already widely grown as a hay crop, millets deserve more general use for soiling. They are particularly valuable for feeding to dairy cattle, young stock, and sheep. There are many sections of the country where this crop can be made to supplement the pastures in such a way as to allow a material increase in the number of stock that can be kept on the farm.

The use of millet as an element in annual pastures may well receive greater attention from farmers in sections where there is a general shortage of pasturage. Such varieties as Hungarian and Common Millet, which "sprout from the root" well, are best to sow for pasturage. Some of the Corean varieties may prove valuable for this purpose. There are few of the annual grasses better adapted for use in pastures. Sheep and calves may be pastured on this crop with excellent results. It would be well to mix some other crop, like field peas, with the millet, or to allow the animals to run on a field of clover, rape, or some such crop for a portion of the time.

On account of the heavy yield of forage and the good quality of

[1] See Appendix.

the product, millets are excellent grasses for use in the silo. Frequently a good crop of millet can be raised under conditions which would not admit of growing corn for ensiling, and in such instances it becomes of especial value.

The seed of the foxtail millets is widely used as food for fowls and birds, but is seldom fed to stock. It has, however, been used in feeding young stock, such as calves, with a fair degree of success. It should never be fed without first being ground or crushed, as otherwise only a portion is masticated and digested, and the rest is lost. The seed is an excellent food for laying hens.

The seed of Broom-corn Millet has won greater favor in this country as a food for stock than that of either the foxtail or barnyard millets. It has been fed to swine and young cattle with very satisfactory results, and is regarded as an excellent substitute for corn for use in preparing animals for the market. The name "Hog Millet," so commonly applied in the West and Northwest, was given because of the fact that the seed was thought to be so well adapted for feeding hogs. As with other millets, the seed makes a good poultry food, and it forms a large part of the various birdseed mixtures offered in the market. The broom-corn millets are better adapted for human food than any other millets grown in this country.

COMPOSITION AND DIGESTIBILITY.

Compared with timothy, which is usually taken as the standard for grasses, the foxtail millets are somewhat deficient in the two most important constituents, fat and crude protein, but they contain about the same percentage of crude cellulose and a slightly higher percentage of extract matter. The percentages of digestibility are somewhat higher, however, in the millets, so that the actual feeding value differs but little, although the timothy is perhaps more palatable. The seed contains almost as much fat and extract matter as shelled corn, a little more protein, and about four times as much crude cellulose.

Hungarian hay is more digestible than corn stover, but rather less so than good fodder. Sixty-five per cent of the total dry matter is digestible, and of the fresh material 63 per cent. As the hay ordinarily contains from 7 to 15 per cent of water, leaving a total amount of from 85 to 93 per cent of dry matter, or 85 to 93 pounds in each 100 pounds of hay, it will be seen that the animal digests from 55¼ to 60½ pounds of the total dry matter in each 100 pounds of hay.

Barnyard-millet hay contains rather more fat and crude protein and less extract matter than the foxtail millets, and about the same amount of crude cellulose. It also has a somewhat higher percentage of digestibility, bearing out the opinions of Professor Brooks, Dr. Lindsey, and others, that it yields, all things considered, a forage superior to that of the foxtail and broom-corn millets.

The Broom-corn Millet agrees fairly well in composition with the barnyard and foxtail millets, the most important differences being in the composition of the seed and silage. The silage is relatively rich in fat, while the seed is richer in both fat and protein than most of the foxtail millets, and richer in protein but poorer in fat than the barnyard millet. Data as to its digestibility are not available, but the chemical analyses indicate a relatively high food value for properly preserved forage, and this agrees with the general experience of stock feeders. In palatability it is considered by some to be rather behind both foxtail and barnyard millets, but our experience indicates that it is at least fully equal to the former in this respect, though somewhat behind the latter.

FERTILIZING VALUE OF MILLETS.

While this crop is of little importance as a fertilizer, when compared with the clovers, cowpeas, and other leguminous crops, a knowledge of the kind and quantity of fertilizing substances contained in the millet plant will give an idea as to the drain on the elements of plant food in the soil by this crop. There are many sections of the country in which the soil is very poorly supplied with vegetable mold, and the turning under of any leafy growth will prove beneficial. If the better leguminous crops are not at hand or can not be grown, millet or any other plant that will grow on the soil and produce a heavy foliage may well be used for the purpose.

The following table shows the amount, in pounds, of the various important fertilizing ingredients found in the millets, and also the comparative value of a ton of the hay, straw, seed, or fresh material at an average market price for these ingredients:

Fertilizing value of the millets.[1]

Variety.	Nitrogen.	Phosphoric acid.	Potash.	Value.
	Pounds.	*Pounds.*	*Pounds.*	*Dollars.*
Japanese Foxtail Millet (fresh)	12.2	3.8	8.2	2.05
Barnyard Millet (fresh)	9.2	2.2	9.8	1.69
Hungarian Millet (fresh)	7.8	3.2	10.8	1.62
Millet ensilage (var. unknown)	5.2	2.8	12.4	1.37
Millet hay (var unknown)	24.4	9.2	32.2	4.95
Millet straw	13.6	3.6	31.6	3.52
Japanese Millet seed	34.6	13.8	7.6	5.15
Common Millet seed	40.2	19.2	9	6.02

[1] Adapted from Ninth An. Rep. Mass. (Hatch) Agr. Exp. Sta.

REPUTED INJURIOUSNESS OF MILLET FORAGE.

In some sections of the country the foxtail millets have gained the reputation of being injurious to certain kinds of stock, and are therefore regarded with suspicion by many farmers and stockmen. Like

many other forage plants, these millets become very harsh and woody with age, and are then difficult of thorough mastication and hard to digest. Then, too, at this stage of growth the beards are stiff and harsh, and are not only difficult to digest, but produce more or less irritation in the digestive tract of the animal, and sometimes unite with other indigestible substances, forming compact balls in the stomach, ultimately causing death. This difficulty may be avoided by cutting the hay in proper season, as recommended elsewhere. No more trouble seems to have been experienced in feeding the millets in the fresh state than with any other succulent forage. Most of the injury has arisen from feeding the hay in large quantities with little or no other grain or forage and for extended periods. At the North Dakota experiment station an extended experiment was recently conducted to determine what, if any, deleterious effects would result to horses from a continued diet in which millet hay replaced that ordinarily used in the ration. The animals were grained, watered, and otherwise cared for as usual. At the end of the experiment, Dr. Hinebauch, the veterinarian of the station, concluded that "millet when used alone as a coarse food is injurious to horses—first, in producing an increased action of the kidneys; second, in causing lameness and swelling of the joints; third, in producing infusion of blood into the joints; fourth, in destroying the texture of the bone, rendering it softer and less tenacious, so that traction causes the ligaments and muscles to be torn loose." These results seem to show conclusively that under certain conditions millet hay becomes injurious to horses at least, if not to other stock also. This agrees, too, with the general experience of farmers and stockmen, that a long-continued diet of millet hay, particularly hay in poor condition, tends to weaken horses and unfit them for doing hard work. Again, both immature and overripe foxtail millet is said to produce abortion in brood mares and cows, but this has not been established experimentally. Millet in any stage of growth acts as a laxative and diuretic. At times the action is more pronounced than at others; thus, hay cut while the plants are quite young seems to be most strongly laxative, while overripe hay is most strongly diuretic. However, if the hay is cut at the right stage of growth and properly cured, the action in either case will not be sufficient to lead to serious results if other hay or coarse forage is fed along with the millet. One feed of millet hay per day for work horses and one or two for other stock is sufficient, and when fed in this manner the millet acts as a stimulant and alterative, and tends to produce and maintain a healthy condition of the animals.

STEEL-TRACK WAGON ROADS.

By Martin Dodge,
Director of the Office of Road Inquiry.

INTRODUCTION.

The steel-track wagon road is still in the experimental stage. Much has been written and proposed in a theoretical way during the last six years or more, but nothing has been done by way of actual tests till very lately. In the Engineering News for May 7, 1896, the editor comments as follows:

> A good deal has been published in the newspaper press and elsewhere during the past few years concerning the scheme of laying steel rails upon ordinary highways as a means of making a better or cheaper road than is furnished by the ordinary macadam construction. Just where the scheme originated is doubtful. The idea has probably occurred to hundreds of men, merely as an idea; but the first to publicly advocate it, so far as we are aware, was the State highway commissioner of Ohio, Hon. Martin Dodge, in his report for 1893.

As early as 1891 the writer had published, unofficially, a plan for laying steel tracks for use on country roads.

The three principal advantages to be sought in the new construction are cheapness, durability, and reduction of power required to move a vehicle.

As to the last two elements, all are agreed that the steel track solves the problem. In reference to the cost and manner of construction there is great diversity of opinion. Many of the plans first submitted and published provided for a substructure of wood, in some form, to support the steel tracks. In 1894 Mr. F. Melber, of Pittsburg, Pa., and Mr. W. I. Ludlow, of Cleveland, Ohio, both submitted plans to the National Road Conference, which met at Asbury Park July 6 of that year. These plans, afterwards published by the Department of Agriculture in Bulletin No. 10 of the Office of Road Inquiry, show wooden substructures of plank, not only to support the steel track, but also to form the treadway for horses or other animals. This wooden substructure adds to the cost of construction without adding to the real value or utility of the road, and can therefore be omitted with advantage, provided we can so adapt the steel track to the roadbed that it will combine with the materials composing the latter in such a way as to form a substantial and integral part of it. This result is effected in the manner indicated by the cross section in fig. 89. Mr. Abel Bliss, of New Lenox, Ill., and Mr. Melber have each put down, as private experimenters, a short section of 25 or 30 feet to represent

their ideas of the best form of construction. These sections are, however, too short to furnish any full and sufficient tests as to the value and utility of such roads as we have under consideration.

It was not until the fall of 1897 that any public authority was given by any public officer or officers to undertake to test the value or utility of the steel-track wagon road. At that time the county commissioners of Cuyahoga County, Ohio, authorized the writer, by contract, to lay 500 feet of steel track on the Brecksville road, immediately south of the city limits of Cleveland. The form chosen for this track was one designed and recommended by Mr. Melber, but without the wooden substructure provided for by him in 1894. This track was not completed till June, 1898, and has been somewhat disturbed and obstructed since by reason of grading done adjacent to the track by the contractor, who was charged with carrying out more extensive improvements on the Brecksville road. This track, when completed,

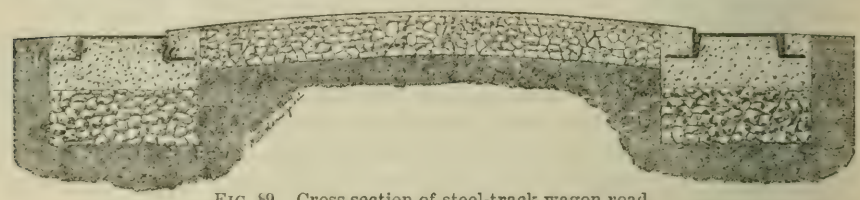
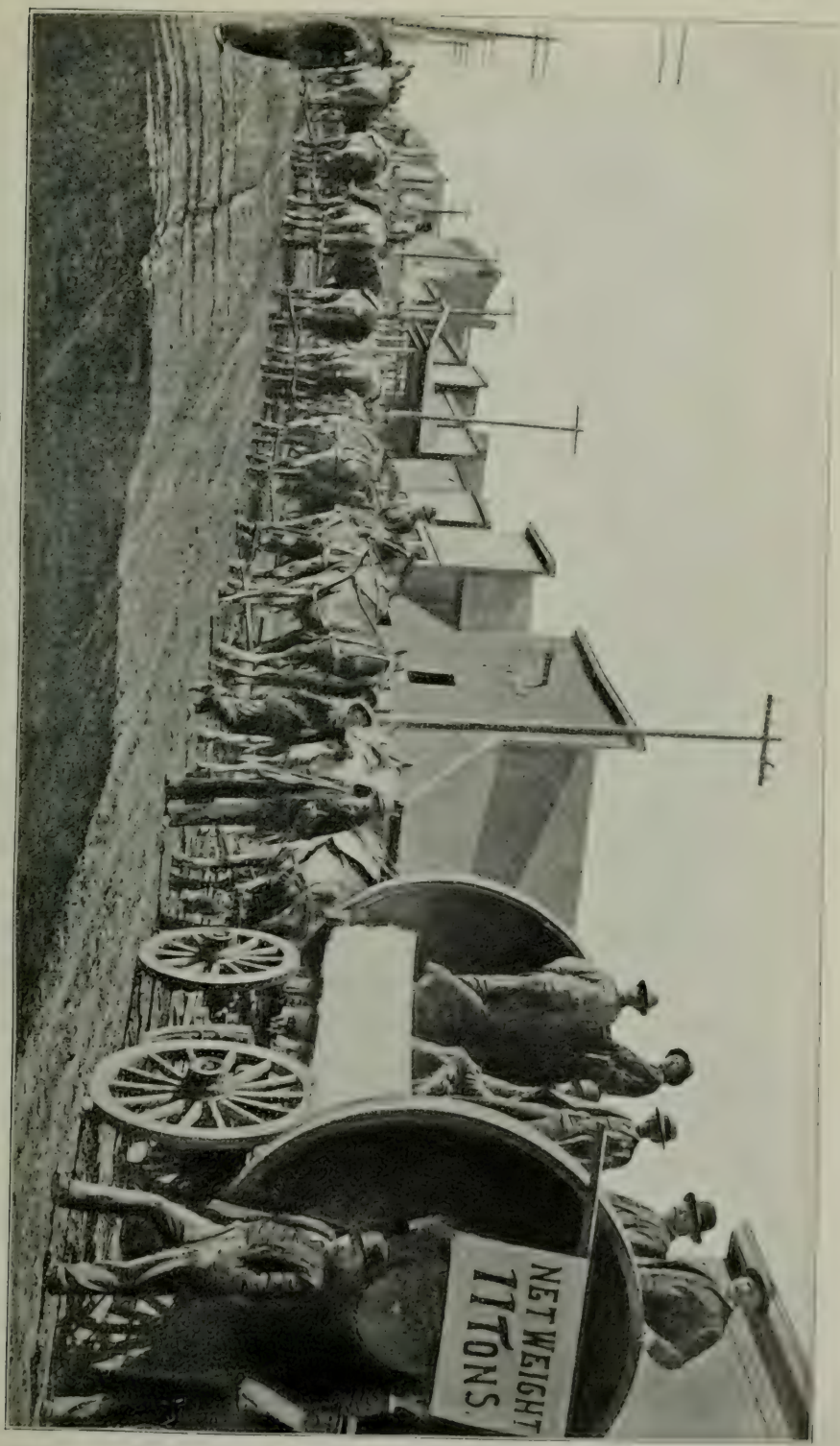


FIG. 89.—Cross section of steel-track wagon road.

presented a fine appearance, and will doubtless give satisfactory results, but sufficient time has not yet elapsed to test it thoroughly in every respect.

TESTS OF UTILITY OF STEEL-TRACK WAGON ROADS.

All steel tracks heretofore placed upon highways have been laid without the aid of the Government; but the Secretary of Agriculture determined to undertake, through this Office, a test as to the utility of the steel track, made and laid so that vehicles without flanged wheels might have the great advantage of a smooth track, heretofore enjoyed only by vehicles with the flanged wheels. The writer, upon being appointed Director of the Office of Road Inquiry, immediately began preparations to build a sample steel-track wagon road which should permit of making tests as to the cost, value, and utility of such a road. For this purpose he secured a suitable space on the grounds of the Trans-Mississippi Exposition at Omaha, where the results might be seen by the greatest number of people, and constructed such a road as he had recommended before, but which had never been fully tested. The road thus laid consists of two parallel lines of steel plates, 8 inches wide, laid at a sufficient distance apart to receive the wheels of vehicles of the standard gauge. These plates have a slightly projecting flange upward and on the inner edge, so as to prevent the wheels of ordinary vehicles, which have no flanges, from easily leaving the track. At the same time the flanges, being only one-half inch, are not of a



ELEVEN TONS HAULED BY TWENTY HORSES OVER AN ORDINARY ROAD.

ELEVEN TONS HAULED BY ONE HORSE OVER STEEL-TRACK WAGON ROAD.

FIG. 1.—HORSELESS CARRIAGE PROPELLED BY ELECTRICITY ON STEEL-TRACK WAGON ROAD.

FIG. 2.—THE STEEL TRACK AS A BICYCLE PATH.

height to prevent the vehicles from leaving the track for the purpose of passing other vehicles whenever the driver so desires. These steel plates are not supported by wooden cross-ties or longitudinal stringers of any kind, but are provided with flanges projecting both downward and outward. These flanges are embedded in the concrete of the roadbed so as to form a substantial part of it, and the steel plates are supported at every point by a substructure of cement or other enduring material.

In addition to the road built at Omaha, upon which the traction tests were made, Mr. E. G. Harrison, road expert of the Office of Road Inquiry, was directed to lay a short section of 150 feet of steel-track road at the agricultural experiment station at Saint Anthony's Park, Minnesota. After completing this, September 24, he laid another section of 180 feet at the agricultural experiment station at Ames, Iowa. Both of these sections were made after the same pattern and style of the Omaha road. Reports so far received from these two stations indicate that the two sections are coming up to the highest expectations.

THE FUNCTION OF CROSS-TIES.

The cross-ties used are not for support, but only to maintain the steel plates at a uniform distance from each other and also to prevent tilting and to maintain the face of the plates in a horizontal position. The road, when properly finished, contains no perishable material, such as wooden cross-ties and stringers, heretofore used and thought necessary for all steel-track construction, but forms a smooth, firm, and compact mass harder and more durable than a road can be made of any other known material.

ADVANTAGES OF STEEL-TRACK WAGON ROADS.

The three great advantages mentioned elsewhere as being sought for in the steel-track wagon road are found in this new roadway, demonstrating—

(1) That the steel-track wagon road can be built without greater cost in most cases, and probably with less cost in many cases, than any other hard and durable road.

(2) That it will last many times as long as any other known material for road purposes and with much less repair.

(3) That the power required to move a vehicle over the steel-track road is only a small fraction of the power required to move the same vehicle over any other kind of road.

This last important fact can be taken advantage of either by increasing the load which a given power would be able to move over a common road or by diminishing the power necessary to move a vehicle over the new road. This is shown by the accompanying illustrations. Pl. XVIII shows a heavy load of 11 tons drawn by twenty horses over a common road. Pl. XIX shows a load of equal weight drawn by one

horse over a steel-track road. This load was twenty-two times the weight of the animal, and was easily moved with light harness. The load could be increased up to fifty times the weight of the animal and still be started and moved without difficulty. Pl. XX, fig. 1, shows the horseless carriage on the track, which is moved with such ease as to require but a small fraction of the power ordinarily used for moving such vehicles. It also shows (Pl. XX, fig. 2) a bicycle rider on the track, indicating the suitableness of this new road for long bicycle rides through the country, a fact which would doubtless have an important bearing on the extension of rural mail delivery.

METHODS FOR LAYING STEEL TRACKS.

The method of laying steel tracks should be varied to conform to the material out of which the roadbed is constructed. In a comparatively dry and sandy or gravelly soil these tracks might probably be laid with no other material except the natural foundation of the roadbed itself, and could be maintained in good repair at very little cost. Also the flanges at the lower extremity, which project outward, might be omitted, thereby diminishing the amount of metal required in the rail. What could be done successfully in a sandy or gravelly roadbed might also be done in any soil that could be kept sufficiently dry, either by reason of the climatic conditions or the natural dryness of the soil. But in all wet and clayey soils there should be a substructure of broken stone under each rail 1 foot deep, also macadam between the rails and for a distance of 1 foot on each side. The cavity immediately under the rail should be filled with cement, so as to give a continuous bearing to support the rail at every point. The joints also should be secured by being bolted to a common cross-tie. In building on a grade of 3 per cent or more, the rails should be corrugated transversely. No experiment has ever yet been made with such a track upon such a grade, nor is there the material for the corrugated tracks. That will have to be produced by the use of special rolls.

COST OF CONSTRUCTION.

The cost of constructing the short section of steel-track road already built was about $1 per foot, but this is much in excess of the necessary cost when built in longer sections, requiring large quantities of material, and when the rolling mills are equipped with suitable rolls to get the shapes desired without the extra cost incurred in making the "built section."

It is probable also that the weight of steel may be considerably diminished below that heretofore used without materially impairing the value of the road. Before making a positive statement as to what the most desirable weight should be, we must observe for a long time the effect of traffic upon rails of different weight, different shape, and different size. It seems probable, however, that a rail weighing 30

pounds to the yard, one-fifth of an inch in thickness, and with the cavity immediately below properly filled, so as to give a continuous bearing, will prove to be sufficient. This would bring down the cost of the steel to about $1,500 per mile, and there is every probability that time and experience will prove this to be sufficient. To that sum must be added the cost of actually laying the track, and bringing the road surface up to it in such a manner as to preserve the surface of the roadbed even with the surface of the steel rail. Allowing an equal amount for that purpose, which is probably sufficient, the road complete could be built for $3,000 per mile.

NEW METHODS IN CONSTRUCTION OF ROADS AND VEHICLES SUGGESTED.

When John L. Macadam advanced his theory of road building in England in 1816 he called the attention of Parliament to the fact that it had hitherto devoted attention mainly to regulating the size of vehicles, the width of tires, the number of horses to be allowed for each vehicle, the amount of toll to be charged, and minor details of that kind, but had paid very little attention to the improvement of the roadbed. To-day, on the contrary, nearly all persons interested in the good-roads problem are exhausting their efforts upon the improvement of the roadbed only, and seeking to imitate or duplicate the stone roads of the older countries. It is the opinion of the writer that the stone age in road building has substantially passed, and that it is possible to introduce new means and methods by which there will be great gains in four different ways.

(1) The improvement of the roadbed can be effected without increasing the cost of its construction; on the contrary, the cost of construction can be diminished one-half or more.

(2) The weight of the vehicle can be greatly diminished in proportion to the load it carries. The bicycle is a notable example of what has been done in this respect. The value of the bicycle depends on the fact that it carries a burden many times its own weight. If it were constructed on the principle of nearly all other vehicles, so as to weigh as much as the burden it carries, or more, it would have no practical value and would not be in use. It is possible to apply the same principle in the construction of other vehicles, at least to the extent that in all cases they shall carry more than their own weight, and in most cases many times their own weight.

(3) Having such vehicles as referred to, it is possible to substitute inanimate power for animal power for all distances upward of 5 miles, and by such substitution there would be a gain equal to four-fifths of the present cost for animal power.

(4) There would be an increase in the speed of vehicles, and consequently a proportional saving in time.

The roadbed as commonly constructed is of great width and solidity,

yet the burdens passing over these roads are, as a rule, only from 1 to 2 tons in weight. It is unnecessary and unwise to build for light vehicles roads capable of sustaining burdens a hundred times the ordinary weight. The roadbed should be hard and smooth, and it can be made so by substituting steel for stone.

In reference to the vehicle, the fault of excessive weight is the result of a natural evolution based upon conditions heretofore existing, but now rapidly passing away, and capable of complete elimination. The wheels were made high in order to overcome the inequalities of the primitive roadway and to enable the vehicle to straddle extraordinary obstructions in the way. This height of wheel necessitated great width of gauge in order to prevent overturning the carriage. Great height and great width called for great strength in the vehicle, and great strength could only be secured by making the vehicle of great weight when constructed of the materials heretofore used for such purposes; so there were constructed and used vehicles whose weight exceeded that of the burdens they carried, and as a consequence the immense sums of money paid for transportation result almost as much from cost of moving the vehicle as from cost of moving the freight it carries.

In order to remedy this defect the first thing to do is to lower the center of gravity of the vehicle. No real progress was made in the development of the bicycle until the low wheels were used and the center of gravity lowered as much as possible. This example should be imitated in the construction of other vehicles. With the lowering of the center of gravity may easily and safely come a diminution in the width of the gauge, and with these two steps it is easy to reduce the weight of the vehicle, especially by substituting the lighter material now available, so that the vehicle may be strong enough to carry ten times its own weight instead of weighing ten times the burden it carries, as is often the case with vehicles in common use. As already stated, with a smooth track and a light vehicle, placed upon roller bearings, it is possible to substitute inanimate power for animal power on all distances of 5 miles and upward, with a saving equal to four-fifths of the present cost for animal power, and at the same time giving a great increase in the speed of the vehicle.

WORK OF THE DIVISION OF FORESTRY FOR THE FARMER.

By Gifford Pinchot,
Forester.

WORK IN GENERAL.

No part of the work of the Division of Forestry is without a distinct influence for good upon the farmer. For example, its study of forest fires, recently begun, has the closest relation to the farmers of Minnesota and Wisconsin, while in all mountainous regions the protection of the forest from fire is of vital interest to agriculture. So with the supply of lumber, to maintain which is the object of the studies by the Division of methods of lumbering, also recently undertaken with a view to improving their effect on the future of the forest without sacrificing the profit of the lumberman. Practical assistance given to the owners of forest lands has the same general object in view. A knowledge of the yearly rate of growth, in cords or board feet, of commercially valuable trees per acre of forest is of great value to every man who owns a wood lot; and this knowledge the Division is engaged in providing, with particular attention to trees which, like the Loblolly or Old Field Pine, are sure to increase in importance as time goes on.

But however close the relation of the others, two branches of the work of the Division are related to the welfare of the farmer in a special manner. These two are concerned with the introduction of suitable trees for planting in the treeless portions of the West, and with the better handling of the wood lots on farms in the regions where trees now grow.

TREES FOR THE PLAINS.

Tree planting is a question of the greatest importance to the farmers of the treeless West. If every other proof were lacking, this would be abundantly shown by the vast amount of planting that has taken place since the Central West began to grow into its present agricultural importance. During several decades immense numbers of trees have been planted, and a vast amount of experience has been accumulated. But so far all that has been learned from failures and successes is not readily accessible for the information of future planters. Many of the trees used would better have been discarded, and very many plantations have failed because they were poorly or wrongly made. The first thing to be done is to compile and collect an account

of the results of actual experience, which of course must be obtained far less from books than from practical planters, and from a careful study of good and bad plantations already made. This done, the next step is to devise new methods of planting, where such are needed, and to find, by experimental plantations, what trees, among all those of the world, are best suited for the different portions of the treeless West. Some such plantations have been established in previous years. The study of what has been done will be taken up during the coming year, and will be carried forward as fast as the available funds will permit. It lies at the foundation of the whole subject.

PRACTICAL ASSISTANCE TO FARMERS.

Of the 623,000,000 acres in farms in the United States, according to the Census of 1890, more than 200,000,000 acres are under wood. This enormous total, broken up into wood lots over a very large part of the United States, exerts a most powerful influence on the welfare of the farmers to whom it belongs. Yet, as a rule, the treatment which farmers' wood lots receive is calculated to destroy rather than increase their productive capacity and value. The object of the undertaking described in the pages following is to devise, and assist the farmer in applying, better methods by which the forest on his wood lot will be improved without appreciably increasing the cost of harvesting the forest crop, or simply to apply such methods where they already exist. The latter is not often the case, for the reason that European ways of dealing with forest land are seldom applicable to the handling of woodlands in America. Practical and paying ways of handling wood lots must be devised, for unless the methods applied with the assistance of the Division are successful from a money point of view they will not answer the general purpose for which they were intended, which is that of examples. It would naturally be impossible for the Division to cooperate with all the farmers of the United States. It can reach the greater number of them only through the published results of its work.

Examples of better ways of handling wood lots calculated to lead others to imitate them must be satisfactory to the owners, in the first place. To benefit the owner and the forest at the same time is the real problem. From this point of view the difference between the ordinary and improved methods of handling this forest land is enormous, but, on the other hand, changes in method are not extreme. In other words, the cost of harvesting the timber crop from a wood lot in the usual way differs but little, if at all, from the cost of harvesting it so that its productive value will be improved and increased. Thus, the difference to the farmer in expenditure will be very small, while the difference in result, both to the individual and, from the enormous area of all wood lots taken together, to the nation at large, will be very great.

Farmers in many cases depend largely on their wood lots for ready cash, received from the sale of ties, cord wood, and other produce, to supplement any shortcoming in the yearly crop. The quality and quantity of this produce is therefore of the first importance to them. The Division of Forestry has undertaken to give practical advice, on the ground, as to how best to secure these advantages, and then to supervise the execution of its own plans, the whole entirely without cost to the farmer. A copy of the agreement which the Department of Agriculture is prepared to make with the owners of wood lots is given here, in order to explain more fully just what is intended, and a working plan, prepared under this agreement, is also given in full (see pages 301–308) to illustrate more at length the way the work is done. It must not be forgotten, however, that there are as many best ways to handle them as there are kinds of wood lots. In other words, a plan prepared for northern New Jersey like the one given would not fit the conditions of southern New Jersey, while it would be suitable, in its main features, for very considerable parts of New England, New York, and Pennsylvania.

The following is the agreement referred to, giving the terms on which the owners of small tracts of forest may cooperate with the Division:

WOOD-LOT AGREEMENT.

WASHINGTON, D. C., *September 1, 1898.*

The Department of Agriculture of the United States and John Doe, of Doeville, county of Bell, State of Pennsylvania, mutually agree together as follows:

1. The Department of Agriculture, in pursuance of investigations in forestry, and in order to disseminate a knowledge of improved ways of handling forest lands, shall, after personal study on the ground by its agent or agents, prepare a plan for harvesting the forest crop and reproducing the forest on the land of the said John Doe, situated and described as follows: 100 acres, more or less, of second-growth hardwood forest land, in the town of Doeville, county of Bell, State of Pennsylvania, on the farm known commonly as the Old Doe Place, and in the northwest portion of the same.

2. The said plan shall be prepared for the purpose of promoting and increasing the present value and usefulness of the said land to its owner, and to perpetuate and improve the forest upon it.

3. Upon the completion of the said plan and its acceptance by the said John Doe, the Department of Agriculture shall supervise the execution thereof, so far as may be necessary.

4. The Department of Agriculture shall render all services under this agreement wholly without charge to the said John Doe, nor shall it participate in any degree in the receipts and expenses arising from the said land, except to defray the pay and expenses of its agent or agents.

5. The Department of Agriculture shall have the right to publish and distribute the said plan and its results for the information of farmers and others whom it may concern.

6. This agreement may be dissolved by either party upon ten days' notice given to the other.

(Signed) .....

(Signed) .....

WASHINGTON, D. C., *October 1, 1898.*

The working plan above mentioned, being now completed, is accepted, and will be carried out under the conditions and during the validity of the above agreement.

(Signed) .....

It is an essential part of the scheme outlined above to print working plans prepared in different parts of the country and distribute them to the farmers in the regions to which they apply. These working plans, with photographs and maps, will contain short, plain, and practical directions for practical work in the woods, so that the owners of similar wood lots will be able to follow the same methods of work.

The conditions under which the Division of Forestry undertakes to assist the owners of wood lots to make the most of them are very simple. It has nothing to do with the receipts and expenses which arise under its plans. The farmer must attend to the actual work of cutting and marketing his wood, or else furnish the necessary labor. The cost of doing so he must pay, and the money it yields goes to him. On the other hand, all investigations, advice, and supervision needed to prepare and carry out a working plan are entirely at the charge of the Division. The assistance of the Division costs the farmer nothing except the desire to improve his property and the willingness to be assisted.

Since the object of this whole undertaking is to convince farmers of the real advantage to them of better ways of handling their wood lots and to spread this conviction by the proof of actual examples in successful operation, which must be satisfactory to the men chiefly concerned before they can be of use to others, the whole scheme is arranged so that its success depends on the way it is received by the farmers. Just so long as the working plans are satisfactory to the farmers for whom they are made, just so long they stand a chance of being useful as examples, but no longer. Consequently the wood lot agreement is so worded that it can be ended at any time upon ten days' notice by either party. Furthermore, as the acceptance clause at the bottom shows, if a working plan is not satisfactory to the owner when it has been made it will not be put into effect.

These conditions have been made so easy because the close relation of the wood lots to so many millions of our people, the vast area they cover, and their very great national importance as sources of fuel, fencing, and other material, require and justify great efforts to improve their condition and increase their productive power.

Applications, which should be made to the Division of Forestry, will be dealt with in the order of their receipt, except that wood lots of special value as examples will be given the preference when the success of the work seems to require it. This plan was first made public in Circular No. 21 of the Division of Forestry, which explains the terms under which not only farmers, but all other owners of timber land, in large or small tracts, may receive the advice and assistance of the Division.

WORKING PLAN FOR A WOOD LOT BELONGING TO MR. E. D. PAGE, AT OAKLAND, BERGEN COUNTY, N. J.

By HENRY S. GRAVES,
Superintendent of Working Plans.

DESCRIPTION OF WOOD LOT.

AREA.—The total area included under the working plan is 70.3 acres, of which 41 acres are covered with merchantable timber, 20.3 acres with a growth of sprouts about seven years old, and the remaining 9 acres with scattered Red Cedar.

SITUATION.—The wood lot is situated on the eastern side of the Ramapo Valley (see fig. 90), on a hill about 200 feet above the river. The land has a moderate slope, partly toward the northwest and partly toward the southeast.

ROCK AND SOIL.—The soil, resulting from the disintegration of the underlying trap rock and the glacial stones and bowlders, which are scattered plentifully over the area, is chiefly a clayey loam, or, on low ground, a loamy clay. The tract is well watered, and the soil is everywhere fresh or moist.

THE FOREST.—With the exception of one small group of trees, the forest is a second growth, composed chiefly of two age classes, one about fifty and the other about eighty years old. The prevailing species are Black, White, Rock, and Pin Oak (see Pls. XXI and XXII), Chestnut, Hickory, Black Birch, Ash, and Pitch Pine. Other species occur, and are mentioned in the description of the several divisions given below. The forest has a fair density, and the trees, for the most part, are tall and clear boled. There have been thinnings from time to time, but no heavy cutting has been done for about fifty years, except on the southern end of the wood lot, where about 20 acres were cleared in 1891.

There is a considerable amount of underbrush, and throughout the forest seedlings of Oak, Hickory, and Ash are abundant. Rock Oak and Ash reproduce themselves better than any of the other trees, but the reproduction of the other Oaks and of Hickory, Elm, and Sugar Maple is good.

DESCRIPTION OF DIVISIONS.

The wood lot has been divided into seven divisions (see fig. 91), each either differing in character and age from its neighbors or isolated from the rest. These divisions are described in detail, as follows:

Division No. 1.

Area: 20.3 acres.
Situation: Moderate northwestern slope.
Soil: Fresh loamy clay, covered with numerous stones.
Forest: A dense growth of sprouts, mixed with scattered seedlings, of Chestnut, Oak, Hickory, Ash, Butternut, etc., about seven years old.

Division No. 2.

Area: 6.2 acres.
Situation: Moderate northwestern slope.
Soil: For the most part covered with bowlders and stones. Northern end drained by brook; has rich alluvial soil.
Forest: At the northern end eighty-year to one-hundred-year old Rock and White Oak, Hickory, and Sugar Maple, reaching a maximum height of 85 to 90 feet, and a diameter, in the case of Maple, of 2 feet. The trees are straight and clear boled, and yield in many cases two or three saw logs. The remainder of the compartment is stocked with thirty-year to fifty-year old Oak, Chestnut, Maple, Ash, Birch, Hickory, Elm, Ironwood, Beech, Basswood, Pepperidge, and Hemlock.

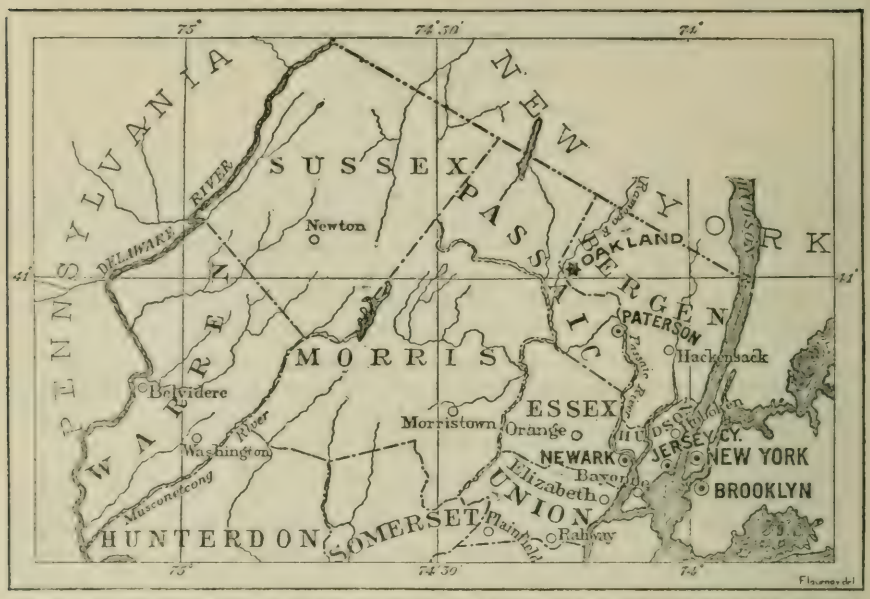


FIG. 90.—Northern part of New Jersey, showing the location of the forest work at Oakland.

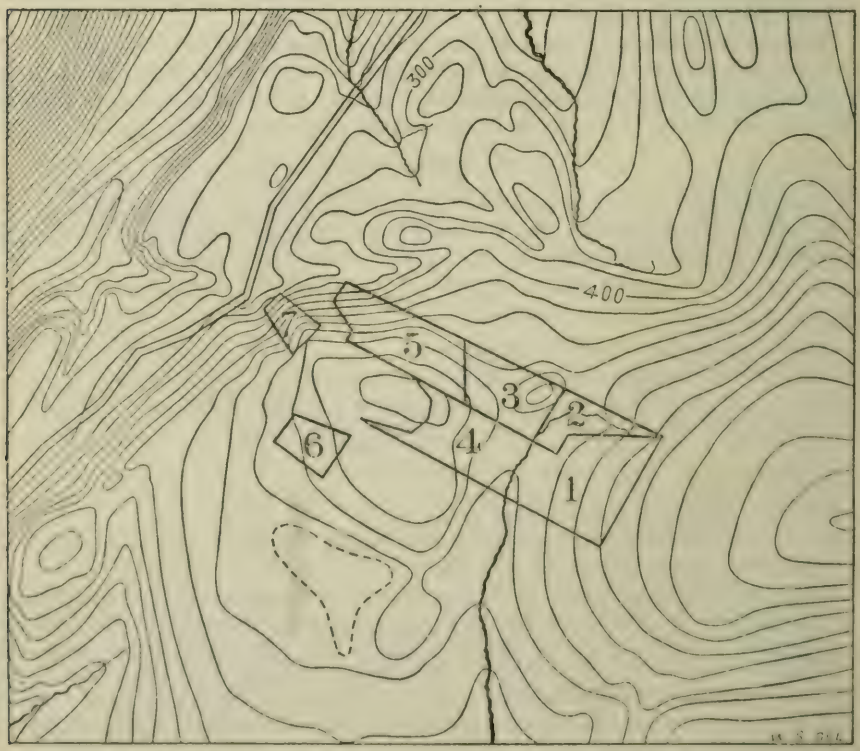


FIG. 91.—Wood lot at Oakland, N. J., showing the divisions.

Density: In young timber, poor; in old timber, good. Average of the whole division, 0.7. The density of a fully-stocked forest is 1.0.

Reproduction: The entire division is covered with a moderately thick undergrowth, of which about one-third is composed of young Maples, Oaks, and Hickories, and the rest of shrubs.

Growth: Very good.

Division No. 3.

Area: 9 acres.

Situation: Top of ridge, the eastern portion sloping toward the south.

Soil: Clayey loam.

Surface cover: Clumps and scattered individuals of Red Cedar fifteen to twenty years old and about 10 to 12 feet high, with a few specimens of broadspreading Oak and Chestnut growing near the old fence. Ground covered with a firm sod.

Division No. 4.

Area: 12 acres.

Situation: Moderate southeastern slope.

Soil: Fresh clayey loam; northern portion swampy.

Forest: Oak (White and Black), 50 per cent; Hickory, 20 per cent; Pitch Pine, 7 per cent; other species (Black Birch, Ash, Red Maple, Cedar, Butternut, Hemlock, Elm, Yellow Poplar, Aspen, Pepperidge, Beech, Ironwood, Mulberry, Basswood), 33 per cent. The greater proportion of the timber is sixty to eighty years old; the largest trees, eighty to ninety years; the Pine partly about sixty and partly about thirty-five years. Average height, 60 feet. Average diameter of all trees over 8 inches, 10.6 inches. Pitch Pine occurs on a ridge on the south side, and there the forest is open, with dense underbrush. Many trees are dying. In the swamp on the north side are numerous Pin Oaks and River Birches. In general, the trees are straight and clear boled.

Density: For the whole division, 0.7. On the northern edge are several large openings where the underbrush is dense.

Reproduction: Fair, but hindered in places by a dense growth of Green Osier, Dogwood, Ironwood, Spicebush, etc.

Growth: Very good.

Division No. 5.

Area: 15.9 acres.

Situation: Northwestern slope, mostly gradual, but at lower end 10° to 15°.

Soil: Well drained, fresh clayey loam, covered with numerous stones and bowlders.

Forest: Forty-year to fifty-year old Black, Rock, and White Oak, Chestnut, Hickory, Black Birch, Ash, and Butternut, chiefly of sprout origin, with scattered large trees seventy to ninety years old, the latter grown from the seed. About 10 per cent of the forest crop is composed of Red Maple, Hemlock, Red Cedar, Pepperidge, Pitch Pine, Buttonball, Beech, Aspen, Elm, Ironwood, Basswood, and Black Cherry. Average height, 60 to 65 feet. Average diameter of all trees over 8 inches, 11.5 inches.

Density: For the whole division, about 0.6. At the southwestern corner there is a dense growth of Red Cedar and small trees.

Reproduction: Very good. A large quantity of Rock Oak, Hickory, and Ash seedlings, and scattered small specimens of other species. Underbrush scanty, probably on account of the grazing of cattle.

Growth: Good.

Division No. 6.

Area: 3.4 acres.

Situation: Gradual southwestern slope.

Soil: A fresh, or in portions moist, clayey loam. A small stream at the eastern end.

Forest: Oak (chiefly White), 50 per cent; Hickory, 9 per cent; Ash, 8 per cent; Elm, 8 per cent; Red Maple, 8 per cent; other species (Black Birch, Chestnut, Butternut, Cedar, Yellow Poplar), 17 per cent. Average age, about fifty years. Average height, 40 feet. Average diameter of all trees over 4 inches, 7 inches. About half the trees are of seedling origin and half sprouts.

Density: On about half the area, 0.8, with trees straight and clear boled; on the remainder, not over 0.4, with several large blanks, and with scrubby trees.

Reproduction: In the less dense portions there are many Oak seedlings. In openings the ground is covered with grass, and seedlings are few.

Growth: Good.

Division No. 7.

Area: 3.5 acres.

Situation: Slope of 5° to 10° toward the northwest.

Soil: Fresh clayey loam covered with rocks.

Forest: Thirty-year to fifty-year old Chestnut, chiefly of sprout origin, mixed with Oak, Black Birch, Hickory, Black Cherry, Elm, Butternut, Red Maple, and Aspen. Average diameter (over 8 inches), 11.3 inches; greatest diameter for Chestnut, 31 inches.

Density: In places rather open, and with one large blank in center of division.

Reproduction: Excellent for Rock Oak, and fair for White Oak.

Growth: Good.

ESTIMATE OF GROWING STOCK.

All timber on the wood lot larger than 4 inches in diameter was measured with calipers. In the absence of American tables for estimating standing timber, Behm's "Massentafeln" were used. They give the contents of European hardwood trees of different species, heights, and diameters. Due allowance was made for the differences in species and in the character of the forest. The following tables give the contents of the standing timber over 4 inches in diameter, together with the annual rate of increment:

Estimated contents and annual growth of standing timber.

OAK AND CHESTNUT.

Number of division.	Area.	Oak.						Chestnut.					
		Board feet.	Ties.	Firewood.	Total cubic feet.	Annual growth.		Board feet.	Ties.	Firewood.	Total cubic feet.	Annual growth.	
	Acres.			*Cords.*		*Per ct.*	*Cu. ft.*			*Cords.*		*Per ct.*	*Cu. ft.*
1[1]	20.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	6.2	4,953	4	72	7,275	2.2	160	342	.....	2.9	340	3	10
3[2]	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	12	6,492	94	218	21,401	2.2	471	80	33	7.5	863	3	25
5	15.9	2,105	9	102	10,317	2.2	227	4,236	284	151	17,445	3	523
6	3.4	.....	.....	30	2,728	2.2	60	.....	.....	.8	70	3	2
7	3.5	.....	6	9.4	879	2.2	19	425	62	39.5	3,990	3	119
Total	70.3	13,640	113	431.4	42,620	.....	937	5,083	379	201.7	22,708	.....	679

[1] Contained seven-year old sprouts. [2] Contained scattered Red Cedar.

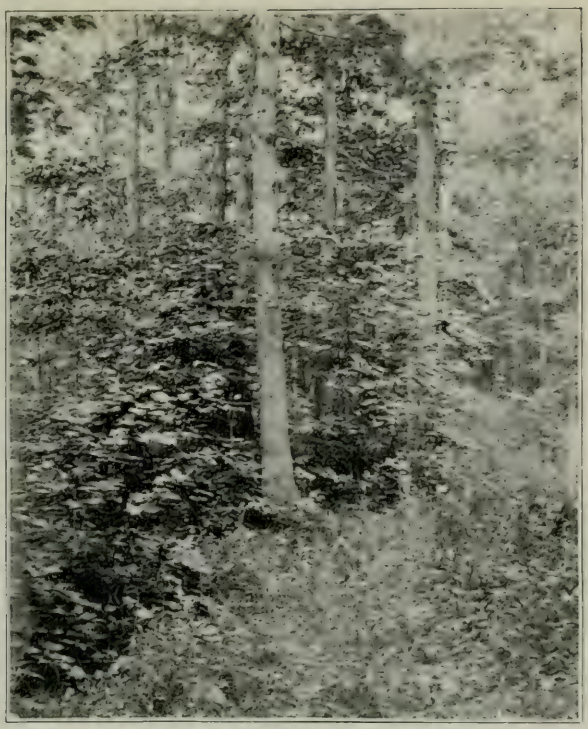


FIG. 1.—A GROUP OF THRIFTY WHITE OAKS, OAKLAND, N. J.

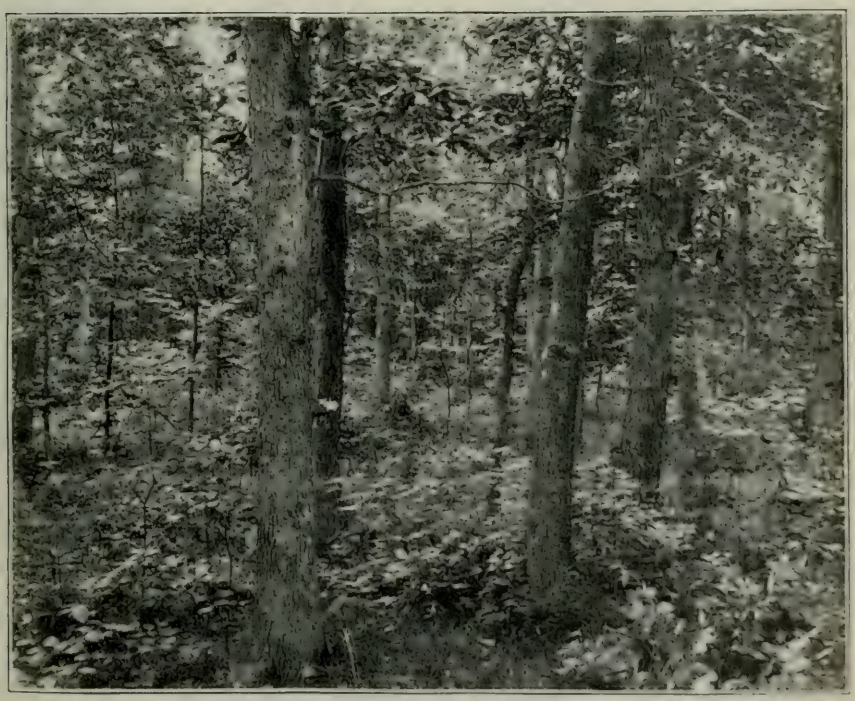


FIG. 2.—WHITE AND BLACK OAKS AND HICKORY, OAKLAND, N. J. (BLACK OAK ON THE RIGHT WILL BE REMOVED.)

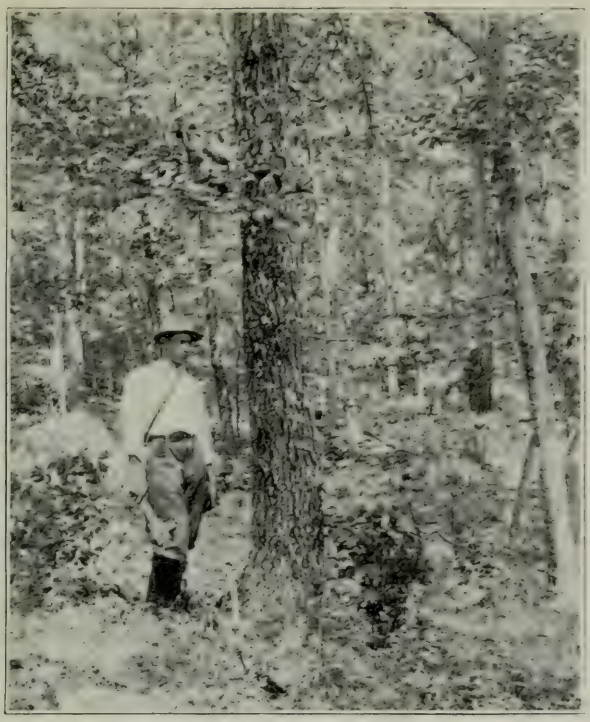


FIG. 1.—BLACK OAK, OAKLAND, N. J.

FIG. 2.—BLACK OAK SPROUTS, ABOUT FIFTY YEARS OLD, OAKLAND, N. J.

FIG. 1.—A GROUP OF OAKS, OAKLAND, N. J. (IMPROVEMENT CUTTING NEEDED.)

FIG. 2.—SCATTERED RED CEDAR ON AN OLD PASTURE, OAKLAND, N. J.

Estimated contents and annual growth of standing timber—Continued.

HICKORY AND PINE.

Number of division.	Area.	Hickory.					Pine.			
		Board feet.	Firewood.	Total cubic feet.	Annual growth.		Firewood.	Total cubic feet.	Annual growth.	
	Acres.		*Cords.*		*Per ct.*	*Cu. ft.*	*Cords.*		*Per ct.*	*Cu. ft.*
1[1]	20.3									
2	6.2	900	50.4	1,843	1.9	35				
3[2]	9									
4	12	392	70.6	6,465	1.9	127	22.6	2,013	1.9	38
5	15.9	270	24.6	2,476	1.9	47				
6	3.4	140	3.7	505	1.9	10				
7	3.5		2.3	240	1.9	46				
Total	70.3	1,702	151.6	11,529		265	22.6	2,013		38

OTHER TREES.

Number of division.	Area.	Maple.	Yellow Poplar.	Ash.	Basswood.	Firewood.	Total cubic feet.	Annual growth.	
	Acres.	*Board feet.*	*Board feet.*	*Board feet.*	*Board feet.*	*Cords.*		*Per cent.*	*Cubic feet.*
1[1]	20.3								
2	6.2	972	408			53	4,944	1.9	90
3[2]	9								
4	12		114	97		67	6,038	1.9	115
5	15.9				194	35	2,390	1.9	45
6	3.4		160			12	1,059	1.9	20
7	3.5					8.5	763	1.9	15
Total	70.3	972	682	97	194	175.5	15,194		285

[1] Contained seven-year-old sprouts. [2] Contained scattered Red Cedar.

SUMMARY.

[Average stand per acre for all divisions except 1 and 3.]

		Per acre.
Oak	board feet	333
Chestnut	do	124
Hickory	do	41
Ties		12
Firewood	cords	24

GROWTH.

The rate of growth was determined by the measurement of the annual rings on sixteen stumps, carefully selected from different parts of the wood lot. If the number of rings is known in 1 inch next the bark, at a place where the rings are of average width, and the diameter is also known, the current annual rate of growth per cent can be calculated. For this purpose the following formula is employed:

$$G = \frac{400}{n\,d}$$

G = the annual growth per cent.
n = number of years in the last inch on an average radius.
d = the diameter of the stump.

By this method the average annual growth was found to be: For Oak, 2.2 per cent; Chestnut, 3 per cent; Hickory, 1.9 per cent; Pine, 1.9 per cent; other trees, 1.9 per cent. These averages show the actual growth of the wood, and are used to determine how much can be cut without injury to the forest. They do not represent the interest on the capital value of the land, for as the timber becomes of merchantable size its increase in value is greater than the growth in volume. If the above averages are applied to the total number of cubic feet on the wood lot, as is done in the above table, which gives the estimate of the growing stock, it will be found that the wood lot is producing annually—

	Cubic feet.
Of Oak	937
Of Chestnut	679
Of Hickory	265
Of other material	323
Total	2,204

The annual growth is, then, for the 41 acres on which the timber is of merchantable size, 2,204 divided by 41, or 53.7 cubic feet of solid wood, or six-tenths of a cord per acre. On the whole 41 acres the annual increase is 24.6, or, in round numbers, 25 cords.

MARKET.

The wood lot is situated about 1½ miles from the railroad station and is connected with it by a good road. There is a constant market at and in the vicinity of Oakland for cord wood, logs, ties, and hoop poles. Provided a sufficient amount of material is taken out at one time, there would be no difficulty in selling the timber on the stump. The following average stumpage prices are quoted by operators at Oakland:

Oak logs	per thousand board feet	$6.00
Hickory logs	do	6.00
Chestnut logs	do	4.00
Ties	each	.25
Hoop poles	per hundred	1.00
Cord wood	per cord	1.00

It is customary to allow about 25 per cent for lapwood (branches), which will bring not over 50 cents per cord.

OBJECT OF MANAGEMENT.

The object to be reached in the management of the forest at Oakland is to make it yield a fair rate of interest on the capital invested through the use of methods of cutting by which its preservation, welfare, and increasing productiveness shall be secured.

PRESENT METHODS OF CUTTING.

At present woodlands in this neighborhood are cut in one of two ways: (1) The land is cleared; (2) trees are selected here and there for special purposes.

Under the first system not only the mature timber is cut, but with it a large number of young thrifty trees which make but little showing in the present product, yet in a comparatively short time would be large enough for logs and ties. The second growth consists largely of sprouts, and twenty-five to thirty years must elapse before the land will yield a crop of cord wood, or upward of sixty to eighty years for logs and ties.

In the present instance the owner of the woodland does not desire to convert the standing timber into money at once at a sacrifice of the producing power of the forest. He prefers to hold a certain amount invested in standing timber in order

to utilize to its full extent the productive capacity of the land. The returns will be obtained at shorter intervals and will in the long run amount to much more than if the land is cleared under the ordinary system.

The second method is similar to that recommended in this working plan, except that under the proposed system the thinnings will be made with special reference to improving the timber which is left on the ground and to seeding the openings to valuable species.

METHODS OF CUTTING RECOMMENDED.

Two kinds of cuttings will be used in harvesting the timber at Oakland. First, the old timber will be cut as soon as it is of merchantable size, but the trees will be selected so that the openings left by their removal shall be seeded to valuable species. This is called a reproduction cutting. Second, the whole wood lot will be thinned annually or periodically for the purpose of harvesting the increase and improving the timber which remains. This is called an improvement cutting.

REPRODUCTION CUTTINGS.—It has already been stated that there are large numbers of small seedlings in the forest. The reproduction cuttings take advantage of this young growth, and when the merchantable timber is removed an opportunity is given for the seedlings to develop. Where the young growth is scanty the cuttings are located with reference to seed trees, so that young growth of valuable kinds may follow. (See Pl. XXI, fig. 2.)

IMPROVEMENT CUTTINGS.—There are in the forest many crooked and scrubby trees of valuable kinds and several species of little value, as well as the straight, thrifty Oaks, Hickory, Chestnut, and Ash. It is the purpose of the improvement cuttings to weed out the undesirable trees, so that the ground will eventually produce only thrifty specimens of the most useful species. (See Pl. XXIII, fig. 1.) These trees in almost all cases can be cut at a profit. In practically all remaining cases they can be got rid of without loss. This working plan does not contemplate any expenditure which will not be met, or more than met, by the return.

The trees which should be removed in this way are:

(1) Old, scrubby trees which have broad crowns and are crowding young, thrifty growth.

(2) Defective and dying trees which will soon be past their usefulness.

(3) Less desirable species, as Red Maple, Pepperidge, Beech, etc., which are crowding more valuable trees.

(4) Dead trees; if not possible to sell this material, it is probable that some one could be found to cut it for the wood.

DETAILS OF CUTTING PLAN.

The working plan is made to cover a period of ten years. Those portions in which no cutting will be done during this time are left out of account in the schedule below. It may be said, however, that the timber on Division No. 1 will be large enough for cord wood in about twenty years, and it is estimated that at that time there will be between 25 and 30 cords per acre. The scattered Red Cedar on Division No. 3 will be large enough for posts in about thirty years. (See Pl. XXIII, fig. 2.) At that time the ground will probably be covered with young growth of other species, which is already beginning to come up in the open portions.

It has been shown that the annual increase on the 41 acres covered with large timber is 24.6 cords, or the growth for ten years 246 cords. That amount may, therefore, be cut during this period without trenching on the producing capital of the forest.

The owner of the forest desires to sell the timber, so far as possible, on the stump. Since a better contract can be made when a considerable amount of timber is

removed at one time, it is proposed to cut the majority of trees suitable for saw lumber in one year. This timber is to be removed in reproduction cuttings, and the total amount of it, including tops, is 135 cords. It is estimated that the sum total of the openings made by the removal of this timber would be 4 acres. If this system of cutting were extended indefinitely, and 4 acres were reproduced every ten years, the whole tract of 41 acres would have been cut over in about one hundred years. At that time the seedlings now established would be one hundred years old. In other words, the rotation of the timber would be one hundred years. The Chestnut and Ash would in many cases be ready for the ax in less than one hundred years, but they would be counterbalanced by other species which it would be advisable to leave longer than this period.

It is proposed to cut 115 cords in the next ten years by improvement thinnings. The amount to be removed from each division is given in the schedule following. The various amounts have been determined according to the needs of the forest. It would be most profitable to cut this material in one year, but for the good of the forest it will be better to thin twice during this period. In the latter case about one-half should be cut at the same time as the reproduction cutting and the remainder in about five years.

Schedule, or special working plan, for ten years.

Number of division.	Reproduction cutting.						Improvement cutting, total cords.	Remarks.
	Oak.	Chestnut.	Hickory.	Other trees.	Ties.	Total cords, including logs and ties.		
	Board ft.	*Board ft.*	*Board ft.*	*Board ft.*				
1								Leave untouched.
2	5,000	300	900	950	4	30	20	
3								Cut cedar posts for local uses.
4	5,000		300	200	14	30	45	
5	2,000	4,200	275	190	147	60	30	
6			140	160			10	
7		400			40	15	10	
Total	1,200	4,900	1,615	1,500	205	135	115	

RULES FOR CUTTING.

The following rules should be observed in cutting the timber:

(1) No trees shall be cut which are not marked.

(2) Whenever possible, trees standing over young growth must be felled toward or away from their longest and heaviest branches. In this way the space struck by the crown of the falling trees will be as narrow as possible, and but little young growth will be broken by the sideways sweep of the long branches.

(3) Care must be exercised not to break or otherwise injure young growth.

(4) All trees must be worked up at once after cutting. If the trees are left on the ground for some time, the injury to the young growth is greater than if they are removed quickly, for saplings which are bent will recover if they are released quickly, and many seedlings will be saved which would be broken or smothered.

(5) The brush from the tops must be cut and scattered about. The danger from fire is lessened in this way, because the branches and twigs decay more rapidly when in contact with the ground; and an opportunity is given seedlings to germinate and develop, which under the piles of brush would be impossible.

UTILIZING SURPLUS FRUITS.

By G. B. Brackett,
Pomologist.

BEST DISPOSITION OF FRUIT AN IMPORTANT QUESTION.

How best to dispose of a crop of fruit and prevent waste is a very important matter for the consideration of all practical fruit growers; and it means a great deal more than appears at first thought. When applied to our nation's fruit industry, it presents for consideration the product of large areas, upon which large amounts of money and labor have been expended. Upon the economic and profitable disposition of the product depends the financial success.

It is well known to every culturist that a crop of fruit can not be grown that will be first class in its entirety. There always will be more or less of inferior product in all crops, which should never be placed on the market to compete with the higher grade fruit. Such a use causes a glut in the market, which depresses the price of both grades, and leaves no margin of profit on either; hence, the necessity of providing for the disposition of inferior grades in some other way to the best advantage possible.

Again, markets may at times become glutted to such an extent as to afford no profitable sale for even first-class products in their natural state, thereby resulting in more or less loss, unless they are prepared artificially in some other commercial form.

The proper solution of this question has great weight in its relation to the early ripening products, and especially those of a quickly perishing character and which require immediate consumption or preservation to prevent loss.

It always should be borne in mind by the producer that each bushel of apples, pears, peaches, etc., of the tree fruits, and each quart of blackberries, raspberries, strawberries, etc., of the class known as small fruit, represents a specific cost and outlay of money; hence, every measure of any kind of fruit product allowed to go to waste is a loss of just so much invested capital.

Considering these matters in all their relations to the fruit industry from an economical standpoint, it is readily seen how important it is that provision for the utilization of the entire crop in some form or other should be at hand and ready for immediate use on all fruit plantations, more especially on those remotely situated or otherwise inconvenient to markets.

PROCESSES FOR SAVING THE CROP.

The several processes which are now in use and regarded as efficient to preserve a crop and put it in commercial form are:

(1) Sun drying or evaporation with artificial heat.

(2) Canning.

(3) Extracting of the juice.

If a plantation is too remote from a market or a preserving factory to justify carriage of the fruit, it will be necessary to work the entire crop at the plantation into concentrated commercial form through the use of one or all of the processes above mentioned.

In some localities all the product of an apple orchard, excepting the first-class fruit (which will generally find a ready sale), may be profitably worked into cider for beverage uses and into vinegar.

The product of peach, pear, and plum orchards, in case the first grade does not find ready sale in its natural state, can be saved from waste through the processes of evaporation and canning.

The product of small fruit plantations, being quickly perishable, requires immediate disposition, either in its natural state or preservation by evaporation and canning to prevent losses. In seasons of great fruitfulness there generally occurs a glutted market, and despite the best efforts of agents and commission houses some large shipments are lost in part or in whole which might be saved by evaporation and canning.

EVAPORATION.

It is not the intention to go into details in this paper, but to treat the subject in a general way. Evaporation is the most economical and profitable process known for the preservation of fruits, and has almost wholly superseded the old process of sun drying. It is suitable for all kinds of orchard products and some classes of small fruits, and when properly conducted gives to the fruit the best conditions of a healthful food. Compared with sun-dried, the fruit preserved by evaporation will keep better, is more nutritious and digestible, less acid, and commands a better price in market. Evaporated fruit, by its cheapness, is within the reach of all the people, and thus is regarded as the most economical form for general use. The importance and economy of any process which will safely preserve the products of our orchards can hardly be estimated, but the one which will give the best results with the least waste is the one that should receive the greatest attention. The changes that take place and the product resulting from those changes are the same in all slow processes of drying, whether in the sun or by some of the imperfect evaporators that have been in use. In order to secure the best results of evaporation it is necessary to run the temperature as high as possible without injury to the fruit and to keep the air in rapid circulation throughout the chamber. It is under these conditions that the slight chemical

changes in perfectly evaporated fruit take place, the albumen, instead of being slowly dried, will be coagulated, and greatly assist in the preservation of the fruit with all the richness and flavor it possessed in its natural state.

TREATMENT OF THE FRUIT.—Apples are generally peeled, cored, and dried by the use of machines adapted to the purpose. They are put upon trays, submitted or not, according to choice, to the fumes of burning sulphur for a very few minutes for the purpose of bleaching, and are then passed to the evaporator, where the temperature is sufficiently high to produce the desired results.

There are some who object to the bleaching process, and perhaps with justification, at least if the treatment is excessive, so that if the consumer consulted the sense of taste rather than the gratification of sight there would be less demand for the bleached product.

Pears and peaches are usually cut in halves and evaporated with or without being peeled, and may or may not be submitted to the bleaching process, according to circumstances. Plums or prunes are treated somewhat differently from most other fruits, and especially is this true in regard to the ripeness of the fruit. For evaporating, it should be allowed to remain on the tree until ripe enough to fall to the ground of its own weight, and some even allow it to remain on the ground some time after it has fallen. It is then gathered and passed over graders, which separate it into several grades or sizes and at the same time remove leaves and all other foreign matter, after which it is placed in bins to remain a short time for further ripening. It is now ready for treatment and curing. There are two methods practiced in curing prunes, about which there is a diversity of opinion. One is what is known as the dipping process, which consists in immersing the fruit for a few minutes in a solution of concentrated lye in the proportion of 1 pound of lye to 12 gallons of water heated to the boiling point and maintained at that point during the dipping. The fruit, having been placed in wire baskets, is dipped in the solution, then taken out and rinsed in pure water to remove all traces of lye and other impurities, placed upon trays, and put into the evaporator. The advocates of this process claim that the fruit dries more quickly, thus causing a saving in expense.

The other method is without dipping in the hot solution. The fruit is taken from the bins, each grade being kept separate, thoroughly rinsed to take away impurities, then spread uniformly on trays, and at once put into the evaporator. Those who advocate this method claim that the cured product is superior in all respects to the dipped fruit and commands a higher price in the market, more than enough to offset the extra expense of drying.

The time of exposure of the fruit in the evaporator must be determined by observation and experience and the degree of heat. From twenty to twenty-four hours is the average time required for drying.

If exposed too long it not only lessens the weight of the product, but injures the quality; if not long enough, the result will be fermentation and mold.

Grading.—After the trays are removed from the evaporator the fruit is put into bins, where it is stirred occasionally and allowed to remain until it has passed through the sweating process. In the case of prunes, they are passed over a grader, which separates them into the different grades, as 20's to 30's, 30's to 40's, and so on, according to size, the grades indicating the number of dried prunes to the pound. Evaporated apples are graded according to quality and are sold on the market under three different brands, the best as "Fancy" second as "Choice," and third as "Prime." None but the best quality of white-fleshed varieties should be used for the highest grade, "Fancy."

Chops.—After using the main crop of apples for the three grades above mentioned, there still remains a lower grade that can not be worked into the above-mentioned class, but which can be profitably utilized by chopping the whole fruit without peeling or coring into coarse pieces and converting it by evaporation into what is known as "Chops." This has a considerable commercial value for export purposes.

Cores and skins.—In the preparation of apples for evaporation the saving of the cores and skins is an additional source of profit accruing from the commercial disposition of the orchard products. This may be accomplished by evaporation under the same treatment given to the solid parts of the fruit. When properly cured they become an article of commercial value in the home and foreign markets, and are used in the manufacture of jellies and wines.

EVAPORATORS.—Many different kinds of evaporators are now offered for sale, and upon the right selection of one of the many success greatly depends. Careful investigation of the various machines should be made before purchasing, with a view to finding the one that will produce the best results at the least cost, and of such capacity as shall meet the wants of the purchaser. Great improvements have been made in evaporators since their first introduction; hence, the necessity of a thorough study of the latest and most improved. There are two principles or methods involved in the process of evaporation as now practiced; one is by the use of heated air made to circulate as rapidly as possible throughout the box or room in which the trays of fruit are placed, and the other is by means of steam pipes passing back and forth through the chamber of the evaporator. This latter method is of comparatively recent introduction, and is found to be the most economical and satisfactory where the business is carried on extensively. The heat is more evenly distributed to all parts of the room and the temperature is uniform, avoiding all danger of scorching

the fruit, which is liable to occur in the use of hot air, where some of the trays are in close proximity to the fire. The use of steam will no doubt in time supersede all other methods. But whichever method is used, if the heat is not sufficient or the circulation of air imperfect, the product will not be of the best quality of evaporated fruit, but will instead be more like the sun-dried article, dark colored, tough, with less of the natural flavor, and the juices may have undergone a slow process of fermentation.

CANNING.

The canning process is so simple and generally so well understood in its application to fruits and vegetables that it seems hardly necessary to go into extended details on the subject. The fundamental principle involved is that of sterilizing or destroying the microbes of fermentation by the application of heat. Fruits properly preserved in this manner retain much of the natural flavor and richness and are both healthful and nutritious. Almost every household in the rural districts may have at hand ready for use all the necessary canning material for putting up a sufficient supply of fruit for home consumption. With a little experience and study of the methods, every housewife may become a proficient canner, and thus be able to save much of the fruit that otherwise would be lost. Tin cans are much less expensive and surer of success than any other. They may be sealed with wax prepared for the purpose, but cans sealed in this way will only do for home use, as they will not stand transportation. The safe and only method for sealing cans for commercial purposes is by soldering the caps, by which more thorough sterilization may be effected. As heat is the all-important factor in destroying ferment germs, it is essential that these principles be understood in order to insure successful work. The fruit after being prepared substantially the same as for evaporation, and after the addition of a sufficient amount of sugar to sweeten to taste, should be submitted to a boiling heat until thoroughly scalded through, and put into the cans at once, filling them as full as possible and sealing immediately, making them absolutely air-tight.

In canning, a lower degree than 212° F. is generally unreliable, and as this degree applied only for a sufficient length of time does not, as a rule, unduly cook ordinary fruit, it may be adopted as a safe standard.

All classes of fruit may be preserved by this process, but it is especially satisfactory for such fruits as peaches, pears, and all kinds of small fruits.

It is therefore a valuable aid in the absence of a convenient market in saving the surplus of a crop or any portion of it which may become overripe.

EXTRACTING THE JUICE.

This might properly be termed the clearing-up process as generally followed. All culls and tailings of the crop are dumped in the stock to be worked up for cider and vinegar, as it is not often necessary to work up by this process any of the first and second grades to save them from waste. A market can generally be found near by for all firm, first-class fruit, and canneries and evaporators are common at every town throughout the rural districts, which offer a market for all second-grade fruit; hence, it is the third grade, composed of damaged and refuse fruit, that this process saves to the grower.

CIDER.—Cider, for a beverage, to be healthful and palatable, should be made from clean, sound fruit, and of varieties that contain the essential constituents for making a first-class article.

All worm-infested, half-rotten, and immature fruit should be thrown out to be worked with the stock for vinegar, and the manufacturer should bear in mind that his goods should be a wholesome as well as a palatable beverage. Neatness and care in this line are as important to the consumer as in any other manufactured pure food.

The process consists in grinding or grating the fruit sufficiently fine to yield up its juice readily under proper pressure.

There are various kinds of machinery manufactured for use in cider making, but one that will extract the juice most thoroughly is the one that will be most profitable.

In selecting machinery the efficiency of a press is as important (if not more important) as that of a grater, for, no matter how thoroughly the pulp may be reduced, if the press power be insufficient more or less waste will occur in extracting the juice.

Fermentation.—It is a well-known fact that fermentation is due to the growth of certain fungous yeast plants in the fermenting fluid, and it is from this knowledge that an explanation is afforded for many of the difficulties that arise in the process and which point out the means best adapted to meet them successfully. The condition most favorable to the rapid growth of these plants, such as juices rich in saccharine matter and a warm temperature, produce a quick, active fermentation, whereas the watery juices deficient in glucose cause them to grow so weakly that a slow fermentation sets in and creates great difficulty at first to increase its activity and afterwards to arrest it.

The fermentation of cider, as described by Downing, is conducted as follows: The newly filled casks, with their bungs out, are placed either in a cool cellar or in the open air, and as the scum works out the barrel is kept filled with some of the same must reserved for this purpose. In a few days the rising will commonly cease, which indicates that the first fermentation is over. The bung is now closed, and in two or three days driven in firmly, leaving a small venthole

open, which should also be stopped a few days later. The clear cider is now racked off by siphon into a clean cask, and if in a few days it is found to remain quiet, a gill of finely powdered charcoal is added to each barrel, when it is closed and left until spring. In March it is again racked off, and if the cider is not quite bright, three-quarters of an ounce of isinglass, previously dissolved, is added to each barrel. In a few days it will be fit for bottling, and this may be done at any time up to May.

ORCHARD BRANDY.—Another product of the orchard may readily be obtained from the refuse of apples, when it is thought desirable to do so, just as it is from that of grapes after wine making. The pomace from the press is added to the lees in the first racking, with a sufficiency of water, and refermented. As soon as the active fermentation is over and the lees settle to the bottom, the spirits may at once be distilled from the liquor, or it may be distilled with better results from the cider after the first fermentation of the must. In either case the distillation should be effected by means of the water bath, or the brandy will have a rancid taste. The brandy will vary in flavor and strength according to the richness of the must and the care with which it has been made.

VINEGAR.—The manufacture of vinegar does not in its first stages exact the same care in treatment as that of cider. The process of grinding and pressing is the same. The juice is placed in vats or casks and exposed to the action of the air, which causes it to undergo vinous and then acetic fermentation. After remaining in this condition for a sufficient length of time it should be drawn off into clean casks, care being taken to prevent the sediment from entering with the juice. In these new vessels it must still be exposed to the action of the air until acidified, when it should be again drawn off into clean casks, the same care being observed regarding the sediment. In this second set of new vessels it must still be exposed to the action of the air until thoroughly acidified, when it should be again drawn off and closed up tight to prevent putrefactive fermentation.

Vinegar, pure and wholesome, is generally made from apples and grape juice, although an equally fine article may be made from refuse pears, cherries, and other fruits.

FRUIT JUICES, UNFERMENTED WINE, AND FRUIT SIRUPS.—These may be put up and preserved by the same process as described for canning fruits, but glass jars or bottles are preferable to tin for this purpose. For the best results, such fruit juices should be carefully expressed, strained, and kept quiet until well settled, and only the decanted pure juice canned or bottled. All such preserved fruit juices make delicious, wholesome, and nourishing nonalcoholic summer drinks. They have an appetizing value in cookery. The demand for such goods is constantly increasing.

JELLIES.—This is one of the most tasty and attractive forms in which fruit is put upon the market. Jelly is made from pure fruit juice and sugar in equal proportions. Apples, quinces, apricots, plums, grapes, strawberries, etc., may be used in its manufacture. Fruits for jellies should not be overripe, and should contain a certain amount of pectic acid, a gelatinous substance soluble in fruit juice, but which, when combined with sugar, exposed to heat for a certain time and then cooled, causes the juice to coagulate, thus forming jelly.

There are many jelly manufactories in the United States at present, and the annual output of the jelly trade has been estimated at 20,000,000 pounds. The business is a profitable one, and the demand for the product is annually increasing, its low price enabling all to indulge in it. The larger part of the jelly now made is from the apple. Much apple jelly flavored with other fruit flavorings is sold for the jelly of fruits less disposed to form jelly.

UTILIZING THE FALLEN PRODUCT.

Through the attacks of insects, which become numerous in some orchards, and through violent windstorms and severe droughts, a portion of the product will prematurely fall and be wasted unless means are used to save it.

This fallen fruit is unfit for any purpose except for swine food, and it is therefore advisable to turn hogs into the orchard to forage upon it, thus converting it into a food for an animal having a commercial value, and at the same time causing the destruction of the infesting insect larvæ and preventing the future increase and spread of such damaging agents.

Thus, it will be seen that there is no necessity for any waste occurring in any portion of the product of an orchard under economical management, as all parts of the fruit may be profitably saved by the several methods presented.

What has been said has been more especially in regard to saving the product of the smaller or family orchard, but the principles involved are the same whether applied to large or small establishments, and the means may be provided according to the necessity of the larger or smaller operation.

CONSTRUCTION OF GOOD COUNTRY ROADS.

By Maurice O. Eldridge,
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INTRODUCTION.

As "the road is a type of civilized society," it becomes the duty of every enlightened nation to solve the great questions of road construction and maintenance to its own satisfaction and good. Rome's greatness marked an era in road construction which was never before surpassed, and which has been equaled only in the present century and in the most civilized countries.

The condition of the public roads in the United States is probably worse than in any other civilized country in the world. This condition is due largely not only to the undeveloped condition of the country and to the allowing of local circumstances to determine location, etc., but to the lack of knowledge on the part of many road officials as to the primary principles of road construction, resulting in the injudicious use of millions of dollars of the public money annually.

Quoting an eminent authority, "The increased cost of haulage actually done is by no means the only loss resulting from bad roads. The loss of perishable products for want of access to market, the failure to reach markets when prices are good, and the failure to cultivate products which would be marketable if markets were always accessible, add many millions to the tax of bad roads," not to speak of the detriment to social communication, education, and religion. In fact the movement for good roads deeply concerns every commercial, financial, and social interest in the land. "We are handicapped in all the markets of the world by an enormous waste of labor in the primary transportation of our products and manufactures while our home markets are restricted by difficulties in rural distribution which not infrequently clog all the channels of transportation, trade, and finance."

PRESENT WORK TO BE CONDUCTED WITH A VIEW TO FUTURE IMPROVEMENT.

All the important roads in the United States can be and probably will be macadamized or otherwise improved in the not distant future. This expectation should govern the present management of roads everywhere; no labor or expense should be expended upon them

other than that which leads to their ultimate improvement as hard roads.

Many roads of this country were originally laid out without any attention to general topography, and in most cases followed the settlers' path from cabin to cabin, the pig's trail from his favorite nut-producing trees to his wallow in the mud and water of the swamps, or the boundary line of farms regardless of grades or direction. Most of them remain to-day where they were originally located, and where untold labor, expense, and energy have been wasted in trying to haul over them and in endeavoring to improve their deplorable condition. It is a great error to continue to follow these primitive paths with public highways. The proper thing to do is to call in a good road engineer and have the location so changed as to throw the roads around the ends or along the sides of the steep hills and ridges instead of continuing to go over them, or in raising the roads up on dry, solid ground, instead of splashing through the mud and water of the bogs and creeks in the lowlands.

LOCATION.

If a road goes over a hill when it might go around, the labor and expense put upon it are absolutely wasted, and the sooner its direction is changed the better. If a road is not rounded up and surface drained, it should be, not only for present use as an earth road but as a preliminary to macadamizing. If it is not underdrained in all wet spots, this should be the first work done. Nothing indeed will pay better for present use than putting in tile or stone drains.

In laying out a road, straightness should always be sacrificed to obtain a comparatively level surface. Although this is one of the most important principles connected with road building, it is one of the most frequently violated. There is no objection to an absolutely straight road, but graceful and natural curves conforming to the lay of the land add beauty to the landscape besides enhancing the value of property.

GRADES.

Good roads should wind around hills instead of running over them; and in many cases this would not increase their length, as it is no further around some hills than over them. Moreover, as a general rule, the horizontal length of a road may be advantageously increased, to avoid an ascent, by at least twenty times the perpendicular height thus saved; for instance, to escape a hill 100 feet high it would be better for the road to make such a circuit as would increase its length 2,000 feet. The reasons for this are manifold, the principal one being that a horse can pull only four-fifths as much on a grade of 2 feet in 100, and gradually less as the grade increases until with a grade of 10 feet in 100 he can draw but one-fourth as much as he can on a level road.

As a chain is no stronger than its weakest link, just so the greatest load which can be hauled over a road is the load which can be hauled up the steepest hill on that road. The cost of haulage is, therefore, necessarily increased in proportion to the grade, as it costs one and one-half times as much to haul over a road having a 5 per cent grade and three times as much over one having a 10 per cent grade as on a level road. As a perfectly level road can seldom be had, it is well to know the steepest allowable grade. If the hill be one of great length, it is best to have the lowest part steepest, upon which the horse is capable of exerting his full strength, and to make the slope more gentle toward the summit to correspond with the continually decreasing strength of the fatigued animal.

It has been estimated that a horse can pull better where the road is slightly undulating; say, where it has a level stretch, then a slight grade not steeper than 1 foot in 125 feet, and following this a decline of the same steepness, etc. In this way three different sets of muscles are brought into action, and while the one is being used the others are being rested. It is hardly necessary to recommend the construction of roads according to this principle at present, as we are a long way from even comparatively level ones. That the principle is a true one, however, is proved by the fact that a bicyclist finds it easier and more restful to ride over slightly undulating roads than over absolutely level ones.

All things being considered, the horizontal grade of a road should never be greater than 3 feet to the 100, nor less than 1 foot in 125 feet.

DRAINAGE.

Inasmuch as all things are governed by nature's law, and nothing by chance, we can only expect to secure economy by a strict observance and application of those principles which are in perfect harmony with that law. Water will not flow up hill, neither will it flow off into ditches when there are no ditches made for it to flow into; on the contrary, water flows in that direction where the least resistance to the laws of gravity exists; if that is down the middle of the road, then you will find after each heavy rain the "tell-tale" gully. Water, being the greatest enemy of the road, it should flow freely off the surface. This is accomplished by preparing the bed so that there may be a fall from the center to the sides of 6 inches, never exceeding 9 inches, on a road 30 feet wide; for a road 18 to 20 feet wide, from 3 to 4 inches is enough. A ditch should be constructed on either side of the road to carry away easily and quickly all water from the road and vicinity. These ditches should have a continuous fall throughout their entire length, and their size should depend upon the amount of water they are expected to carry. Water should never be allowed to flow across a roadway; culverts, tile drains, or, if nothing better can be had, a hollow log should be provided for that purpose.

In order to have good roads, it is just as necessary that water should not be allowed to attack the substructure from below as that it should not be permitted to percolate through it from above. Especially is the former provision essential in cold climates, where if water is allowed to remain in the substructure the whole roadway is liable to be broken up by frosts or destroyed by the wheels of vehicles. Where roads run over low, wet lands or over certain kinds of clayey soils, surface drainage is not all that is necessary.

Underdrains are easily and cheaply made and, when properly constructed with the best tools and materials available, will last for ages. They should be about 4 feet deep and carefully graded at the bottom so as to have a fall throughout their entire length of at least 6 inches for each 100 feet in length. Tile drains should be used if possible, but if they can not be secured, large flat stones can be carefully placed so as to form an open channel at the bottom. Slim fagots of wood or brush bound together in bundles and laid lengthwise at the bottom will answer fairly well. The ditch should then be filled with field stones, small stones, or gravel, or, if none of these can be had, with soil. The drains should be protected by straw, sod, or brush, so as to prevent the soil from washing in and clogging them.

THE SURFACING OF ROADS.

A great difference in roads lies in the nature of their surface. On a well-made gravel road one horse can draw twice as much as he can on a well-made earth road, while on a hard and smooth stone road he can pull four times as much. Consequently, where we have good gravel roads, instead of earth ones, it is possible to make one horse do the work of two, while on stone roads one horse will do the work of four. On a level steel road one horse can do the work of twenty or more horses over a level common road.

After a road has been properly located, graded, and drained, the important qualities of hardness and smoothness should by all means be secured. The various surfaces for good country roads will be considered in the following order: Earth, gravel, and stone.

EARTH ROADS.

For earth roads, as commonly built, there is little to be said. They should be tolerated only in a new country or where there is absolutely nothing but earth of which to make them. Yet, with earth alone a passable road can be made and maintained, if sufficient care is taken to have it thoroughly rolled and drained and the surface kept in a proper condition.

Whenever the subgrade soil is found unsuitable, it should be removed and replaced with good material rolled to a bearing. On the prepared subgrade the earth should be spread, harrowed if necessary, and then rolled to a bearing.

FIG. 1.—AN IDEAL GRAVEL ROAD IN SOLDIERS' HOME GROUNDS, WASHINGTON, D. C.

FIG. 2.—UNITED STATES OBJECT-LESSON ROAD AT GENEVA, N. Y. (PLACING THE MACADAM FOUNDATION.)

FIG. 1.—SURFACING A MACADAM ROAD IN MASSACHUSETTS.

FIG. 2.—STATE ROAD IN MASSACHUSETTS. (LAYING THE TELFORD FOUNDATION.)

With narrow roads, enough material may be excavated to raise the roadway above the subgrade in forming the side ditches by means of road machines. If material can not be secured as indicated, the required earth should be obtained by widening the excavations, or from cuttings on the line of the new roadway, or from borrow pits close by. When the earth is brought up to the final height it is again harrowed, then trimmed by means of road levelers or road machines, and ultimately rolled to a hard and smooth surface.

No filling should be brought up in layers exceeding 9 inches in thickness. During the rolling sprinkling should be attended to whenever the character of the soil requires such aid for its proper consolidation. The cross section of the roadway must be maintained during the last rolling stage by the addition of earth as needed. On clay soils a layer of sand, gravel, or ashes spread on the roadway will prevent the sticking of clay to the roller. The finishing touches to the road surface should be given by the heaviest roller at hand. Before the earth road is open to traffic the side ditches should be cleaned and left with the drain tiling in good working order.

GRAVEL ROADS.

Where good packing gravel is easily obtained, a satisfactory road can be made by covering the prepared surface for a greater or less depth with this material. (See Pl. XXIV, fig. 1.) Blue gravel or hardpan and clean bank gravel, when properly mixed and placed, give a surface almost like concrete in hardness.

The most excellent gravel for road building stands perpendicular in the bank, compact and firm, and can not be dislodged except by use of the pick, and when it is dislodged falls in great, solid chunks. Such material contains just enough cementing properties to enable it to readily pack and consolidate, and when properly placed on the prepared roadbed makes a surface which possesses most all the qualities of a good stone road. Rounded or water-worn gravel should never be used for the surfacing of roads, as such gravel remains loose and shifting, like materials in a shaken sieve. For the wearing surface gravel should be comparatively clean, hard, angular, and tough. Such gravel is easily consolidated, and will not readily pulverize into dust and mud.

The foundations for stone and gravel roads are too often neglected. It is well to remember that without a durable foundation there is no durable road. The cross section of the foundation should conform to that of the finished road, and should be so thoroughly rolled that wagons passing over it make no perceptible impression.

A layer of gravel not less than 4 inches nor more than 6 inches in thickness should then be spread on, sprinkled thoroughly, and rolled until very compact and firm. Next, spread another layer of the best gravel available over the surface to a depth of not exceeding 4 inches.

All inequalities, together with stone and gravels exceeding three-fourths of an inch in diameter, should then be raked out. It is again sprinkled and rolled until the desired hardness and smoothness are obtained. The roller is doubtless the most important piece of machinery connected with the building and maintaining of roads, and it is well to remember that it can not be used too often, especially in the spring, when the frosts and rains are so destructive.

STONE ROADS.

The advantages to be derived from good stone roads are so manifold that all other material should be discarded where tough road stone is available for their construction and maintenance. But it is greater economy to use earth or gravel than to go to the expense of macadamizing roads with too soft, too brittle, or rotten material. Many use this because it is more easily prepared. A road should never be surfaced with anything short of trap rock or serpentine. Inferior material may often be used with impunity for the first layer or foundation, but even this should be selected with great care.

The evils resulting from improper construction of stone roads are even greater than those from the use of improper material. John L. Macadam never intended that a heterogeneous conglomeration of stone and mud should be called a macadam road. Neither did he intend that the name should be applied to roads constructed of large and small stones mixed together and spread upon the surface. The surface of a road built in this manner is constantly disturbed by the larger stones, which work to the surface and which are knocked hither and thither by the wheels of vehicles and the feet of animals. Such methods of construction can not be too severely condemned.

PROPER CONSTRUCTION OF ROADS.

Broken-stone roads may be conveniently divided into two classes—macadam and telford. The principal difference between these two constructions is as to the propriety or necessity of a paved foundation beneath the coating of broken stone. Macadam denied the advantage of this, while Telford supported and practiced it. This point will not be argued here, but it is suggested that good judgment should be used in the selection of one or the other of these systems. The macadam system is the best under some conditions, while the telford is more advantageous under others. The latter system seems to have the advantage in swampy, wet places, or where the soil is in strata varying in hardness, or where the foundation is liable to get soft in spots. Under most other circumstances experienced road builders prefer the macadam construction.

The earth foundation for either system is identical. It should have the same slopes from center to sides as the finished road, with sufficient shouldering to hold the stone in place at the sides. All vegetable

matter should be removed and the earth made perfectly smooth and of uniform quality. It should then be thoroughly rolled until hard and dry.

MACADAM.

The first course or foundation of the macadam road can be made of the coarsest stones from the crusher, provided that they are of uniform size, and that each stone shall weigh not over 6 ounces, and will pass through a 2½-inch ring. (See Pl. XXIV, fig. 2.) Where the road is to be 8 inches thick this foundation should be 4 inches after rolling. If the road is to be of greater thickness than 8 inches, the foundation should be composed of two courses, separately rolled.

After having thoroughly rolled this foundation apply enough ground stone or coarse sand to fill the interstices. This should be wetted and thoroughly rolled until a hard and uniform surface is obtained. Upon this foundation the surface material should be placed, wetted, and thoroughly rolled. The stones of which this surface material is composed should be, if possible, crushed to a size of 1 inch in diameter, but if that is not possible they should never be larger in diameter than 1½ inches.[1] Ground-stone screenings should then be spread upon the surface, wetted, and rolled as before, until a hard, smooth surface is obtained. (See Pl. XXV, fig. 1.)

TELFORD.

The telford foundation is composed of stones of various sizes, not exceeding 10 inches in length and 6 inches in breadth on the broadest side, nor 3 inches in thickness on the narrow side. These stones are placed lengthwise across the road, breaking joints as near as possible; the interstices are filled with stone chips, all projecting points are broken off, and the whole structure is wedged, consolidated, and made as firm as possible. (See Pl. XXV, fig. 2.)

In case the finished road is to be 10 inches in thickness, this foundation should not exceed 6 inches in depth. If large stones are used, so as to necessitate a greater thickness than 6 inches, there should always be an allowance made for a 4-inch broken-stone surface.

This foundation should be covered with coarse sand or stone screenings, or if neither of these can be obtained, fine loam may be used, so that all voids may be filled and the whole brought to a hard and uniform surface by thoroughly rolling. A layer of broken stone is then added and treated as in the macadam system. Where the funds will permit and the traffic requires it, a regular two-course macadam surface may be placed upon the telford foundation with good result.

[1] Macadam declared that a stone of over 1 inch in diameter was detrimental in a road, as it had a tendency to tip when the wheels came over it, and thus move the adjacent material. This rule does not apply to the foundation material, however, as he allowed 6-ounce stones therefor.

ROAD MAINTENANCE.

Without proper care the most expensive road may go to ruin in two or three years, and the initial expense of constructing it be nearly lost. It is of greatest importance, therefore, that all good roads should have daily care. They not only wear out, but wash out and freeze out. Water is the greatest road destroyer.

It is necessary to the proper maintenance of a road that it should "crown" or be higher in the middle than at the sides. If it is flat in the center it soon becomes concave, and its middle becomes a pool or a mud hole if on a level or a water course if on an incline.

A hollow, rut, or puddle should never be allowed to remain, but should be evenly filled and tamped with the same material of which the surface was originally constructed. A rake should be used freely, especially in removing stones, lumps, or ridges. Ruts may be avoided by using wide tires on all wagons which carry heavy loads. If this is not always possible, the horses should be hitched so that they will walk directly in front of the wheels. This can be accomplished by making the double, or whiffle, tree of such length that the ends may be in line with the wagon wheels. A horse will not walk in a rut unless compelled to do so, and, consequently, if all horses were hitched in this way ruts would eventually disappear from stone roads.

If stones are cracked on a road with a hammer a smooth surface is out of the question. Use stone chips for repairing stone roads, and remember that all foreign material and rubbish will ruin the best road, and that dust and mud will double the cost of maintenance.

Ordinarily the chief work done by country people on highways is repairing the damage resulting from neglect. Why this negligence? The adage, "A stitch in time saves nine," can never be applied more appropriately to anything than to the maintenance or repair of all kinds of roads.

CONCLUSION.

The above comprises the general principles of road construction and maintenance, in conformity with which the art of road making depends essentially for its success. The proper conception and fulfillment of these principles will result in rapidity, safety, and economy of transportation.

THE PUBLIC DOMAIN OF THE UNITED STATES.

By Max West, Ph. D.,

Of the Division of Statistics.

INTRODUCTION.

There are within the limits of the United States, exclusive of Alaska and the new island possessions, nearly 573,995,000 acres of vacant Government land, besides 145,122,000 acres in Indian reservations, forest reserves, national parks, reservoir sites, and military reservations, or for some other reason reserved from settlement. The vast area of Alaska, which is very nearly all public land, together with lesser areas in Hawaii, Puerto Rico, and other new dependencies, will bring up the total extent of the national domain, exclusive of reservations, to nearly 1,000,000,000 acres. The table on page 326 shows the distribution of the public land by political divisions, and also compares the amount of public land in each State and Territory with the amount appropriated. The latter includes lands owned by the States and by public and private corporations, as well as all lands either actually owned by individuals, or "entered," though not yet patented, under the land laws of the United States. Since there are in the Western United States some 262,000,000 acres still unsurveyed, the figures given should be taken as being only approximately rather than absolutely correct; and besides the areas shown there are probably a few small isolated tracts of public land remaining undisposed of in Ohio, Indiana, and Illinois. The figures refer to the conditions existing on June 30, 1898, as shown by the report of the Commissioner of the General Land Office, except that corrections and additions have been made for forest reserves set aside since that time, and for the public lands of Hawaii. The table shows that more than 30 per cent of the area of the United States proper is still vacant public land, while about 7⅔ per cent is reserved.

Future additions to the reservations for permanent forests and reservoir sites will no doubt diminish the area open to settlers, but these additions are likely to be counterbalanced in whole or in part by the opening of Indian and military reservations to settlement. The 1,000,000 acres granted to each of the arid States by the so-called "Carey act" will still further reduce the amount of land to be obtained by settlers directly from the National Government, but doubtless without reducing the total amount of public land available for settlement. At the present rate of disposal to individuals, the vacant lands in the United States proper would last for nearly a century.

Areas of vacant, reserved, and appropriated lands.

States and Territories.	Unappropriated and unreserved.		Reserved.		Total Government land.		Appropriated.		Total.	
									Acres.	Per cent of land area of United States.
	Acres.	*Per cent.*	*Acres.*	*Per cent.*	*Acres.*	*Per cent.*	*Acres.*	*Per cent.*		
Alabama	522,373	1.60	86,240	0.26	608,613	1.86	32,049,387	98.14	32,658,000	1.72
Arizona	51,734,783	71.07	[1] 15,372,262	21.12	67,107,045	92.19	5,685,455	7.81	72,792,500	3.83
Arkansas	3,696,990	11.02	1,920	.01	3,698,910	11.03	29,844,590	88.97	33,543,500	1.77
California	42,443,023	42.72	[1] 16,249,170	16.35	58,692,193	59.07	40,668,890	40.93	99,361,083	5.23
Colorado	39,708,551	59.81	6,225,533	9.38	45,934,084	69.19	20,456,566	30.81	66,390,650	3.49
Florida	1,757,275	4.98	19,840	.06	1,777,115	5.04	33,487,385	94.96	35,264,500	1.86
Idaho	44,207,949	83.68	1,939,869	3.67	46,147,818	87.35	6,682,382	12.65	52,830,200	2.78
Indian Territory	.....	.....	19,575,040	100.00	19,575,040	100.00	.....	.....	19,575,040	1.03
Kansas	1,060,883	2.02	987,875	1.89	2,048,758	3.91	50,334,242	96.09	52,383,000	2.76
Louisiana	755,545	2.62	1,474,834	5.11	2,230,379	7.73	26,632,869	92.27	28,863,188	1.52
Michigan	505,895	1.37	87,746	.24	593,641	1.61	36,225,359	98.39	36,819,000	1.94
Minnesota	5,720,326	11.07	4,983,409	9.64	10,703,735	20.71	40,985,705	79.29	51,689,440	2.72
Mississippi	383,950	1.29	.....	.....	383,950	1.29	29,301,050	98.71	29,685,000	1.56
Missouri	445,911	1.02	.....	.....	445,911	1.02	43,350,089	98.98	43,796,000	2.30
Montana	71,567,296	75.13	[1] 11,464,533	12.03	83,031,829	87.16	12,227,891	12.84	95,259,720	5.01
Nebraska	10,548,450	21.47	70,522	.14	10,618,972	21.61	38,518,367	78.39	49,137,339	2.59
Nevada	61,358,609	87.23	5,983,409	8.51	67,342,018	95.74	2,994,482	4.26	70,336,500	3.70
New Mexico	54,550,795	69.76	[1] 8,356,488	10.69	62,907,283	80.45	15,289,722	19.55	78,197,005	4.12
North Dakota	20,574,613	45.82	3,050,610	6.79	23,625,223	52.61	21,277,764	47.39	44,902,987	2.36
Oklahoma	7,007,222	28.31	7,207,160	29.11	14,214,382	57.42	10,539,281	42.58	24,753,663	1.30
Oregon	35,897,869	58.25	5,467,702	8.87	41,365,571	67.12	20,260,647	32.88	61,626,218	3.24
South Dakota	12,784,426	26.55	[1] 11,120,906	23.09	23,905,332	49.64	24,253,223	50.36	48,158,555	2.53
Utah	43,870,056	83.43	[1] 5,451,307	10.37	49,321,363	93.80	3,258,637	6.20	52,580,000	2.77
Washington	13,442,582	31.49	11,131,345	26.08	24,573,927	57.57	18,110,157	42.43	42,684,084	2.25
Wisconsin	413,799	1.17	365,353	1.04	779,152	2.21	34,495,848	97.79	35,275,000	1.86
Wyoming	49,035,663	78.54	[1] 8,216,643	13.16	57,252,306	91.70	5,180,694	8.30	62,433,000	3.29
Other States	.....	.....	232,119	.04	232,119	.04	578,791,910	99.96	[2] 579,024,029	30.47
Total, exclusive of outlying Territories	573,994,834	30.21	145,121,835	7.64	719,116,669	37.85	1,180,902,532	62.15	1,900,019,201	100.00
Alaska	[3] 369,526,041	[3] 100.00	([4])	.....	369,526,041	[3] 100.00	3,559	.....	369,529,600	.....
Hawaii	[5] 1,772,640	41.71	.....	.....	1,772,640	41.71	2,476,960	58.29	4,249,600	.....
Total [6]	945,293,515	41.57	.....	.....	1,090,415,350	47.96	[7] 1,183,383,051	52.04	2,273,798,401	.....

[1] Including forest reserves withdrawn from entry since July 1, 1898. [2] Land area of Ohio, Indiana, Illinois, and Iowa, formerly public-land States, as given in the General Land Office reports, 117,913,629 acres; land area of eighteen Eastern States, the District of Columbia, and Texas, according to the Eleventh Census, 461,110,400 acres. [3] Nearly. [4] Area unknown. [5] Including leased lands. [6] Exclusive of Puerto Rico, Guam, and the Philippine Islands. [7] Total area disposed of by the National Government, 720,027,810 acres, including 3,559 acres in Alaska.

In the case of land grants in aid of railroad construction, lands within the limits of the grants are considered "unappropriated and unreserved" until selected by the grantee, though it is not certain that the usage of the various land offices is uniform in this respect. It follows from this mode of classification that to ascertain the amount of land still available for entry a deduction should be made from the amount given as "unappropriated and unreserved" to represent that portion of railroad grants not yet selected by the railroad companies. While no exact figures are available for this purpose, the General Land Office estimates the total amount of land granted to aid in railroad construction at 156,893,468 acres, and as the amount patented up to July 1, 1898, was but 88,947,862 acres, the remainder is a little less than 68,000,000 acres. It is, however, very unlikely that patents will actually issue to the grantees for half that quantity of land, for some portions of the grants had been appropriated by settlers before the grants were made, and still larger areas are so mountainous and barren as to be scarcely worth selecting and patenting. A deduction of 25,000,000 acres from the area unappropriated and unreserved would probably be sufficient to cover future patents on account of railroad land grants. These grants consist of the alternate sections lying within wide strips of territory crossing the western part of the United States, and in some cases indemnity lands have been granted beyond the limits of the original grants. The Northern Pacific Railroad grant extends in a band 40 miles wide across Minnesota and 80 miles wide across North Dakota, Montana, the northern end of Idaho, and Washington; the Union Pacific and Central Pacific Railroad grants are in a strip 40 miles wide extending from the Missouri River across Nebraska, southern Wyoming, northwestern Utah, Nevada, and California, to San Francisco, with branches in Colorado and Kansas and northward through California and Oregon; the Atlantic and Pacific and Southern Pacific Railroad grants extend from the Rio Grande in New Mexico across Arizona and California to San Jose, with a branch to the southeastern corner of California. There are also many smaller grants in the more easterly public-land States, besides several wagon-road grants in Oregon and elsewhere.

PUBLIC LANDS FIT FOR PRODUCTIVE USES.

Far more important than the exact area of the public domain legally open to settlement is the question how much of this public land is actually fit for cultivation or for other productive uses. Having regard to present conditions, it must be admitted that all the best parts of the public domain have been appropriated, and that comparatively very little good agricultural land remains open to settlement; the mineral value of that which remains may be very great, but even of the mineral deposits it may be said that the most accessible and

most easily worked among them have probably been appropriated. Looking into the future, the question becomes much more difficult, for no one can tell even approximately how much of the land now lying waste may be ultimately reclaimed to productive uses. The one thing needed, as far as concerns the greater part of the 573,995,000 acres of vacant public land in the United States proper, including nearly all west of the ninety-eighth or one hundredth meridian, is an adequate supply of water; and this applies to much of the mineral land, as well as to that which it is desired to reclaim for agricultural purposes. Vast tracts of arid land in the Western United States contain in an unusual degree all the elements of fertility except water, and with the aid of irrigation could be made to yield more abundantly than even the best land of the humid regions. It has been said that "sagebrush is unerring evidence of kindly soil and abundant sunshine."

Estimates of the amount of this land which can be irrigated with the water at command vary greatly, but there is none for the arid region as a whole more authoritative than those of Maj. J. W. Powell, formerly Director of the United States Geological Survey, and Mr. F. H. Newell, chief hydrographer of that Survey. Major Powell estimated that at least 150,000 square miles, or 96,000,000 acres, could be economically reclaimed by irrigation within the present generation; or, as he said before a Congressional committee in 1890, that about 100,000,000 acres could be reclaimed by the utilization of perennial streams alone.[1] Mr. Newell places the irrigable amount at 74,000,000 acres,[2] or about 7.6 per cent of the total area of the sixteen Western public-land States and Territories. This is a very conservative estimate, in which financial as well as engineering considerations are taken into account, and it looks not to the remote future, but only to what is likely to be profitable and therefore practicable within a generation. Future improvements in irrigation engineering and methods and discoveries of new underground water supplies, together with the increasing demand for agricultural products resulting from an increasing population, may in the course of time make it profitable to irrigate a much larger area; but any attempt to state the ultimate extent of irrigation would be only conjecture. The amount of land irrigated in 1889, the latest year for which census figures are available, was in most of the arid States so small in proportion to the estimated irrigable area as to be almost negligible in a rough calculation, so that it will not be far from the truth to take Mr. Newell's conservative figures as representing the probable future increase of the irrigated area. But it must be remembered that some part of the lands to be reclaimed will probably be lands now in private ownership. Although the area

[1] First Annual Report of the United States Irrigation Survey, 1888-89, pp. VII, 14; Second Annual Report of same, 1889-90, p. 204.

[2] The Public Lands and their Water Supply. (Extract from the Sixteenth Annual Report of the United States Geological Survey, 1894-95, p. 494.)

now irrigated is very small as compared with the total irrigable area, the canals and ditches already constructed take most of the water which is easily obtainable, and the future development of the West depends mainly upon the construction of storage reservoirs and large canals, or other difficult and expensive undertakings which are beyond the power of individuals or small groups of individuals. Much will therefore depend upon the policy adopted for attracting capital to the irrigation industry. It is evident that the work of reclamation must be undertaken either by public agencies or by large corporations.

PUBLIC RESERVATIONS.

As shown by the table following, the land reserved from settlement consists mainly of Indian reservations and forest reserves; but there are also numerous military reservations and reservoir sites, seven national parks, some unconfirmed Spanish and Mexican private land grants in New Mexico and Colorado, and probably some unpatented portions of grants in aid of railroads, which are included in the area reserved. The figures given under the head of "Forest reserves" include some small areas which do not really belong to the reserves, though included within their boundaries. The "reservoir sites" do not include all sites selected by the United States Geological Survey, but only lands actually withdrawn from settlement. The area of the military reservations in the public-land States and Territories, as shown by the records of the General Land Office, is 786,838 acres; but according to a recent compilation made in the Judge-Advocate-General's Office, which includes national cemeteries and military parks and reservations purchased by the Government as well as those reserved from the public domain, the total area for those States and Territories is more than 835,000 acres. The General Land Office figures are here given for the public-land States, however, as the areas of some of the smaller reservations are unobtainable from any source, and the figures are thus made comparable with those given in former General Land Office reports and in the Sixteenth Annual Report of the United States Geological Survey. The comparison shows that the area devoted to military reservations in the Western States has been diminished by one-half within three or four years. Illinois, which the General Land Office report still treats as a public-land State and credits with 750 acres, is here included among "other States." The table does not include grounds occupied by public buildings in the District of Columbia and elsewhere; nor does it include the Afognak Forest and Fish-Culture Reserve, the military reservation at Fort St. Michaels, or any of the other reservations in Alaska. It is impossible to make the total agree with the total "area reserved" as given in the General Land Office report, because in several Commonwealths the sum of the areas of the Indian, forest, and military reservations alone is greater than the area given by the General Land Office as reserved.

Classification of lands reserved from settlement in the United States proper.

States and Territories.	Indian reservations.	Forest reserves.	National parks.	Reservoir sites.	Military reservations.	Other reserved land.	Total
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Alabama					[1] 1,950	84,290	86,240
Arizona	15,150,757	4,496,000	[2] 480	3,960	101,412		19,752,609
Arkansas			[3] 912		15	993	1,920
California	406,556	8,571,794	[4] 1,130,240	3,463	86,997	6,050,210	16,249,170
Colorado	1,021,230	3,103,360		33,875		2,067,068	6,225,533
Florida					15,573	4,267	19,840
Idaho	1,364,500	4,008,960	[5] 38,400	1,561	1,925		5,415,346
Indian Territory	[6] 19,575,040						19,575,040
Kansas	28,279				22,649	936,947	987,875
Louisiana					1,515	1,473,319	1,474,834
Michigan	5,944				2,728	79,074	87,746
Minnesota	1,565,606				7	3,417,796	4,983,409
Mississippi							
Missouri					1,000		1,000
Montana	9,382,409	5,649,000	[5] 118,400	33,201	257,344		14,831,345
Nebraska	124,053				56,719		180,772
Nevada	954,135					5,029,274	5,983,409
New Mexico	1,667,485	2,758,080		25,179	159,240	3,746,504	8,356,488
North Dakota	3,782,347						3,782,347
Oklahoma	6,949,715				26,880	230,565	7,207,160
Oregon	1,484,039	4,653,440			1,945		6,139,424
South Dakota	9,835,781	1,166,080			11,185	107,860	11,120,906
Utah	3,972,480	943,360		139,712	8,957	386,798	5,451,307
Washington	3,874,324	7,902,720	[7] 207,360		18,633		12,003,037
Wisconsin	393,177				1,046		394,223
Wyoming	1,810,000	3,241,760	[5] 1,897,000		8,458	1,259,425	8,216,643
Other States	[8] 188,853				[9] 43,266		232,119
Total	83,596,701	45,885,554	3,392,792	240,951	829,354	24,874,390	158,759,742

[1] Including a reservation partly in Mississippi.
[2] Casa Grande Ruin.
[3] Hot Springs Reservation.
[4] Sequoia, Yosemite, and General Grant National parks.
[5] Part of the Yellowstone National Park.
[6] Area according to the Commissioner of Indian Affairs, 19,822,888 acres.
[7] Mount Ranier National Park, created by act of March 2, 1899.
[8] New York, North Carolina, and Iowa.
[9] Connecticut, Delaware, District of Columbia, Georgia, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, and Virginia.

THE CHARACTER OF THE PUBLIC LANDS.

The table on page 331 gives approximately the areas of forest and woodland, grazing lands, and desert composing the public domain in fifteen Western States and Territories. It is based upon the estimates of Mr. F. H. Newell,[1] which show that of 609,000,000 acres of land vacant in these States and Territories in 1894 there were about 166,000,000 acres of forest and woodland, 374,000,000 acres of grazing land, and 69,000,000 acres of desert, or land too barren even for grazing.

[1] Sixteenth Annual Report of the United States Geological Survey (1894-95), p. 494.

Making allowance for the forest reserves which have been set aside since that time, and also for some areas which have been opened for settlement, and estimating the probable division of lands entered by settlers between timber and grazing land, the land now unappropriated and unreserved is found to consist of about 124,300,000 acres of forest and woodland and 365,400,000 acres of grazing land, with nearly or quite as much desert land as before.

Character of the vacant public lands in fifteen Western States and Territories.

States and Territories.	Woodland and forest.	Grazing land.	Desert.	Total.
	Acres.	*Acres.*	*Acres.*	*Acres.*
Arizona	6,900,000	29,800,000	15,000,000	51,700,000
California	900,000	22,500,000	19,000,000	42,400,000
Colorado	10,500,000	29,200,000		39,700,000
Idaho	24,600,000	19,600,000		44,200,000
Montana	19,800,000	51,800,000		71,600,000
Nebraska		10,500,000		10,500,000
Nevada	800,000	40,600,000	20,000,000	61,400,000
New Mexico	8,600,000	46,000,000		54,600,000
North Dakota	200,000	20,400,000		20,600,000
Oklahoma		7,000,000		7,000,000
Oregon	19,200,000	16,700,000		35,900,000
South Dakota		12,800,000		12,800,000
Utah	17,000,000	16,900,000	10,000,000	43,900,000
Washington	7,100,000	6,300,000		13,400,000
Wyoming	8,700,000	35,300,000	5,000,000	49,000,000
Total	124,300,000	365,400,000	69,000,000	558,700,000

In the present paper the public domain is briefly described by States and Territories (arranged in the order of the extent of public lands in each, except that Kansas is treated with the other Western States), with special reference to the amount of public land which can probably be made available for agricultural purposes. In discussing the possibilities of the arid region, Mr. Newell's estimates of the available water supply are adopted, but in some cases other estimates are given also for the sake of comparison. It will be observed that estimates made by local engineers are usually, though not in every case, considerably larger than those of Mr. Newell. The other data given are also taken almost wholly from official sources, including State and national publications. It should be borne in mind that the vacant public lands are not wholly unused at the present time, for grazing is permitted upon them without restraint, and thus they furnish sustenance to a vast number of sheep, cattle, and horses; but the area of good grazing land belonging to the public domain is in some localities being rapidly diminished by overstocking and too close grazing.

MONTANA.

About three-fourths of the total area of Montana, or 71,567,000 acres, is still vacant public land, mainly unsurveyed. Including reservations of all kinds, about 87 per cent of the State belongs to the

public domain. Little has been appropriated, except along the rivers, and even of the land so situated there is some still vacant. The greater part of the public land consists of mountain ranges, partly covered with forests, and arid plains, useful in their present condition only for grazing; but some vacant agricultural land is reported in nearly every section of the State except in the westernmost counties. More than 1,000,000 acres of "good farm land" are reported by the General Land Office in Carbon, Gallatin, and Park counties alone. Mr. Newell estimates that with the water supply now available a total area of about 11,000,000 acres can be irrigated. This is a little less than the amount already disposed of by the Government, but as much of the latter will probably remain unwatered, the area ultimately irrigated will doubtless include large tracts of what is now public land. The amount of irrigable land might be considerably increased by the construction of large canals to take water from the Missouri and Yellowstone rivers, but these flow so far below the surface of the plains to be watered that the expense would be very great. Much will depend upon the possibility of storing the spring floods; but according to the most hopeful view of the case, about one-fifth of the State is reclaimable from its arid condition. The opportunity for irrigation seems especially favorable in the southeastern part of the State, in the Yellowstone basin, the Yellowstone and Big Horn rivers carrying an amount of water in excess of any probable demand. The greater part of the State, however, lies within the Missouri basin, where perhaps 1,000,000 acres may be irrigated by an economical use of the water supply. This central portion of the State is nearly all between 2,000 and 7,000 feet above the sea, the greater part having an altitude of about 3,000 or 4,000 feet. In the western end of the State are vast areas of forest and woodland, partly on the mountains.

The climate of Montana is mild for the high latitude, and one of its features is an early spring. The agricultural products which are grown most extensively are hay, oats, wheat, barley, potatoes, and vegetables. Apples and other hardy fruits are also raised successfully. The principal industries of the State thus far, however, are mining and stock raising. The mountains in the western part of the State are rich in both precious and base metals, while coal is found also in several places farther east. Transportation facilities are provided by the Northern Pacific and Great Northern railroads, which traverse the State from east to west, with a few branch lines in the western half, and by a branch of the Union Pacific system from Idaho. The Northern Pacific Railroad land grant extends in a broad curve from the eastern boundary to the northwestern corner of the State.

NEVADA.

The vacant public land of Nevada amounts to about 61,358,000 acres, or very nearly seven-eighths of the total area—a larger proportion than in any other State. There are in addition nearly 6,000,000 acres

reserved from settlement. Of the 3,000,000 acres or less no longer in the hands of the National Government, by far the greater part is included in a 2,000,000-acre grant to the State for the support of common schools, and in minor grants for various other purposes. The amount taken up by individuals is therefore a very small proportion of the State's surface, and it is scattered in small tracts along the borders of streams, the only considerable areas being in the western corner of the State, near Lake Tahoe. The vacant public land is described in the General Land Office report as mountainous, arid, grazing land, with little or no timber; but it appears to include also the greater part of numerous small valleys lying between the mountain ranges.

Nevada forms most of the western and central part of the Great Basin, and with the exception of small areas in the northeast and southeast, contributes no water to the ocean. The streams either flow into saline lakes or are dissipated by evaporation and by sinking into the ground before forming any considerable bodies of water.

The surface of the State is a diversified plateau, and, exclusive of mountain peaks, ranges in altitude from 800 feet in the southeast to 7,000 feet in the northeast. The variations in altitude, together with the great length of the State from north to south, make the climate suitable for the production both of semitropical fruits and of the grains and fruits of the temperate zone. As yet, however, Nevada's agricultural possibilities have scarcely begun to be developed.

Nevada is often referred to as the most arid State in the Union, yet the water supply will undoubtedly be found sufficient to reclaim a large extent of land near the streams and springs, but now forming part of the desert. The United States Geological Survey's estimate of the amount of irrigable land in Nevada is only 2,000,000 acres. In 1889 the State board of reclamation and internal improvements estimated the amount at 12,000,000 acres. According to the estimate of the Nevada commission of the National Irrigation Congress, of which the State surveyor-general was chairman, Nevada has about 6,000,000 acres of arable land capable of irrigation, this estimate being made on the basis of 1 acre-foot of water to an acre, permitting the application of water amounting to 12 inches in depth each year. The possible sources of this water supply are given as follows:

Sources of water supply for irrigation.

	Acre-feet.
Truckee, Carson, and Walker rivers	1,000,000
Humboldt River	1,000,000
Salmon, Bruneau, and Owyhee rivers	400,000
Quinn River	175,000
Rio Virgin	100,000
Small streams and springs	2,411,000
Total surface waters	5,086,000
Subsurface supply, say	914,000
Total	6,000,000

The utilization of the amount of water indicated involves extensive storage of spring floods in reservoirs, as well as the use of underground waters where possible. There are many natural reservoir sites along the principal streams, consisting of the beds of ancient lakes or other depressions, a number of which have been reserved by the National Government for reservoir purposes. In some cases the amount of water which can be retained in reservoir sites already known is greater than is needed for the arable land within reach. Artesian waters have been obtained in some parts of the State, but not in large quantities. Springs are numerous, but in some cases contain too much mineral matter to be available for irrigation. In the Humboldt Basin the amount of land which has already been alienated, including that granted to the Central Pacific Railroad, is greater than can probably be irrigated; but in the remainder of the State the area estimated to be irrigable, even excluding underground supplies, is greater than the amount which has been patented. Agriculture without irrigation can not be carried on except in a few of the lower valleys.

Thus far the principal industries of Nevada have been stock raising, carried on largely on the public lands, and mining. The silver mines which made the State famous still contain quantities of fairly good ore, and it has recently begun to be questioned whether Nevada is not as much a gold as a silver State. Several less precious metals are also found, as well as a variety of other mineral substances, including coal, granite, sulphur, gypsum, alum, niter, borax, soda, salt, chalk, soapstone, and mineral soap. But the mining interests, as well as the agricultural, suffer at present from lack of adequate transportation facilities.

NEW MEXICO.

New Mexico has about 54,550,000 acres of public land open to settlement, 8,356,000 acres which are reserved for various purposes, and 15,290,000 which have been appropriated. Most of the land in private ownership consists of large private land grants from the Spanish and Mexican governments, but recognized by patents from the General Land Office. Vast tracts of land remain undisposed of in the eastern and southern parts of the Territory, and to a less extent in the northwestern corner, just east of the Navajo Indian Reservation. This land consists of both mountains and arid plains, some portions of which are too arid even for grazing. There is some timber scattered through the Territory, and minerals exist in the mountains in great variety and in unknown quantities.

For its water supply New Mexico is dependent upon the Rio Grande and the Pecos with their tributaries, the Canadian River in the northeast, and a few smaller streams which rise near the western boundary and cross it on their way to the Colorado. The Rio Grande and its tributaries are so far below the level of the surrounding country as to be unavailable for irrigation except to a limited extent where the canyons widen out into narrow valleys. There are many

good reservoir sites, and it is estimated that about 4,000,000 acres can be irrigated with the aid of sufficient capital. Wells have been fairly successful in various parts of the Territory.

Alfalfa, wheat, oats, barley, Kafir corn, and sugar beets are among the important crops of New Mexico. The climate seems to be especially well adapted also to fruit raising. Throughout most of the Territory, however, the raising of sheep and cattle will doubtless continue to be the chief industry. The Territory is traversed by a number of railroads, and along the Rio Grande Valley especially the transportation facilities are good.

ARIZONA.

Arizona contains 51,734,000 acres of Government land open to settlement, besides several large reservations for the use of Indians and for other purposes. Only about 5,685,000 acres have passed out of the hands of the Government. The vacant public lands are variously described as mountainous, broken, arid, grazing, and timber lands. It is estimated that nearly one-half the total area of the Territory is excellent grazing land, and the climate is favorable for stock raising, which thus far has been a more important industry than the raising of crops. The cultivation of the soil by the aid of irrigation is coming to be of more and more importance, however, especially in the valleys of the Gila and Salt rivers, which are supposed to have been used in the same way by some prehistoric people. New canals in course of construction in these valleys are expected to water considerable areas of what is now public land. It is thought that a single large dam can be constructed which will hold back enough water to irrigate all the vacant land in the Salt River Valley, the soil of which has been found on analysis to be richer than that of the Nile. The Colorado River, which flows through the northern part of the Territory and forms its western boundary, is confined in such deep canyons that it is impossible to divert its waters, except in the extreme southwest, where it is hoped that a sufficiently long canal will bring them out upon the plains. Mr. Newell estimates the amount of land in Arizona reclaimable in the near future without too great expense at 2,000,000 acres, but the irrigation engineer of the Arizona Experiment Station has estimated that more than 6,000,000 acres can be irrigated in the Gila and Salt River valleys alone, and that by utilizing all the reservoir sites in the Territory at least one-fourth of its entire area could be reclaimed.

The northern and eastern part of the Territory is a high plateau, bordered and marked off from the lower lands of the south and west by abrupt precipices, and covered for the most part by an immense forest, mainly of yellow pine. Although Arizona as a whole is one of the most arid sections of the country, there are some places on the plateau and in the valleys among the mountains where agriculture is carried on without irrigation. The diversity of climate is so great that the products include both the grains of the temperate zone and

semitropical fruits—oranges, lemons, figs, raisins, dates, almonds, olives, and bananas being raised successfully and ripening a month or six weeks earlier than in any other part of the United States. Successful experiments have been made in raising sugar beets and canaigre, and in the Salt River Valley strawberries are said to ripen every month in the year. The most important staple crop continues to be alfalfa, which supplies the elements most lacking in the soil. There are mines of copper, gold, and silver, and a variety of other mineral deposits.

Arizona is traversed by the Southern Pacific Railroad near the Mexican boundary and by the Atlantic and Pacific farther north, and these two trunk lines are connected and supplemented by local railways.

UTAH.

In Utah there are 43,870,000 acres of unappropriated public land, more than three-fourths of which is still unsurveyed. Two large Indian reservations, together with smaller amounts of land reserved for other purposes, swell the total of Government land in the State to 49,321,000 acres, the amount appropriated being only 3,259,000 acres. The public lands which are open to settlement are partly mountainous, and practically all the remainder is so arid as to require irrigation to fit it for agricultural uses. There are only a few places in the State where "dry farming" has been at all successful.

The western half of Utah forms the eastern part of the Great Basin, and includes an arid region southwest of Great Salt Lake known as the Great American Desert, while the portion of the State lying east of the Wasatch Mountains drains into the Colorado River and its tributaries. More than half the area of the State is from 4,000 to 6,000 feet above sea level, and nearly all the remainder lies still higher, many mountains exceeding an altitude of 10,000 feet. The rugged contour of the country leaves many excellent reservoir sites which can be utilized without great expense. Besides the works already constructed, seven or eight reservoirs definitely projected are designed to reclaim more than 100,000 acres of land now lying waste, and there are several other reservoir sites selected as such by the United States Geological Survey. The water supply of Utah, according to Mr. Newell's estimate, would be sufficient, with a good system of storage, to irrigate 4,000,000 acres; the estimate of the Utah commission of the National Irrigation Congress was 3,654,000 acres, divided as follows:

Sources of water supply for irrigation.

	Acres.
Salt Lake drainage system	2,155,520
Colorado drainage system proper	1,117,180
Sevier Valley drainage system	283,500
Southwestern drainage system	97,800
Total	3,654,000

About 1,350,000 acres of this irrigable land are on the Indian reservations, where agriculture is already carried on by means of irrigation; and altogether something over 1,000,000 acres of the irrigable land in the State are already under ditch,[1] this being about one-third of the amount of land in private ownership. The lands ceded to the State on its admission to the Union include about 1,304,000 acres of the irrigable land, so that after a million acres have been reclaimed under the Carey act there will be little, if any, irrigable land to be obtained by settlers directly from the National Government.

Among the more important agricultural products of Utah are alfalfa, wheat and other cereals, sugar beets, garden produce, and fruits, including especially apples, pears, peaches, plums, and grapes. Stock raising and mining are among the leading industries.

The Union Pacific and Central Pacific railways meet in the northern part of the State, reaching thence north and south by means of the Oregon Short Line, while the Rio Grande Western extends from Ogden and Salt Lake southeastward, with short branches in various other directions.

IDAHO.

The public land still open to settlement in Idaho amounts to 44,207,000 acres, or nearly 84 per cent of the entire area of the State. It consists mainly of forest-covered mountains in the northern and central portions of the State, and farther south, of lava plains on which the sagebrush grows luxuriantly; but some vacant agricultural land is reported among the mountains in the northernmost counties, where dry farming is successfully carried on.

Idaho lies to the west and south of the Bitter Root Mountains, the Snake River traversing its broad southern end and forming part of its western boundary, where it is joined by the Boise, the Payette, the Weiser, the Salmon, and the Clearwater. There is thus, on the whole, a large and well-distributed water supply, but the largest rivers, the Snake, Salmon, and Clearwater, are for the most part considerably below the level of the surrounding country. In the Snake Valley is one of the largest tracts of irrigable land in the West, but its reclamation as a whole will require large and expensive works.

The Payette River receives much of its water from heavily timbered areas, where the snow is late in melting, and hence it has a large and fairly constant volume, more than sufficient to irrigate all the agricultural land in the valley through which it flows. It is proposed to divert some of the surplus into the valley of the Weiser, and to use it both along the Weiser itself and south of its mouth along the Snake. The Boise River also is thought to be large enough, with economical use, to reclaim its entire valley. In the southeastern corner of the State water can be taken from the Bear River to water a large tract

[1] Brough, "Irrigation in Utah," p. 106.

of land near Chesterfield and Bancroft at a moderate cost per acre. In other localities much land may be reclaimed by the development of natural reservoir sites. Artesian wells have brought water to the surface, or nearly to the surface, in various parts of the State, and in some places it has been found possible to bring the underground flow out on the land by means of trenches. The amount of irrigable land in the State is estimated by Mr. Newell at 7,000,000 acres;[1] the State engineer makes a more conservative estimate of 4,000,000 or 5,000,000 acres. In 1896 it was estimated that existing canals would irrigate 1,250,000 acres, only one-fourth of which was then actually under cultivation.

The leading industries of Idaho are mining and stock raising. The principal crops thus far have been hay, cereals, and vegetables; but the soil and climate have been found to be well adapted to the cultivation of sugar beets, prunes, apples, peaches, pears, grapes, and cherries. The Snake River Valley has excellent transportation facilities in the Oregon Short Line Railroad, while the northern part of the State is crossed by the Great Northern and Northern Pacific roads.

WYOMING.

Wyoming contains about 49,035,000 acres of public land open to settlement, besides 8,216,643 acres reserved for various purposes. Of the latter amount, 1,897,000 acres are in the Yellowstone National Park, almost an equal amount is in the Wind River Indian Reservation, and 3,241,760 acres are devoted to forestry.

The vacant public land is valuable chiefly for grazing and timber, and in many places for coal, oil, and other mineral products; but there are vast areas which need only irrigation to transform them into very productive farms. The water supply is fairly abundant and well distributed, and is estimated to be sufficient to reclaim 9,000,000 acres. The principal streams available for this purpose are the North Platte River and its tributaries in the southeast, the Green in the southwest, the head waters of the Cheyenne in the northeast, and the Big Horn and Powder rivers, which rise in the central part of the State and flow northward into Montana. There are still some places where land can be reclaimed without great expense by small ditches; but as these places are more than 6,000 feet above the sea level, hay is almost the only important crop that can be depended upon to mature there. The better lands can be reclaimed only by means of reservoirs and large canals, requiring considerable capital; but in the Big Horn basin and elsewhere there are large tracts of public land so situated that the expense of reclamation would be by no means

[1] In the Sixteenth Annual Report of the United States Geological Survey the estimate is only 1,500,000 acres, the difference being made up by additions to North Dakota and South Dakota. The figures quoted in this paper are from Mr. Newell's paper as published separately.

excessive. The best agricultural land in the State is said to be that lying along the Platte River and along the northern border east of the Big Horn Mountains. In nearly all cases the ditches thus far constructed water only the bottom lands near the rivers, leaving the upper bench lands, where the soil is even better, to be reclaimed by more extensive works in the future.

The tillable lands of Wyoming lie from 3,500 to 7,000 feet or more above sea level, higher on the whole than the agricultural land of any other State. There are high mountain ranges in the north and west and a few peaks near the southern boundary. The climate has been found to be well adapted to the cultivation of cereals and grasses, while the raising of hardy fruits is also becoming an important industry. There is a lack of railroad facilities in the central and northwestern part of Wyoming, but the Union Pacific Railroad traverses the southern part of the State, while the eastern part is served by the Northwestern and Burlington systems and by local lines, and the Oregon Short Line enters the southwestern corner.

CALIFORNIA.

In California the vacant public land aggregates 42,443,000 acres, or a little more than the amount which has been appropriated. There are also seven forest reserves, besides the General Grant, Sequoia, and Yosemite national parks, and several small Indian reservations.

Topographically, California consists of the Sierra Nevada and Coast ranges of mountains, with a broad, level valley between them and narrow exterior strips of comparatively low land. Through the central valley flow the Sacramento River in a southerly and the San Joaquin in a northwesterly direction to Suisun Bay and the Golden Gate. Tributary to these rivers are a number of streams which rise in the Sierra Nevadas, while the Klamath in the extreme north and many shorter streams flow directly into the Pacific Ocean. There are also many small streams which contribute their waters to interior lakes or are used up in irrigation near their source in the mountains. There is thus an abundant water supply, and California as a whole can scarcely be called an arid State. The annual rainfall is not very deficient in quantity, but during August, September, and October there is drought; from this it results that while grains can be raised successfully without irrigation in many of the valleys, artificial watering is essential to orchard crops except in the most humid sections. Dry farming has been carried on to some extent in every county in the State, and there is a considerable area along the Sacramento and San Joaquin rivers which is too wet, and where the problem is one of drainage instead of irrigation. The great mass of vacant public land, however, is in the arid southeastern part of the State, east of the forest reservations in the mountains. San Bernardino County, containing a large part of the Mohave Desert, has 7,500,000 acres of

public land, and Inyo County, in which Death Valley is situated, has 5,700,000 acres, including some land on which crops might be raised. In the northern part of the State the largest amounts of public land are in Siskiyou and Lassen counties. In the former there are 2,300,000 acres of mountainous, grazing, timber, mineral, and farming land; nearly five-sixths of the latter county is still public land, much of which is irrigable from Honey Lake, Eagle Lake, and other sources, while the remainder consists of nonirrigable grazing land and mountains, partly timbered. Small amounts of agricultural land are still vacant in a number of other counties.

It is estimated that altogether 17,000,000 acres of California lands are capable of irrigation, but it is doubtful how much of the land now vacant will be reclaimed in that manner; a large part of the available water supply may be used to irrigate lands which have been already cultivated without irrigation. There are, however, projects for reclaiming part of the desert in the extreme southeast, especially near Salton Sink, which, like Death Valley, lies below sea level, and which in 1891 and 1893 was covered by natural overflows from the Colorado. Artesian wells are extensively employed in southern California and in the San Joaquin Valley, and many of the natural reservoir sites have been utilized.

California, as a whole, is fairly well supplied with railroads, and both the Santa Fe and the Southern Pacific systems have lines crossing the large tract of public land in the southeast; but there are some counties in the north and east of the Sierra Nevadas where the development of the fruit industry has been hindered by lack of transportation facilities.

COLORADO.

In Colorado there are still 39,708,000 acres of public land, exclusive of reservations, or nearly twice as much as the amount in private ownership. The public land is mainly in the mountainous western half of the State, where almost none has been appropriated except along the borders of streams; but there is a greater or less amount of it in every county. More or less vacant agricultural land is reported from every part of the State, as well as large areas of grazing and mineral lands, the latter including extensive coal deposits. The vacant land ranges for the most part from 5,000 to 10,000 feet above sea level, but there is a little as low as 4,000 or 4,500 feet, mainly in the east.

The rainfall in Colorado is light, but more than 60 per cent of the total usually occurs during the crop-growing season, so that in good years dry farming is fairly successful in the eastern part of the State. The irrigable area is estimated by Mr. Newell at 8,000,000 acres, of which 890,735 acres were already irrigated in 1889; but State Engineer Cramer computed in 1894 that there were 54,152,000 acre-feet of water available yearly, and that over half the mesa and valley lands, or

more than 20,000,000 acres, could probably be irrigated, while less than 2,000,000 acres were then under cultivation. Considerably more than half of the surface-water supply is on the western slope of the mountains, where most of the public land is situated, but the valleys of the Grand, Yampa, and White rivers and their tributaries are narrow for the most part, and the plateaus are too far above the water to be irrigated without great expense. On the plains east of the mountains the only large rivers are the South Platte and the Arkansas, and the amount of water obtainable at present is not sufficient for the land already under ditch; but by storage of the spring floods and by more careful use of water, with the aid of artesian and other wells, it is expected to extend the irrigated area very materially, and it may be made to include some of the lands now vacant. The Rio Grande, which rises among the mountains in the southern part of the State, already serves to irrigate extensive areas.

The principal agricultural products of Colorado, besides hay, are the common cereals, which are raised both with and without irrigation, and the various fruits of the temperate zone. The western slope is becoming famous for its peach orchards and vineyards. Tobacco has been successfully raised in several counties, and sugar beets can probably be raised on both sides of the mountains, where irrigation is possible. Numerous railway lines afford excellent transportation facilities throughout the State, except in the northwestern corner.

OREGON.

The vacant public land in Oregon amounts to 35,897,000 acres, or more than half the area of the State, besides Indian, forest, and military reservations, which bring the total up to 41,365,000 acres. Nearly all the land owned by individuals is included in a narrow strip along the coast and a somewhat wider strip between the Cascade and Coast ranges, and in a few counties along the northern boundary.

West of the Cascade Mountains the rainfall is so abundant that agriculture is carried on for the most part without irrigation, the Willamette Valley especially being considered an excellent farming country; and there is still a little vacant agricultural land left in this humid portion of the State, in Clackamas and Marion counties in the north, and farther south in Douglas and Coos counties, besides much timber and grazing land among the mountains. East of the Cascade Range is a vast plateau, varying in elevation from about 2,000 to 5,000 feet above sea level, and similar in general character to the plains of Idaho, while south of this is that part of the Great Basin which extends into Oregon. It is in this eastern part of the State that much the greater part of the public lands are situated, and rough estimates show that they include fully 4,000,000 acres of agricultural land, besides large areas of grazing land and timber. Wheat and other cereals are grown here also without irrigation, but not without

risk of failure from lack of rain; and irrigation is practiced to a considerable extent, though mainly as yet by means of short ditches. There are numerous small rivers tributary to the Snake and the Columbia, and while most of the water now runs to waste in the early spring, it is estimated that by constructing reservoirs and using artesian-well waters about 3,000,000 acres in eastern Oregon can be irrigated. Where irrigation is practiced the cereal crops are usually supplemented by the raising of fruits, vegetables, and forage crops. Besides agriculture and stock raising, mining is carried on to some extent in eastern Oregon as well as in the mountains farther west.

There are several railroads in the Willamette Valley, and the Willamette River is navigable throughout more than half its course. Other railroads run along the northern border and across the northeastern corner of the State, but through most of eastern Oregon there are no better means of communication than wagon roads.

WASHINGTON.

In Washington there are now only 13,442,000 acres of vacant public land, an amount considerably less than that which has been appropriated. Indian and forest reservations, etc., make the total public land about 24,573,000 acres. The largest areas of unappropriated land are in the northern, northeastern, and central portions of the State.

Washington is similar to Oregon topographically, being divided by the Cascade Mountains into a coast region with abundant rainfall and a region of semiarid lava plains. The Columbia River flows in an irregular course through the eastern division of the State, and after being joined by the Yakima on the west and the Snake on the east, forms most of the southern boundary. The Columbia flows from about 1,000 to 2,000 feet below the surface of the surrounding plains, so that its waters can not be used to irrigate them; but the Yakima and its tributaries are used to some extent already, and there are excellent reservoir sites near their sources in which sufficient water can be stored to irrigate a large part of the valley, which includes much public land. Some streams elsewhere in the State can also be utilized, and artesian wells are successful near the eastern border, in Spokane and Whitman counties, and also near the foot of the Cascade Mountains. Altogether it is thought that 3,000,000 acres east of the mountains are irrigable. Agriculture is not wholly dependent upon irrigation, however, even east of the Cascade Range. Wheat is raised extensively without artificial watering, especially on the eastern half of the plains, and the irrigated areas are devoted largely to fruits, vegetables, and alfalfa. The vacant public lands include some tracts in the wheat belt, as well as much grazing land and vast mountain areas valuable chiefly for timber and minerals.

Washington is well favored in the matter of transportation, being

crossed by two transcontinental railways, and having a number of local roads in the eastern part. Okanogan County, which contains the greatest area of public land, lacks transportation facilities except along its southern boundary, but Stevens, Douglas, and Kittitas counties, which are next in order, have each two railroads.

NORTH DAKOTA.

The amount of vacant public land in North Dakota, 20,574,000 acres, is nearly equal to the amount which has been appropriated. There are also more than three million acres in Indian reservations. Most of the western half of the State still belongs to the public domain, but in the eastern half the amount of public land diminishes rapidly, and in the valleys of the James and Red rivers, where dry farming is most successful, there is hardly any left. In the western part of the State, where irrigation is most needed, there are only limited areas in which water can be easily secured. The Missouri River is so far below the surface of the arable land and has so slight a fall that its waters can be diverted only with difficulty and at great expense. Some of the Missouri's lesser tributaries, however, especially the short streams flowing from the north, may be made available for irrigation by the construction of storage reservoirs. East of the Missouri River the main dependence is upon artesian wells, which are already in use throughout a large territory for various purposes, and which promise to be of great importance in agriculture. In time much of the public land along the Missouri south of Bismarck will probably be watered in this manner.

The vacant public land is at present of value chiefly for grazing, but it is very fertile for the most part, and wherever irrigation is practicable can be made to produce abundant crops of wheat and other cereals, hardy fruits, etc., as well as forage crops. There is a little timber in the Turtle Mountain region in the extreme north, and deposits of lignite coal are found throughout nearly all the western half of the State.

The public lands in the western part of the State are crossed by the two northern transcontinental railways running nearly east and west, and diagonally by the Minneapolis, St. Paul and Sault Ste. Marie Railway.

SOUTH DAKOTA.

There are 12,784,000 acres of vacant public land in South Dakota, besides the greater part of the Black Hills Forest Reserve and a number of large and small Indian reservations, making the total amount of public land a little less than half the area of the State. There is comparatively little public land left east of the Missouri River, though there are few counties which have none at all; and there is little land open to settlement immediately west of the Missouri, except in Stanley County, because the river is bordered most of the way by Indian

reservations. In the southeastern corner of the State are several small tracts of swampy grazing land, amounting in the case of Charles Mix County to some thousands of acres. Most of the appropriated land in the western part of the State is along the Cheyenne River and the streams which flow into its southern fork from the Black Hills, and the largest areas of vacant land are in the northwestern corner, in the Bad Lands of the southwest, and between the Cheyenne and White rivers. It is thought that by water storage and the use of artesian wells at least 1,000,000 acres of South Dakota lands can be irrigated. There is an extensive and remarkable artesian-well area east of the Missouri, and recent investigations make it seem probable that this area extends also into the public lands of the western and northwestern portions of the State, in which case the estimate of the irrigable area will need to be considerably increased.

South Dakota is an important cattle raising and wheat and corn growing State, and does well in the production of flax. A large part of the State lies in the sugar-beet belt, and fruit raising also promises to be a very profitable industry. South Dakota is well supplied with railroads in the east and in the Black Hills region, but the portion of the State containing most of the vacant land is not easily accessible.

NEBRASKA.

Rather more than one-fifth of Nebraska, or 10,548,000 acres, is still vacant public land. Nearly all of this is in the north central and northwestern parts of the State, and consists mainly of a sandy soil, at present valuable only for grazing. There is a little vacant farming land reported in Custer County, near the center of the State, and there is some timber on public land in Dawes and Sioux counties, in the extreme northwest. Mr. Newell estimates that 1,500,000 acres of the semiarid western part of the State can be reclaimed for agricultural purposes by irrigation; the secretary of the State board of irrigation estimates that altogether 6,000,000 acres can be irrigated. The canals already built and under construction are estimated to cover more than a million acres.

The principal rivers of Nebraska are the Platte and its tributary the Loup, which drain the central part of the State, the Niobrara, which flows along the northern boundary, and the Republican in the south. The flow of the Loup and Niobrara is fairly constant throughout the year. There are also many springs and creeks from which water is easily obtainable. There are many artesian wells in Nebraska, but they are most successful in the northeastern part of the State, where there is now little public land. By the use of windmills or other machinery, however, underground water may be obtained for irrigation on a small scale in central and western Nebraska. The alkali in the soil is sometimes troublesome, especially where too much water is used, but in such cases sugar beets can often be grown with much

benefit to the soil. There are several railways crossing Nebraska, and one of them traverses the region in which is most of the public land.

OKLAHOMA.

The settlement of Oklahoma has progressed so rapidly that more than half the available land has been taken up, leaving only 7,007,000 acres of vacant public land. Nearly all the eastern half of the Territory has been appropriated, but Beaver County, comprising the strip of territory formerly known as "No Man's Land," together with some of the other western counties, is still mainly public land. There are also tracts of vacant land scattered through the central part of the Territory, including some agricultural and grazing land in Custer, Canadian, Woods, and Kingfisher counties. There is also timber in some of the western counties, and there is said to be some good farming land left in Greer County, in the southwest. In the western third of the Territory cattle raising is now the leading industry, the rainfall being often insufficient for farming; but, although the waters of the Cimarron, the Black Bear, and the Salt Fork of the Arkansas are unfit for irrigation, while the North Fork of the Canadian River is considered doubtful, it is estimated that 1,000,000 acres can be irrigated from wells and small streams. Artesian water has been found in Woods County, in the northern part of the Territory. Good crops of wheat and other cereals, cotton, etc., are raised in eastern and central Oklahoma, and wherever irrigation has begun to be employed the climate has been found very favorable to fruit raising. Cotton is successfully grown in the southern part. For a new country Oklahoma is well supplied with railroads, for there are a number crossing the eastern half of the Territory and one running diagonally across Woodward and Woods counties, while several more lines are more or less definitely projected.

KANSAS.

In Kansas there are only about 1,060,000 acres of vacant public land, this being but 2 per cent of the total land area, and a much smaller amount than in any other State so far west. It is nearly all in the western end of the State, the eastern half having only a few thousand acres of public land all told, and of poor quality. The vacant land is for the most part broken or rough grazing land, though some agricultural land is reported.

The principal streams of western Kansas are the Arkansas and Cimarron rivers in the south, the headwaters and tributaries of the Republican and Solomon in the north, and between these, the Smoky Hill River and its tributary the Saline. Especially in the extreme west, where irrigation is most necessary, the streams are either very small or often dry during the summer, and hence are of little value to agriculture without a system of storage. It is evident that water must be obtained very largely from underground by means of pumps,

which are already in use in many places, being driven either by wind or by gasoline or steam engines. The underground water is usually found near the surface and seems to be extremely abundant; and in the southwestern part of the State, especially in Meade and Hamilton counties, there are many successful artesian wells. It is probable that this underground supply will ultimately be used throughout western Kansas to irrigate a small area on each farm. Mr. Robert Hay, chief geologist of the United States artesian and underflow investigation, estimated that the underflow in this part of the State was sufficient to irrigate from 5 to 20 acres in each quarter section; while Mr. W. G. Russell, an assistant hydrographer for the United States Geological Survey in charge of the Kansas measuring stations, relies upon the rivers to water about 28 acres to a section. The president of the State Board of Irrigation Survey and Experiment estimates that altogether about one-sixth of western Kansas is irrigable; Professor Haworth, of the Kansas State University, calculates that from all sources more than half the total area of the State can be irrigated.[1] Mr. Newell's estimate allows nothing for Kansas, so that whatever area is found to be irrigable must be added to his total of 74,000,000 acres.

MINNESOTA.

There are still 5,720,000 acres of vacant public land in Minnesota, besides about 400,000 acres of Indian land opened to settlement since June, 1898. The vacant land is mainly in the extreme north, in the rather inaccessible region north and east of the Red Lake Indian Reservation; about one-half the whole amount is in the two counties of Beltrami and Itasca, large areas of which are still unsurveyed. Much of the public land in this part of the State is covered with timber, including pine, spruce, poplar, and hard woods, and a part is swampy; but there is also some which lacks only transportation facilities to make it valuable for farming. There are also unworked mineral deposits in Itasca, Saint Louis, Lake, and Cook counties; they are chiefly of iron, but there is a gold-bearing formation in the northern part of Itasca County, and nickel in the extreme northeast of the State. West of Duluth, in the country around Leech Lake and Millelacs, there are many thousand acres of timber, brush, and swamp; but the only public land in the southern half of the State is in small isolated tracts.

ARKANSAS.

Scattered through nearly every part of Arkansas are tracts of public land aggregating 3,696,000 acres, or more than one-tenth of the area of the State. Throughout eastern Arkansas the vacant land is timbered

[1] Seventh Biennial Report of the Kansas State Board of Agriculture, 1889-90, p. 133; Ninth Biennial Report, 1893-94, p. 333; Report of the Board of Irrigation Survey and Experiment, 1895-96, pp. 186, 190.

and partly swampy, with a little grazing land in Arkansas, Lonoke, and Prairie counties; in the southwest it is swampy for the most part, with a few thousand acres of timber in Ouachita County; while in the central and northwestern parts of the State it consists mainly of hills and low mountains, which are partly covered with timber, and among which there is some well-watered agricultural land.

FLORIDA.

The vacant Government land in Florida, not including the swamp lands granted to the State, amounts to 1,757,000 acres, or nearly 5 per cent of the entire land area. About one-third of this amount is in the northwestern extremity of the State, lying between Alabama and the Gulf of Mexico, the largest amounts being in Walton and Washington counties; the remainder is scattered about on the peninsula, and, except at the southern end, mainly in small tracts. The public domain in Florida consists mainly of low-lying pine land, with some swamps and marshes not yet selected by the State government. Extensive deposits of phosphates are found on the western half of the peninsula, and at the southern end there is a little rocky land of no apparent value.

LOUISIANA.

There are 755,000 acres of public land in Louisiana, besides nearly 1,475,000 acres reserved from settlement. Most of the vacant land is covered with pine, but there is some swampy land, especially in the extreme southeast, and there are several thousand acres of open prairie in the south and southwest. Along the Mississippi there is still some farming land to be had, with rich alluvial soil, but subject to occasional damage by floods. In the northwestern part of the State the land still available is sandy, with more or less clay.

ALABAMA.

The vacant public land in Alabama amounts to about 522,000 acres. It is mainly in the hilly or mountainous region which makes up the northern part of the State, and part of the remainder is sandy or barren; but there are also many thousand acres of unappropriated pine timber scattered through the southern half of the State, besides a little hard wood, and some marshy lands on either side of Mobile Bay which ought not to be very difficult to drain. Some agricultural land is reported in Clarke County, lying between two navigable rivers and less than 100 miles from Mobile; also a small tract of hilly farming land in Barbour County.

MICHIGAN.

The vacant public land in Michigan amounts to about 505,000 acres, scattered through the Upper Peninsula and the northern end of the Lower Peninsula. In the Upper Peninsula it is in large part sandy soil, partly covered with timber, mainly beech, birch, and hard

maple, with some pine, spruce, and hemlock. There is no unappropriated timber on the Lower Peninsula except a small amount in Kalkaska County; much of the remainder is a fair quality of agricultural land with light soil. The largest areas of public land in this part of the State are in Oscoda, Gladwin, Iosco, Montmorency, Crawford, and Presque Isle counties.

MISSOURI.

The public land in Missouri amounts to 445,000 acres, situated wholly in the southern half of the State, and mainly in the extreme south and southwest. It is nearly all rough or hilly land, covered with timber for the most part, but near the center of the southern half of the State, especially in Dallas, Laclede, and Pulaski counties, there is some open grazing land. There are said to be also some tracts suitable for fruit growing, and others probably containing mineral deposits of various kinds.

WISCONSIN.

Wisconsin contains only about 413,000 acres of public land, besides several small Indian reservations. The greater part of the vacant land is in the forest region comprising the eleven or twelve northernmost counties. The timber is partly pine and partly hard wood, and varies from dense forest to scattering woodland; there are also considerable areas of swampy land. There are several thousand acres of public land as far south as Adams, Juneau, and Monroe counties, but most of this is covered by a scattering growth of small oak trees, and the soil of the remainder is of poor quality.

MISSISSIPPI.

The public land in Mississippi amounts to only 383,950 acres. It is scattered throughout the State, except in the extreme north, but is mainly in the southeast corner and in Wilkinson and Franklin counties in the southwest. It is officially described as agricultural and timber land.

ALASKA.

Almost the entire area of Alaska is still public land, the only portions filed upon up to the close of the last fiscal year being less than 3,000 acres of mineral land, one town site, and a few small tracts used for manufacturing or commercial purposes. The inhabitants are now occupied mainly in mining, fishing, and fur hunting, but in the coast region of southeastern Alaska agriculture is expected to become of more and more importance. The temperature along the coast is very moderate for that latitude, with no violent fluctuations; the soil is fertile, though sometimes requiring to be drained; the rainfall is abundant, and there is a vast quantity of accessible timber. Grasses, vegetables, berries, wheat, and some other crops are already grown to a slight extent, and stock raising is practiced on a small scale.

HAWAII.

The Government lands in the Hawaiian Islands, including those formerly classed as Crown lands, amounted in August, 1898, to about 1,772,640 acres, of an estimated value of $5,581,000. The lands at present under lease yield a revenue of something over $100,000 a year. It is estimated that there are about 70,000 acres of public land suitable for coffee growing, which is said to be the coming industry of Hawaii, about 25,000 acres of cane lands, and nearly 1,000 acres of rice lands, besides 451,000 acres now used only for grazing and 681,000 acres of forest. Most of the remainder is either barren or mountainous, with the exception of 145 acres of valuable city lots in Honolulu and Hilo. About two-thirds of the Government land is on the island of Hawaii, the remainder being scattered about on the other islands of the group.

PUERTO RICO AND PHILIPPINE ISLANDS.

There are public lands in Puerto Rico from which some revenue has been derived in the past, but no exact information concerning their extent or character is available.

A very large part of the Philippine Islands is either uninhabited or inhabited only by wild tribes.

THE LAND LAWS.

The vacant public lands of the United States are open to settlement under various acts of Congress, the main provisions of which, together with some of the most important regulations made thereunder, are here briefly summarized:

HOMESTEADS.

Any citizen of the United States or any person who has declared his intention of becoming such, who is the head of a family, or has attained his majority, or has served in the Army or Navy in time of war, and is not already the proprietor of more than 160 acres of land in any State or Territory, is entitled to enter a quarter section (160 acres) or any less amount of unappropriated public land, and may acquire title thereto by establishing and maintaining residence thereon and improving and cultivating the land for a period of five years. In grazing districts stock raising and dairy farming are accepted in lieu of cultivation of the soil. Each homestead entryman is required to make affidavit that the application is made honestly and in good faith for the purpose of actual settlement and cultivation, and not for the benefit of any other person or corporation or for the purpose of speculation. Persons who served as soldiers or sailors of the United States in the civil war are entitled to have their period of service deducted from the homestead period of five years, and those who were discharged from service on account of wounds or disabilities may have the whole period of enlistment deducted; but

at least one year's residence is required in all cases. Homestead settlers not wishing to complete the five-year term of residence may obtain title to the land by paying for it in cash after a residence of not less than six months. In other cases, with the exception of certain lands formerly reserved for the use of Indians, the only payments required are certain fees and the cost of publishing notice of final proof. The fees for 160 acres of land in States lying east of the one hundred and fourth meridian amount to $14 at the time of making application and $4 at the time of making final proof; in the States and Territories lying farther west the corresponding payments are $16 and $6, respectively. When "double minimum" lands are entered the payments are somewhat higher. In the case of certain lands in Oklahoma, homestead settlers are required to pay from $1 to $2.50 an acre in addition to the usual fees; on the Chippewa lands, in Minnesota, they are required to pay $1.25 an acre; and on what was formerly the Great Sioux Indian Reservation, in Dakota, they are now required to pay 50 cents an acre, besides the fees.

DESERT LANDS.

A resident citizen of any of the arid-land States or Territories may obtain title to 320 acres or less of desert land therein by paying $1.25 an acre, by expending at least $1 an acre each year for three years in reclaiming the land by irrigation, in the purchase of water rights, and in permanent improvements, and by cultivating one-eighth of the land. One-fifth of the purchase money must be paid at the time of filing the application and the remainder at the time of making final proof, at any time within four years; the applicant must also pay for the publication of notice of final proof. The application must be accompanied by a map or plan of the land, showing the mode of irrigation proposed and the source of the water to be used, and at the expiration of the third year another map or plan must be filed, showing the character and extent of the improvements. Proof must also be given each year that at least $1 an acre has been expended in reclaiming the land. Any number of persons entering separate tracts may associate together in the construction of canals or ditches for irrigation, and may file joint maps.

The legal definition of desert land is "all lands exclusive of timber lands and mineral lands which will not, without irrigation, produce some agricultural crop." It thus includes lands naturally suitable for grazing, as well as deserts in the usual sense of the word. The desert-land law applies only to public lands in the States of California, Nevada, Oregon, Washington, Idaho, Montana, Utah, Colorado, Wyoming, North Dakota, and South Dakota, and the Territories of Arizona and New Mexico. No patent will be issued under this law to any person or association that already holds more than 320 acres of arid or desert land.

GRANTS OF DESERT LAND TO THE STATES.

The so-called "Carey act," which is really section 4 of the sundry civil act of 1894, as amended by the corresponding act of 1896, provides for the donation to each of the arid-land States of 1,000,000 acres of desert land, conditioned upon the reclamation of the land so granted by irrigation. Each State applying for land under this section is required to file a map of the land showing the proposed mode of irrigation and the source of the water. As fast as the lands are irrigated patents will issue either to the States or to their assigns; but no State is permitted to dispose of more than 160 acres to any one person, and any excess of the proceeds above the cost of reclamation is to be applied to the reclamation of other desert lands.

TIMBER AND STONE LANDS.

Public lands valuable chiefly for timber or stone and unfit for cultivation may be sold to citizens of the United States or persons who have declared their intention to become such, in quantities not exceeding 160 acres to each person or association, at $2.50 an acre.

ISOLATED TRACTS.

Isolated tracts of less than a quarter section of public land, which have been subject to homestead entry for three years after the surrounding lands have been appropriated, may be advertised for sale by order of the Commissioner of the General Land Office. Any person wishing to purchase an isolated tract must file in the district land office an affidavit describing the land and pay for the advertisement. Thirty days' notice is required after the land is ordered into the market, after which it is sold at public sale to the highest bidder, but not for less than $1.25 an acre. The amount which any person may purchase in this manner is limited to 160 acres.

PRIVATE ENTRY, PUBLIC SALE, ETC.

Public lands of the United States situated in the State of Missouri are still subject to private entry, and hence may in general be purchased at the rate of $1.25 an acre; but the alternate reserved sections within the limits of railroad grants, with certain exceptions, are held at the "double minimum" price of $2.50 an acre. Certain lands in other States, including the Osage Indian trust and diminished-reserve lands in Kansas, are also subject to private entry under special laws.

No public lands are now sold at auction except isolated fractional tracts, abandoned military and other reservations, and mineral and other lands authorized to be sold at auction by special acts of Congress.

No person is permitted to acquire title to more than 320 acres of public land, agricultural in character, under all the land laws.

The preemption and timber-culture laws have been repealed, except as to claims instituted before March 3, 1891.

INDIAN LANDS.

The President is authorized to allot lands in Indian reservations to the Indians in severalty, in amounts of one quarter section to each head of a family, one-eighth of a section to each single person over 18 years of age and each orphan under 18, and one-sixteenth of a section to each other single person under 18 years. When the lands are valuable for grazing only, double allotments are provided for. The United States holds the land in trust for the benefit of the allottees for twenty-five years, during which it can not be alienated; at the expiration of that time the land is conveyed in fee to the original allottees or their heirs. The Indian Territory, the reservations of the Seneca Indians in New York, and a certain strip of territory in Nebraska adjoining the Sioux Nation on the south, are excepted from these provisions.

Any portion of a reservation ceded by the Indians to the United States, adapted to agriculture with or without irrigation, is to be disposed of only under the provisions of the homestead law.

MINERAL LANDS.

Mineral lands are excepted from the provisions of the law relating to other public lands, but all valuable mineral deposits in the public lands are open to exploration and purchase by citizens of the United States and those who have declared their intention to become such, and by associations of such persons, under the mining laws and the local customs or rules of miners. Mining claims in general are of two classes, lode claims and placers. In the case of mining claims on veins or lodes of rock bearing valuable deposits, the maximum surface area permitted by law is a space of 1,500 by 600 feet. Labor must be performed or improvements made to the extent of at least $100 during each calendar year after that in which the claim is located until entry is made and the patent certificate issued. A patent may be obtained after the performance of labor or completion of improvements to the amount of $500 on payment of $5 for each acre or fraction thereof, the applicant paying also for publishing the notice of application. Mill sites on nonmineral land, not exceeding 5 acres in extent, may also be obtained at the rate of $5 an acre, and may be applied for and patented with the lode claim proper.

Placer-mineral claims are subject to entry and patent upon the same conditions as to labor and improvements, but the price is only $2.50 an acre. Placer claims on surveyed land must conform to the legal subdivisions of the public lands (including for this purpose 10-acre tracts), and the maximum size is 160 acres for an association or 20 acres for each individual. Lands chiefly valuable for petroleum or other mineral oils may be acquired under the provisions of law relating to placer-mineral claims, and lands chiefly valuable for building stone may be acquired either by placer entry or under the law relating to timber and stone lands.

Mineral lands in Michigan, Wisconsin, Minnesota, Missouri, Kansas, and Alabama are excepted from the provisions of the general mineral land law, and are either offered at public sale or disposed of in the same manner as agricultural lands.

Coal lands are sold for $10 an acre, or $20 an acre if situated within 15 miles of a completed railroad. The maximum amount which may be purchased by an individual is 160 acres; but associations of four or more persons which have expended $5,000 or more in improving and working a mine may enter as much as 640 acres.

Saline or salt-spring lands, except in certain States and Territories which have never received grants of saline lands by act of Congress, may be sold at public auction for not less than $1.25 an acre, and if not sold when so offered they become subject to private sale at the same minimum price.

TOWN SITES.

Title to public lands comprised in town sites may in general be acquired in either of the three ways described below:

(1) The President is authorized to reserve from the public lands town sites at any natural or prospective centers of population. The town lots are offered for sale at auction, and those not sold in that manner are held subject to private entry; but in no case may a lot be disposed of for less than its appraised value.

(2) When any persons have founded or desire to found a city or town on the public domain they may file with the county recorder a plat for not more than 640 acres, together with a statement of the extent and character of the improvements, transcripts of which are transmitted to the General Land Office and to the district land office. The lots may then be offered at public sale by order of the President, subject to a minimum price of $10 a lot, and those not so disposed of are thereafter subject to private entry at the same minimum price or at such reasonable increase or diminution as the Secretary of the Interior may order in view of the increase or decrease in the value of property. Before the day fixed for the public sale actual settlers are entitled to purchase the lots which they have improved at the minimum price. If no transcript map and statement are filed in the General Land Office within twelve months from the establishment of a town or city on the public domain, the Secretary of the Interior may cause the survey and plat to be made, in which case the minimum price of lots is $15. The usual minimum is also increased in the case of lots containing more than 4,200 square feet.

(3) Whenever any portion of the public lands is settled upon and occupied as a town site, the corporate authorities, or if the town is not incorporated, the judge of the county court, may enter the land so occupied at the proper land office, at the minimum price, in trust for the benefit of the several occupants, in which case the sale of lots

and the disposition of the proceeds are conducted as prescribed by the State or Territorial legislature.

In Oklahoma town sites are entered by boards of trustees appointed by the Secretary of the Interior, and must contain reservations of from 10 to 20 acres for parks, schools, and other public purposes.

ALASKA.

The homestead land laws of the United States, with some additional limitations, were extended to Alaska by the act of May 14, 1898. No homestead in that district may exceed 80 acres in extent or extend more than 80 rods along the shore of any navigable water; and along such shores every alternate space of 80 rods is to be reserved from entry. Any citizen of the United States or any association of such citizens occupying public lands in Alaska for the purposes of trade, manufacture, or other productive industry, which is needed for such purposes, may purchase not exceeding 80 acres of such land, not including mineral or coal lands, at $2.50 an acre, upon submitting proof that the area embraces improvements made by the claimant. Alternate spaces of 80 rods in width abutting on navigable waters are to be reserved, but the use of such reserved lands may be granted to citizens or associations for landings and wharves. Suitable tracts of land are also to be reserved as landing places for the natives. The Annette and Pribilof islands and the islands used for the propagation of foxes are excepted from the provisions of the act.

The Secretary of the Interior may sell timber from public lands, to be used in Alaska only, at an appraised value, but such sales must be limited to the actual necessities of consumption in Alaska from year to year. Actual settlers, miners, etc., are permitted to use limited amounts of timber for firewood, buildings, and certain other purposes free of charge.

The laws of the United States relating to mining claims are in force in Alaska, and town sites may be entered for the benefit of the occupants by trustees appointed by the Secretary of the Interior.

HAWAII.

The land laws of the United States have no application in Hawaii, and no provisions have yet been made for the disposition of public lands there; but it is provided in the joint resolution of annexation that all revenue or proceeds from such lands, exclusive of those occupied for civil, military, or naval purposes or assigned to the use of the local government, shall be used solely for the benefit of inhabitants of the Hawaiian Islands for educational and other public purposes.

IMPROVEMENT OF PLANTS BY SELECTION.

By Herbert J. Webber,
Special Agent of Division of Vegetable Physiology and Pathology.

INTRODUCTION.

Selection is one of the most important factors in plant breeding, the natural capacity of all plants to vary furnishing the basis on which the breeder has to work. The prime factor of selection, or, as Darwin calls it, the "law of the preservation of the favorable individual differences and variations and the destruction of those which are injurious," consists in the skillful selection and propagation of plants showing desirable variations. Selection is frequently understood as meaning simply the use of large, vigorous seed, and a consequent slight increase in production. While such selection is no doubt beneficial, a factor of far more importance is that the seed be taken from vigorous, productive plants. The inherent potentiality of the mother plant, if it may be so expressed, is a more important consideration than the size of the seed, which is so materially influenced by the general productiveness of the plant.

The object of selection is to effect a complete transmission of the desired qualities and to augment them if possible, and the main factor with which the breeder has to contend is the varying degree of the power of inheritance possessed by individual plants.

Plant breeding includes two processes, largely distinct in their nature: (1) The methods of securing variation, and (2) the fixation of desirable variations by methodical selection. The first process has been discussed in previous Yearbooks, the variations arising naturally and supposed to be induced directly or indirectly by environment having been the subject of a paper by the writer in the Yearbook of 1896, pages 89–106, while the variations induced by crossing different varieties, species, or genera were treated of by the writer in conjunction with Mr. W. T. Swingle in the Yearbook of 1897, pages 383–420. In the present paper will be discussed the second process—the fixation of desirable variations by methodical selection and the gradual improvement of plants resulting from the cumulative effect of selecting through many generations those showing the very slight modifications which normally occur in all plants.

UNITY OF THE INDIVIDUAL.

The unity of the individual taken as a whole is a factor of prime importance in selection and should be clearly recognized by every one striving to secure improved pedigree plants. If the object in selecting

any fruit is to decrease seed production it is of prime importance that the seeds be selected from plants which have been found, through examinations of a number of fruits from different parts of such plants, to have a general tendency toward reduced seed production. The plants from such seeds are very liable to inherit the tendency to seedlessness in a greater or less degree, but seeds taken from selected individual fruits that produce but few seeds, cases of which can be found on almost any tree, are no more apt to produce seedless fruits than are seeds taken from unselected fruits. Henri de Vilmorin, whose extensive experience enables him to speak authoritatively on such points, says that "the unity of character of any single plant is the main factor in the work of pedigree or grade breeding." His experiments with chrysanthemums forcibly illustrate this point: "I tried an experiment with seeds of *Chrysanthemum carinatum* gathered on double, single, and semidouble heads, all growing on one plant, and found no difference whatever in the proportion of single and double-flowered plants." Had the seeds been selected from plants on which all the flowers were double or semidouble a very large and probably even an increased proportion of double flowers would have been obtained.

Livingston, who has had such marked success in establishing improved sorts of the tomato, in explaining the origin of the Paragon tomato very graphically describes his independent discovery of this principle of the unity of the individual:

> In passing over my fields of growing tomatoes, which were still of all sizes, sorts, and shapes, my attention was attracted to a tomato plant having distinct characteristics and bearing heavy foliage. It was unlike any other in the field or that I had ever seen. It showed itself very prolific. Its fruit was uniformly smooth, but too small to be of general market value. As I examined it closely, observing how alike every tomato was on the stalk, wishing they were larger, and meditating over its possibilities long, it came to me like an inspiration, Why not select special tomato plants instead of specimen tomatoes?

In selecting Indian corn for seed it is the common practice to collect the best ears at the time of husking, the main object being to secure ears of good size and shape, and having large, well-formed kernels and a proper proportion of cob to kernel. This method of selection, while good so far as it goes, does not take the vigor of the plant into account, and hence does not accomplish all that is intended. The largest ears may grow on comparatively unproductive or weak stalks, and therefore to obtain the best results seed corn should be selected in the field, and attention given to the habit, productiveness, general vigor, etc., of the plant, as well as to the characters of the ear, kernel, and cob, and uniformity in ripening. The same remarks apply to the selection of seed wheat, but the difficulty in selecting wheat from plants fulfilling all the requirements would probably be too great for this method of selection to be feasible as a common practice.

Individuals may be very unequally endowed with the power of

transmitting their own characteristics to their progeny, and where several individuals are selected in breeding for the same feature it is best to keep the seed from each plant separate. The principal aim is to secure the complete transmission of the qualities desired, and in case the progeny of any plant selected shows a decided tendency to revert to the original unselected type it is best to make future selections from the progeny of some other plant which has more uniformly impressed its qualities on its offspring.

The instability of "bud sports" further illustrates the importance of attention to the unity of the individual when depending on selection to improve or fix a sort. Frequently a certain branch differs greatly in form of fruit or leaf from all other branches on the same tree. Such variations, termed "bud sports," are seldom reproduced true through the seed from fruit grown on the branch showing the variation. If such variations are desirable, they may of course be perpetuated by budding or grafting in the case of plants commonly propagated by such methods. The different branches on any plant almost invariably possess certain characteristic differences, and in selecting an individual from which to obtain seed with a view to improve any feature, it is important that this feature should be common to all branches of the tree and not limited to any particular one.

METHODS OF SELECTION.

The variations which form the basis for selection and the formation of new and improved races of plants are the direct or indirect results of changed environment or of hybridization and cross fertilization. Ray Lankester says:

> For the present I see no evidence of a production of new races on the face of the earth excepting by the method adopted by these men (breeders, nurserymen, etc.), viz, by the selection of congenital variations being produced as the result of (but without any direct adaptational relation to) a disturbance of the material of the reproductive particles of both sexes, that disturbance being increased if not determined by change of environment of the parental organisms or the coupling of remote strains.

Probably the most common way of obtaining initial variations is to select them from seedlings as they appear, but their advent can be greatly hastened by artificially changing the conditions under which the plants grow or by crossing different races or species. As soon as the desired variation makes its appearance its improvement and fixation by selection should begin.

In all cases where selection is the means adopted for transmitting a desired feature, large numbers of individuals should be grown in order to provide a greater scope for selection and thus increase the probabilities of securing the variation desired. The testing grounds and seed farms of large seed establishments are fruitful sources for variation. In such places a large number of individuals of the same race are grown together, and in the necessarily careful

elimination of all variations from the type of the race (roguing) in order to insure the production of seed true to the type, attention is forcibly called to all variations, and if any of these promise to be desirable improvements the intelligent seedsman almost invariably marks the plants showing such variations and preserves the seed for further trial and selection.

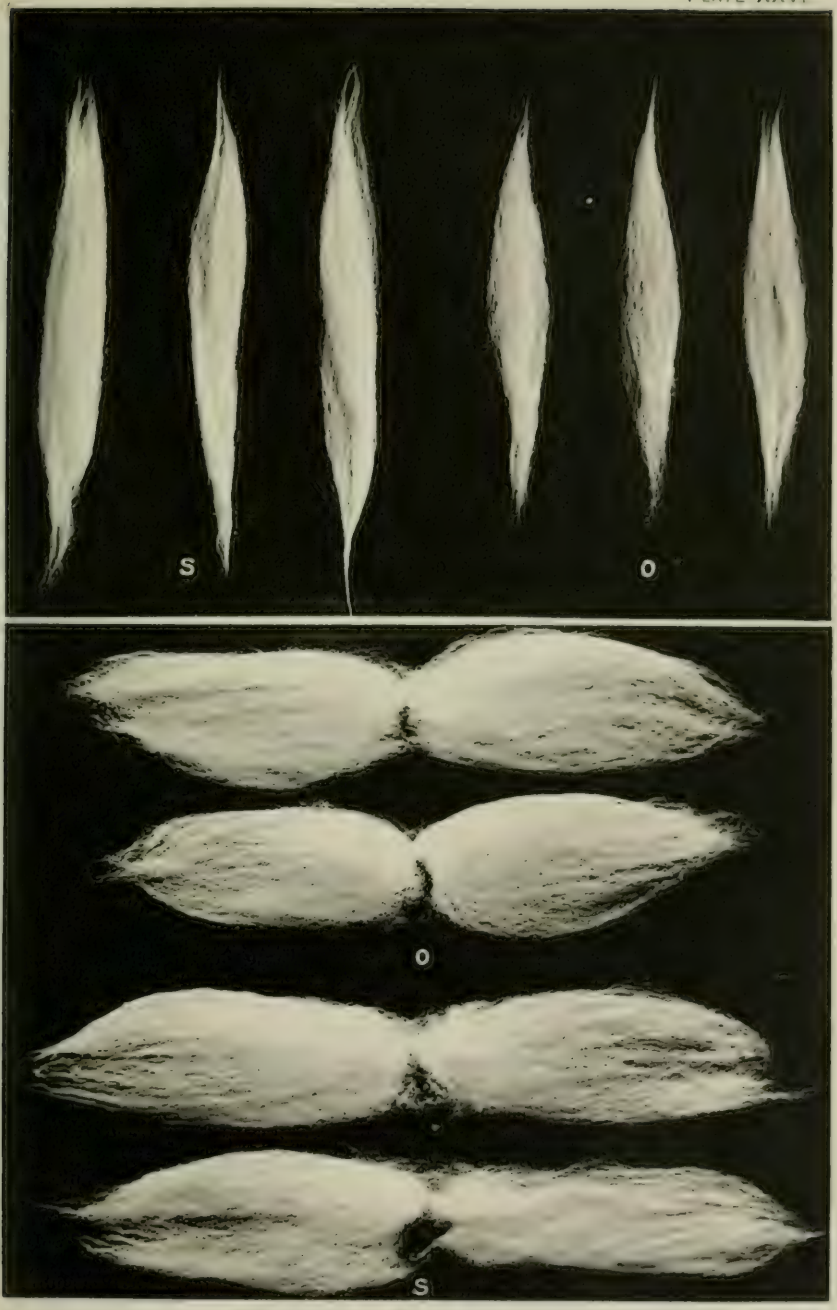
Another factor of great importance in selecting to improve races is the selection of individuals for breeding which exhibit in the most marked degree the feature to be improved. Galton has shown that the rate of racial changes which accompany different degrees of severity in selection can be determined with almost mathematical precision, and emphasizes the great necessity of using highly selected parents. As the result of carefully conducted work, he says: "One generation of the 99-degree[1] selection is seen to be more effective than two generations of the 90-degree selection, and to have about equal effect with the 80-degree selection carried on to perpetuity. Two generations of the 99-degree selection are more effective than four of the 95-degree and than a perpetuity of the 90-degree." Thus, in selecting wheat or any other plant to increase the productiveness, it is of the greatest importance that very many individuals grown under the same conditions should be examined and the seed taken only from those producing the largest yield.

IMPROVEMENT OF SEA ISLAND COTTON BY SELECTION.

The methods of selection pursued by certain growers of sea island cotton through many years are the most careful and painstaking known to the writer, and a description of these methods is given as an illustration of the actual procedure in continuous selection.

According to tradition and the reports of growers, sea island cotton when first introduced into this country from the West Indies was a perennial, unsuited to the duration of the seasons of the latitude of the sea islands off South Carolina and Georgia, where it seldom matured fruit. However, through the selection of seed from early-maturing individual plants and through better methods of culture there has been developed an improved race, which now seems to be thoroughly adapted to the conditions of growth in the region referred to. Furthermore, under the continuous and rigorous selection to which the plants have been subjected the fiber has been gradually improved (Pl. XXVI), and now that produced along the coast and on the islands lying off South Carolina and Georgia is considered superior to that grown in any other part of the world. The custom of carefully selecting the seed has grown with the industry and may be said to be inseparable from it, and it is only by such careful selection that the staple can be kept up to its present superior

[1] The degrees or "percentiles" here used indicate the variation above the mean average of any quality, which is considered as 50 degrees.



IMPROVEMENT OF SEA ISLAND COTTON BY SELECTION: *OO*, ORDINARY SEA ISLAND COTTON—ORIGINAL TYPE FROM WHICH SELECTION WAS MADE: *SS*, SELECTED SEA ISLAND COTTON. (NATURAL SIZE.)

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excellence. Several different strains have been developed and are maintained by different growers selecting with different ideals in view. The method described below is that which has been employed for many years by Mr. W. A. Clark, of Columbia, S. C., on his James Island plantation, and to him the writer is greatly indebted for the details. This method and similar ones employed by numerous other growers are applicable, with slight variations, to most of our common crops, such as corn, wheat, etc.

FIRST-YEAR SELECTION.

(1) The first selection is made in the general field, where there are a great number of individuals growing and consequently abundant opportunity for choice. Each plant in the field is somewhat hastily examined, special attention being given to the vigor and productiveness of the plant, the strength, silkiness, and general quality of the staple, etc., and a number of those which appear to be distinctly superior to the general crop are marked.

(2) The selected plants are then compared, and several of the best selected for more careful comparison, field notes on these being recorded and preserved for comparison with more critical notes to be taken later. The following is an illustration of field notes copied from Mr. Clark's selection notes of 1895: "No. 1, stalk medium, pod medium, bearing close, fairly double, lint fair; No. 2, stalk medium, pod medium, bearing good, lint fair; No. 3, stalk large, pod large, bearing close and double, lint fine and long; No. 4, stalk large, pod medium, bearing extra close and double, lint fine and long; No. 5, stalk medium, pod medium, bearing close and double, lint fine and long."

(3) Critical house examinations of the specially selected plants are now made at leisure, the fiber being "pulled" and carefully examined and graded according to (*a*) covering of seed; (*b*) size of seed; (*c*) length of staple; (*d*) fineness of staple; (*e*) uniformity in length (an important feature in preventing loss in manufacture). The following table, taken from notes made by Mr. Clark in 1895, the selections being based on critical pulling, shows how carefully the record is kept:

Results of examinations of specially selected plants.

Factors used in grading.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Covering	First	Fifth	Second	Fourth	Third.
Size of seed	Second	Fifth	Fourth	Third	First.
Length	Third	Fifth	Fourth	First	Second.
Fineness	Fourth	Fifth	Third	First	Second.
Uniformity	1	1	1	1	1

NOTE. All stalks present good appearance in field except No. 3, which is defective in middle of top.

"Valuing the first place as 5 and the fifth place as 1, and in like manner intervening positions, the general grade or rank of stalks, valuation of uniformity being omitted, as it is the same in all, would be as follows: No. 1, 14 points; No. 2, 4 points; No. 3, 11 points; No. 4, 15 points; No. 5, 16 points. Nos. 4 and 5 would therefore seem to rank first."

(4) The next step in the selection is the comparison of the ginning quality, that is, the actual weight of lint to seed in the individual plants selected. The nearer the weight of the lint approaches the weight of the seed the better. In the early days of sea island cotton growing in the United States the proportion of lint to seed by weight stood about as 1 to 5, but under the influence of continuous selection the difference in the ratio has been gradually reduced until now it is frequently about as 1 to 3. In order to obtain values easy to compare, Mr. Clark weighs the seed and lint after ginning and determines the weight of unginned cotton necessary to produce a standard 300-pound bale. This is obtained by the following proportion: Weight of lint is to combined weight of lint and seed as 300 pounds is to X (X equaling the weight of the unginned product necessary). To illustrate this point, according to Mr. Clark's notes the five plants above referred to ranked as follows, as shown by their ginning qualities: No. 5 required 1,001 pounds to produce a 300-pound bale; No. 4, 1,001 pounds; No. 1, 1,038 pounds; No. 2, 1,060 pounds, and No. 3, 1,068 pounds.

(5) To secure further evidence as to the qualities of the selections and as a check on individual judgment, the ginned fiber is sent, labeled by number, to an expert cotton commission merchant known as a factor, who judges the sample from the standpoint of the expert marketer. Of the above plants, Mr. Clark's factor selected No. 5 as outranking the others. This number being on the whole superior to the others, it was finally selected and the seed retained for further breeding, the other numbers being discarded.

SECOND-YEAR SELECTION.

The seed of the individual plant selected the first year is planted in the spring of the second year, and as each cotton plant yields from 500 to 800 seeds, 500 or more seedlings will probably be produced. When these reach the proper stage of maturity, all are carefully examined, as in the preceding year's selections, and several chosen for further and more careful examination. These specially selected individuals of the second generation are put through the same careful tests as to covering, size of seed, length of staple, proportion of lint to seed, etc., as those of the first year's selection, and the plant found to be of particularly high grade is selected for further breeding. The seed from the remaining plants (about 500) resulting from the first year's selection are retained for planting the third year in order to obtain sufficient seed of a selected strain to plant the general crop.

THIRD-YEAR SELECTION.

The seed from the second year's selection is planted in the spring of the third year, and when the plants reach maturity each one is examined as in the first and second years, and an individual particularly good in all respects selected for further breeding, as in the previous years. The seed produced by the plants (some 500 individuals) resulting from the single plant selected the second year, and which are not specially selected for further breeding, are retained to plant in the spring of the fourth year in order to provide sufficient seed the fourth year to plant the general crop the fifth year. The seed from the 500 or more unselected plants of the second year's selections are grown this year, being sufficient to plant an area of 5 or 6 acres and furnishing enough seed to plant the general crop the fourth year.

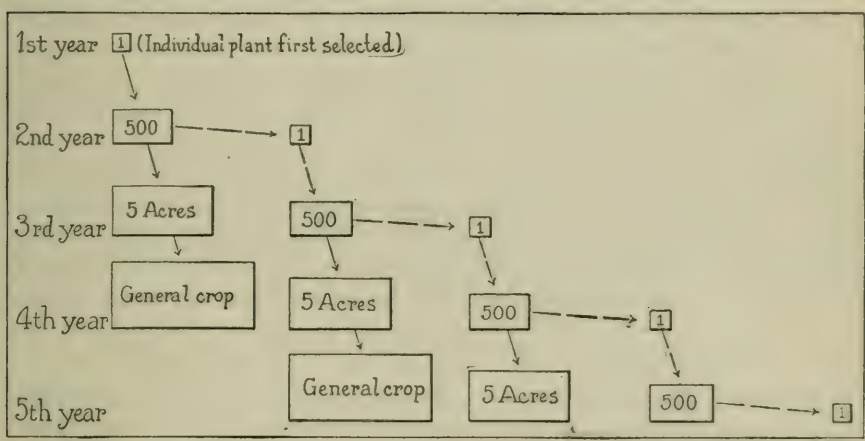


FIG. 92.—Diagram illustrating method of selecting sea island cotton.

FOURTH-YEAR SELECTION.

The seed from the specially selected plant of the third year are planted, and from the resulting 500 or more seedlings a particularly fine individual is again carefully selected for further breeding, as in the preceding years. The seed of the plants descending from the individual specially selected the third year is sown to obtain sufficient seed to plant the general crop of the fifth year. The seed used to plant the general crop of the fourth year is that from plants of the third year grown from the unselected plants of the second year, and thus the general crop this year is derived directly from the first-year selection, and so on through succeeding generations. (See fig. 92.)

PRACTICE OF GROWERS.

The foregoing description and diagram show that after the selection work is under way special selections are made each year from the small plats of very select seed, and that the general crop is

continually grown from stock descending from a single selected individual plant. In the method of selection above outlined the selection of a single individual each year only is considered. In practice, each grower generally selects several plants each year from which to breed; for example, two being selected for superior excellence of staple, one or two for general vigor and productiveness, etc. Each of these, however, is chosen from several selected individuals, the same care being exercised as in the first-year selection. It is always desirable to choose several special plants each year as breeders, as occasionally a selected plant may prove erratic and produce seedlings materially differing from the type, even after the selection has been carried on for a number of years with the same ideal in view.

Under this continuous painstaking selection the quality and length of the fiber has been gradually increased (Pl. XXVI) and the proportion of seed to lint gradually decreased. The fiber from unselected plants is only from 1¾ to 2 inches long, while that from the selected strain is about 2½ inches long and is very strong and silky. The finest grades are used to adulterate silks. These high-bred strains are maintained only by continuous selection, and if for any reason the selection is interrupted, there is a general and rapid decline in the quality of the staple. The cotton produced by these rigidly selected plants commands a much higher price than the general crop and is sold direct to manufacturers for special purposes. The price of such cotton is governed entirely by the excellence of the crop, so no regular quotations for the product of the highly selected plants are given in trade journals. The finest grades from the selected plants, the writer is informed, sell for from 50 to 60 cents per pound, while the ordinary sea island cotton is quoted at from 15 to 30 cents per pound.

Different growers select with different ideals in view, and the crop of each plantation may differ greatly in quality and value from that of adjoining plantations. Mr. Clark selects mainly with a view to increasing the fineness and length of the staple, and this is done at the expense of quantity. His fine product, however, commands the very highest price, and this compensates for the small yield. Mr. W. G. Hinson, another careful grower of sea island cotton, selects with a different ideal in view and has produced a strain with somewhat coarser fiber, but yielding heavier; and although the coarser grade may not bring so much per pound, yet it may prove fully as remunerative because of the greater productiveness of the strain.

INFLUENCE OF MATURITY OF SEED.

Gardeners believe that the maturity of the seed has considerable influence on the offspring, particularly as to time of ripening, plants grown from immature seed being said to ripen their fruit much earlier than those grown from mature seed. In 1885 Goodale and later

Goff observed that certain of the early sorts of market vegetables indicate that they may have originated in this way. Arthur, who has given this subject careful attention, says: "Another feature of importance is the tendency to an increased earliness of ripening the fruit on plants raised from immature seeds. In the cumulative trials with tomatoes by Goff, the strain from green seed ripened from ten days to four weeks earlier in different years than the corresponding series from ripe seed." According to C. L. Allen, specialists on Long Island who give careful attention to growing cabbage for seed, always examine each plant carefully before cutting it when harvesting their stock seed, and "if the seed is of large size it is rejected, because they hold that such seed will make leaves instead of heads. Besides that, these men will not use seed until it is at least three years old, for the same reason." He states further that "gardeners with keen observation note the fact that the older melon, cucumber, and squash seeds are, without having lost their germinating power, the better, as the proportion of flesh to the seed is greater and the vines are more productive of fruit and less inclined to throw out branches." From the evidence at the writer's command it is not clear how great an influence the maturity of the seed may have in selection experiments for general features. From Arthur's experience, however, it is practically certain that while immature seed gives a tendency to earliness, its use commonly results in lessened vitality and smaller fruits, and therefore fully matured seed should commonly be used.

SUITABLE LOCALITY FOR SELECTION EXPERIMENTS.

It is very desirable that plants for selection purposes be grown in a region well suited to the crop under consideration and especially one having conditions of soil and climate favorable to the development of the feature which the selections are intended to accelerate and render stable. According to Allen, cabbage, which is particularly sensitive to changed conditions of growth, furnishes a good illustration of the necessity of giving attention to these points. "All our improved varieties of cabbage have come from careful selections in different localities. We have our best early types from light soils, which are favorable for early growths, and our large, late varieties from heavy soils, which encourage continuous growth, consequently a larger head and one better adapted to wintering over." If it is desired to produce a bush bean from a twining or pole variety, the best place to conduct the selection experiment would be in some locality as far north as the sort will grow successfully, Burpee, Wood, and other seedsmen having observed that when seed pole beans for the trade are grown in the far North without poles, which is a common practice, they to a great extent lose their habit of sticking close to the poles. It must not be thought, however, that climatic conditions favorable to the best growth of the plant should always be secured, for in many cases

exactly the opposite is desirable. In selecting with a view to obtaining a sort suited to local conditions of soil or climate somewhat adverse to the best growth of all existing sorts, the plants for selection must be grown in that location in order that they may be subjected to the adverse conditions, and those individuals selected which survive and prosper best.

NECESSITY OF CLEARLY DEFINED IDEAL OF TYPE DESIRED.

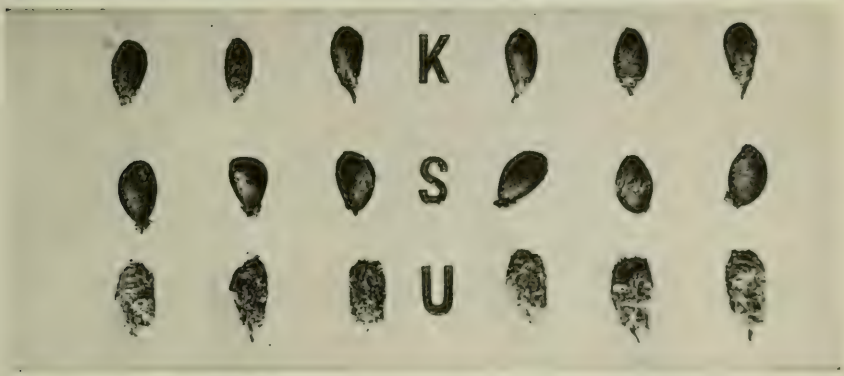
The most experienced seedsmen and plant breeders claim that a clearly defined ideal of the type desired is of the greatest importance, as is also a rigid adherence to this type year after year in making the selections. Mr. W. W. Tracy, who has had extensive experience both in selecting seed-bearing plants to keep the variety true to type and in orignating and improving new sorts by selection, says: "My success in seed breeding has always been in direct proportion to the clearness of my conception of the ideal I was striving to produce and the persistency with which I adhered to that ideal in my annual selection of breeding stock."

Before beginning a selection experiment, the variety from which the selection is to be made should be carefully studied and a definite ideal formed of a perfect type of the sort desired. Mr. Tracy described an interesting experiment in selecting corn, which forcibly illustrates the necessity of adhering to the type in such work:

> The result of the work was that the sixth year I had on that same 5-acre field a crop over 50 per cent of which was within the limits of the variation established for breeding six years before when not one plant in a thousand came within the limit. * * * In the fourth or fifth year of this selection one lot showed a very remarkable ability to resist drought. The plants were fairly true to type, and this new quality was so desirable that the seed breeder was tempted to save his "breeders" from that lot, but resisted it, and saved them according to rule, but he also saved the ten best plants from the new departure and planted the seed in a lot by itself. The result was that only a very few of the plants showed the drought-resisting quality so noticeable the year before, and all of the ten blocks varied more and had a smaller proportion of plants true to type than had any single lot since the first year.

FIXATION OF SEED RACES BY SELECTION.

When a desirable variation of any race of plants is obtained by hybridization or by changed environment or otherwise it should be fixed, that is, it should be so stamped on the strain by selection as to render it hereditary and cause it to be produced true through the seed. Many of our most valuable sorts of vegetables and agricultural plants are developed from individuals in the general crop which exhibit marked differences from the normal type of the race to which they belong and from other known races. The plants from the seeds of such individuals usually in greater part resemble the type of the original race, but by selecting seed through several generations from



SEEDS OF KLONDIKE, SEA ISLAND, AND ORDINARY UPLAND COTTON: *KK*, SEEDS OF THE KLONDIKE, WITH AND WITHOUT LINT; *S*, SEEDS OF SEA ISLAND; *UU*, TUFTED SEEDS OF ORDINARY UPLAND (THE VARIETY FROM WHICH THE KLONDIKE WAS DEVELOPED), WITH AND WITHOUT LINT. (NATURAL SIZE.)

THE HELIOTYPE PRINTING CO., BOSTON

individuals which most nearly resemble the original variation, the changed characters may be rendered hereditary and a new race created. In sorts propagated vegetatively by cuttings, suckers, slips, etc., such variations may be utilized without waiting for fixation, as in such cases simply the portions of the individual showing the variation are grown. The original cause of these fortuitous variations, or "seminal sports," as they are frequently called, is not definitely known, but many of them are probably chance hybrids of a first, second, or later generation, or cases of partial reversion to some ancestral type, while others may result from environmental conditions. It is difficult to trace any connection between such marked variations and the conditions of environment, however, while they are exactly what would be expected to occur in the markedly unlike progeny of a hybrid. All the fine races and strains of tomatoes originated by A. W. Livingston, such as Acme, Paragon, etc., were selected from accidental variations, being simply variations found in large fields of growing tomatoes and improved and fixed into stable races by selection.

The smooth-seeded upland cotton Klondike is an interesting illustration of the fixation of seed races by selection. Some years ago Mr. W. A. Clark, whose methods of selection have been described, conceived the idea of producing a finer grade of upland cotton suitable for the finer textiles. In view of the injurious effects of the saw gin upon a long-staple cotton and the difficulty of separating the lint from a tufted seed with the roller gin, he determined to produce by selection an upland cotton growing on a clean, black seed, which when once secured could be improved in length and quality of the staple by hybridization with the sea island cotton. In the ordinary sorts of upland cotton, smooth black seeds, similar to those of the sea island cotton (Pl. XXVII, *S*), are occasionally found mixed with the ordinary tufted or green seeds (Pl. XXVII, *U U*). Originally, certain upland sorts, such as Peterkin, had smooth seeds, and the production of such seeds in sorts commonly having tufted seeds may be due to hybridization of the ancestors of the plant with the sea island or some smooth-seeded sorts of the upland.

Mr. Clark selected at random and planted a quantity of smooth black seeds from the ordinary upland cotton, and the great majority of the resulting plants produced the ordinary tufted seed, but a few had mainly smooth black seed like those from which the plants were grown. Seeds were selected from the few plants which produced mainly smooth black seed, and were planted the second year. This season a much larger proportion of the plants produced smooth black seed, but still many produced the ordinary tufted seed. Seeds were again selected from the plants producing smooth seed and planted the third year, and so on through five generations, when the character was fully fixed, and all the plants came true, producing only the smooth black seed (Pl. XXVII, *K K*).

To avoid the introduction of any new disturbing elements in the fixation of hybrids it is usually necessary to inbreed or close fertilize them, and if this, together with careful selection, is carried on through several generations hybrids can usually be fixed so that they may be depended upon to reproduce themselves in the main true to seed, even under different conditions. Hybrids found to be sterile to their own pollen, which is not infrequently the case, should be fertilized with pollen from hybrids showing the same characteristics, and preferably from the same parents.

As generally understood, the so-called fixation of a seed race is simply the strengthening of the inherent stability of the individual so that it will impress its characteristics more strongly and surely on its offspring. It may well be asked whether this does not also necessarily include the character of more or less marked prepotency to its own pollen. Most species and natural varieties are more stable than cultivated races, principally because they are markedly prepotent to their own pollen. It seems quite probable that in some of our most stable cultivated races prepotency has also been developed to some extent. If, during selection, prepotency could be acquired, it would add greatly to the stability of the race.

After a race is fairly well fixed, as generally understood, it is probable that the character of prepotency could be acquired by growing plants of the race in close proximity to plants of nearly related races or strains and planting the seeds of each individual the second year in separate plats or rows and again close to plants of related races. By carefully examining the plants grown the second season it could probably be determined which individuals grown the first year were least affected by crossing with the related races grown in connection with them, and in this way any tendency to prepotency detected. The second year the seed to be used for further planting should be selected only from the plats of seedlings resulting from plants showing this tendency to prepotency. Furthermore, the seed from such plats should be selected only from individuals which careful examination has shown to be true to the type of the race. By continuing such selection through several generations it is probable that the race could be rendered largely prepotent to its own pollen.

Selection experiments, as normally conducted, and the rigorous "roguing" practiced by all good seed firms, have a tendency to produce prepotency, all individuals varying from the type (such variation being caused largely by hybridization) being in this way rejected. The difficulty in such cases, however, is that no attention is given to the unity of the individual so far as prepotency is concerned. Belt says: "Artificial selection is more rapid in its results, but less stable than that of nature, because the barriers that man raises to prevent intermingling of varieties are temporary and partial, whilst that which nature fixes when sterility arises is permanent

and complete." By selection, man can render variations hereditary through the seed and establish new races as markedly different from each other in visible characters as different natural species, but unlike these they cross easily and thus are swamped immediately when abandoned by man's fostering care.

If some attention were given to securing prepotency in new races, before their introduction to the trade, it is probable that there would be less complaint of lack of fixity of type. In sorts which present marked characteristic features of value even such an expensive way of securing stability might be justifiable, for by such care the cultivated race could possibly be made to approach natural species and varieties in stability.

EFFECT OF CROSS FERTILIZATION IN SELECTION.

The effect of cross fertilization on plants grown for selection is a factor seldom carefully considered. It is well recognized that the greatest source of variation among plants is the crossing of individuals, which, though very similar, always show slight differences, and doubtless imperceptibly differ in constitution and structure also.

In the fixation of hybrids inbreeding is apparently very necessary, but doubtless results in lessened vigor. In the case of the cotton selection described above, however, and in almost all similar cases of gradual improvement by selection, no attention is paid to the crossing of different individuals further than growing the selected seed by itself in a plat isolated from other plants of the same species, to prevent the selected individuals from crossing with the unselected. In cases of this sort, and in all cases of gradual improvement by selection of slightly superior individuals, it is probable that more is gained in vigor by allowing the free crossing of the different selected plants than is lost by the greater variation introduced thereby into the selected strain. Furthermore, in selecting cotton, as described above, it is impossible to decide at the time of flowering which of the 500 seedlings resulting from the single selected individual will prove the best, and it is obviously impracticable to carefully inbreed all the flowers on each plant, or even a small per cent of them. If ten to twenty plants having the best qualities could be selected from the 500 and bred together, it is probable, considering the greater vigor of cross-fertilized plants, that the result would be much better than that from the most careful inbreeding. The 500 seedlings resulting from the selected individual being planted together and allowed to cross freely, it is highly probable that some of the numerous seeds developed on the individual plant finally selected from them for further breeding will have been fertilized with pollen from some similar high-grade individual among the 500. In selection experiments of this nature, therefore, it seems desirable to plant the seedlings resulting from a single plant close together in a square plat, rather than in a single

long row, as by so doing mixed cross fertilization is favored. It is of course highly desirable that plats of selected plants be some distance from the general crop to prevent crossing with unselected individuals.

LIMITATIONS OF SELECTION.

Many horticulturists believe that selection has had the greatest influence in the development of the various races and sorts of cultivated plants, and some go so far as to assert that all other factors are of minor importance. The skillful plant breeder, however, takes all elements into consideration, in order to bring about the amelioration desired. Both hybridization and selection have their definite and distinct places in every rational system of plant breeding. As explained above, hybridization and changing the environment artificially are the principal means of securing desired variations, and selection is the means by which a variation when once secured is augmented and fixed. When used alone in the improvement of plants, selection depends upon the adding up of small, unimportant variations through many generations, which in the end may possibly result in marvelous differences; but by this method the breeder has no way to force the change, and must be satisfied with slight variation and long-continued selection. However, when marked changes and new creations are desired, it is to hybridization or to chance sports that attention must be turned. In the words of Henri de Vilmorin, "Cross breeding greatly increases the chance of wide variation, but it makes the task of fixation more difficult. It, however, gives the raiser the only means in his possession to unite in one the qualities of two different plants while discarding their weak points. All the different qualities of the two parents seem to unite in the most varied combinations in the crossbred products." It would hardly be possible to obtain in a lifetime by selection a markedly hardy orange or rose, a fragrant pansy, or a new creation like Burbank's hybrid walnut or raspberry-blackberry hybrid "Primus,"[1] although it is just possible that such changes could be ultimately secured by this means. The most feasible and by far the quickest way to secure such decided variations and new creations is by hybridizing different species or sorts. Where it is desired to render a sort hardier, it should be crossed with a hardy relative, and where it is desired to render an odorless flower fragrant, it should be crossed with a scented related sort.

DEVELOPMENT OF NEW RACES BY SELECTION.

The improvements effected by selecting a variation may be slight in one generation, but, as before explained, if these slight improvements are continued year after year, very marked improvements may result in the course of time. Bailey says: "It is the slow and patient

[1] Yearbook for 1897, Pls. XVIII and XIX and fig. 12.

care and selection day by day which permanently ameliorate and improve the vegetable world. Nature starts the work; man may complete it."

The origin of our various cultivated plants is doubtless due to the cumulative effects of more or less unconscious selection through centuries. The wild progenitors of important cultivated plants are in many instances unknown, and in but very few cases is there any knowledge of the early stages in their development. They came down to historic times in an advanced stage of development. In some instances the fact of the development of cultivated forms from wild plants has been proved by experiment. The experiments of Buckman in developing the wild parsnip, those of Louis de Vilmorin in developing the wild carrot, and those of Carrière in improving the wild radish have become classical. After several years of selection, Buckman developed from the wild parsnip an improved form which he called the Student. This was further improved by Messrs. Sutton & Son, and was finally sent out. According to Henslow, "it still remains, after more than forty years, the best parsnip in the trade." The changes effected by Louis de Vilmorin in the wild carrot clearly show what can be accomplished in this manner. He sowed seed of wild plants, and found that the offspring flowered continually through the summer. By collecting seed from plants producing the latest flowers and sowing them late the following season he encouraged the enlargement of the root. In this way the carrot was induced to flower uniformly in the second year of growth, and hence is now a biennial instead of an annual, the acquired habit having become hereditary. The selection of wild radish or jointed charlock seeds, carried on for some time by Carrière, resulted in the production of several varieties of radish similar to those commonly cultivated.

A still more interesting case of development from cultivation and selection is described by Henri de Vilmorin:

I may relate here, in a few words, an unpublished experiment which I have been conducting for more than twenty years, from 1872 to the present year [1893]. It has consisted in cultivating one of our parsley-worts (*Anthriscus sylvestris*), an European weed, in order to change its slender and much-forked roots into fleshy, straight, and clean roots, say like those of the parsnip. Among the first batch of roots raised from wild seeds a dozen were selected with a tendency in their roots to larger and straighter bodies. Each root was planted separately and its seeds harvested separately. Of the dozen lots obtained eight or nine were discarded at once, and roots were selected only in such lots as exhibited some trace of variation. Again, a dozen roots or so were chosen (a drawing made of each root), which were afterward planted separately. I have sketches of all the roots selected, so that it is possible to follow all the stages of variation of each plant living at this day. For the first ten years the changes were slight, but now they are more and more marked with every generation, and in some of the lots the straight and smooth roots are the most numerous.

SPECIAL FEATURES ACQUIRED BY SELECTION.

IMPROVED QUALITY OF FRUIT.

The improvement in the texture, shape, and flavor of the tomato wrought by selection is a good illustration of what can be accomplished in this direction. Livingston, who originated so many of our improved sorts of tomatoes, depended entirely on selecting from large fields of growing tomatoes certain individuals which showed desirable variation and selecting from their progeny through several generations to improve and fix the variation. In describing the origin of the Perfection tomato, Livingston says: "I selected a plant from a field of Acme (a purple tomato) and secured what is known everywhere as Livingstons Perfection tomato (a blood-red tomato), which I introduced in 1880. The stalks and foliage are lighter than those of Paragon, but stronger than those of Acme." All his numerous new sorts of tomatoes were from accidental variations selected in this way, and the same can be said of Bailey's Ignotum tomato. The underlying cause of such accidental variations is unknown, but is doubtless the result of accidental hybridization, partial reversion to some ancestor, or to the variations known as "seminal sports" (fortuitous variations), the production of which seems entirely accidental or depends upon causes not yet understood.

INCREASED SIZE AND PRODUCTIVENESS

Increased size and productiveness are among the most common and important features resulting from selection. The increased length and quantity of fiber of the sea island cotton, previously described (Pl. XXVI), are good illustrations of this, and doubtless all common agricultural crops could be similarly improved. Allen cites an interesting case of increased yield in corn as a result of selection, as follows: "Four years ago my foreman, at my earnest request, began the selection of field corn for seed purposes. He grew the white dent red-cob variety. Before harvesting the main crop he went over the field and selected the lowest-growing, stocky stalks, with two perfect ears each. He has followed the same plan ever since, with an increase of fully 25 per cent in productiveness."

INCREASED SUGAR, STARCH, AND PROTEID CONTENT.

Louis de Vilmorin's classical experiments in selection, which resulted in increasing the richness of sugar in the sugar beet, shows what exceedingly important results can be obtained by careful attention in selecting the seed-producing plants. These experiments in fact saved the beet-sugar industry of France and established it on a paying basis. His method consisted simply in testing the individual roots to determine their richness in sugar, and selecting for seed production, or "mothers," as they are termed, only those showing the largest percentage. In his early experiments the quantity of sugar was estimated

by the specific gravity of the root, but later a more accurate method was devised, consisting in cutting out a small cylinder from each root and testing the richness of the juice by polarization. This method does not injure the roots for seed purposes and furnishes accurate data as to richness in sugar content on which to base the selections.

Louis de Vilmorin's careful methods have been continued by the firm of Vilmorin, Andrieux & Co., and by many others engaged in the production of sugar-beet seed, and upon these methods depends the success of the industry. The White Improved Vilmorin beet, which is Vilmorin's selected strain of the old White Silesian, has a world-wide reputation, and immense quantities of its seed are distributed annually. It has been the subject of careful and persistent selection for over thirty-five years, and its quality of richness in sugar has become fixed and constant. Mr. Ernest Clarke says that "some thousands of analyses have shown it to yield up to as high a proportion of sugar as 16 per cent of the weight of the roots, 1¾ pounds of sugar per gallon of juice being a very ordinary yield with it." Similar results have been obtained from the same kind of selections of seed-producing plants of the Kleinwanzlebener and other races of sugar beets. The following statement by Mr. Ernest Clarke in regard to selections made by a single firm will give an idea of the extent to which the selection work is carried on: "Messrs. Rabbethge & Giesecke, the famous cultivators of the Kleinwanzlebener variety, who have been growing beets for seed for upwards of thirty years, state that in 1889–90 they tested 2,782,300 roots, from which they selected 3,043 roots for seed-growing purposes." The percentage of proteid matter in wheat, peas, etc., and of starch in potatoes and barley, etc., could doubtless be increased by similar methods of selection.

CHANGE OF FORM.

There is evidence to show that a decided change of form may be brought about by selection carried through numerous generations. The origin of the Blanche Ferry sweet pea, described by Tracy, is an interesting illustration of modifications of this sort:

Some forty years ago a woman in northern New York noticed and saved the seed of a particularly bright-flowered plant of the old Painted Lady. She planted them in her garden and each succeeding year saved and planted seed of what she thought were the best plants. She did not raise many, some years not more than a dozen plants and never more than could be grown in 3 square yards. She was the wife of a quarryman and her garden was always over limestone ledges, where the soil, though fertile, was very thin, often not over a foot in depth, and gradually her plants became more compact and sturdy, until after some ten or twelve years she ceased to "bush" them, simply letting them support themselves. After she had raised them in this way for some twenty-five years a seedsman noticed their beauty, obtained about one hundred seeds, and from them has come the Blanche Ferry.

In many instances the form of flowers has been greatly modified by selection. Darwin says:

Williamson, after sowing during several years seeds of *Anemone coronaria*, found a plant with one additional petal. He sowed the seeds of this and by perseverance in the same course obtained several varieties with six or seven rows of petals. The single Scotch rose was doubled and yielded eight good varieties in nine or ten years. The Canterbury Bell (*Campanula medium*) was doubled by careful selection in four generations.

CHANGE IN TIME AND UNIFORMITY OF RIPENING.

Many very valuable improvements in this direction testify to the importance of the results secured by selection. For instance, the decided shortening of the period required for sea island cotton to mature, as previously described, has fitted it for cultivation in certain portions of the United States, in which it is now an important crop.

The uniformity of heading or ripening of lettuce obtained in the forcing business is also, as the writer is informed by Mr. P. H. Dorsett, of the Division of Vegetable Physiology and Pathology, an interesting and valuable illustration of improvements of this nature obtained by selection. Careful growers of this crop, particularly in the vicinity of Boston, where the industry has reached its greatest perfection, always raise their own seed, claiming that it is impossible to purchase seed suitable for their requirements. In growing lettuce under glass it is of the utmost importance that all the plants be ready for cutting at one time, so that the house may be immediately reset with other plants, in this way constantly utilizing the available space. Several selected strains have been developed with this idea in view, and also with some reference to habit and vigor of plant, quality, shape, firmness of head, etc., and, as the writer has been informed, the plants have become so perfectly uniform as to time of maturing that frequently an entire house may be cut in the morning and replanted the same day.

IMPROVEMENT OF SORTS BY THE SELECTION OF CUTTINGS, SLIPS, BUDS, ETC.

Some doubt has always existed as to whether plants normally propagated vegetatively by cuttings, slips, buds, etc., could be improved or permanently modified by a selection of these parts from certain individuals or parts of individuals by methods similar to those used in seed-propagated plants. Each joint of a plant, with its bud and leaf attached, possesses in most cases the faculty of growing into a new plant much like the parent. These new plants vary the same under environmental influence as do individuals produced from seed, and while parts of the same seedling, still they are in a physiological sense distinct, each possessing individual characteristics and constitutions

depending upon the conditions under which they were grown. As is well known, even branches on the same tree may differ in many characters, and while such variations are not commonly recognized when slight, yet in certain cases they become very marked, and are then easily distinguished, being known as "bud sports." Mr. B. T. Galloway says:

> Every one who propagates plants by cuttings knows that hardly any two of them possess exactly the same characters. Starting with two rooted cuttings from the same plant and growing them under as nearly the same conditions as possible, one may give a plant that will bloom freely, forming flowers of large size, and its leaf development may also be perfect, while the other may be a vegetable runt, lacking in vigor of leaf and utterly unable to give anything but small and imperfect flowers.

Bailey also cites cases showing the change produced by different climatic conditions on different individuals produced by budding:

> We know, too, that the same variety of fruit tree takes on different characters in different geographical regions, so that in the West and South the Greening apple is no longer the Greening of Rhode Island. So it is apparent that even when we divide a plant into many parts and distribute the members far and wide, and when there is no occasion for concerning ourselves with fixing the type—even here there is variation.

Darwin says:

> Mr. Salter brings the principle of selection to bear on variegated plants propagated by buds, and has thus greatly improved and fixed several varieties. He informs me that at first a branch often produced variegated leaves on one side alone, and that the leaves are marked only with an irregular edging or with a few lines of white and yellow. To improve and fix such varieties he finds it necessary to encourage the buds at the bases of the most distinctly marked leaves and to propagate from them alone. By following with perseverance this plan during three or four successive seasons a distinct and fixed variety can generally be secured.

For several years Messrs. B. T. Galloway and P. H. Dorsett, of the Division of Vegetable Physiology and Pathology, have been carefully selecting violet cuttings to determine to what extent the plants can by this means be improved in productiveness, vigor, and ability to resist disease, etc. The results already obtained show that productiveness is remarkably increased, and they also clearly demonstrate that violets can be gradually improved by a continuous selection of the cuttings used in propagation and of the plants from which these are obtained. The method consists in selecting a number of the finest-looking plants before they begin to bloom, placing beside each a stake to which a blank tag is attached, and carefully recording on each tag the daily pick of salable flowers from the plant, so that at the end of the season the number of flowers produced by each plant is known. The cuttings for the ensuing year are taken only from the plants producing the greatest yields and which are known from continual observation through the season to be desirable in other ways. The

pedigree cuttings thus obtained are again subjected to selection, and only those which root well and form good, vigorous young plants are finally used (figs. 93 and 94).

FIG. 93.—Selected rooted cutting of Lady Hume Campbell violet (from a photograph by P. H. Dorsett).

Mr. Dorsett has recently described some very striking results obtained in 1897 by growing comparison beds of selected and unselected cuttings of the Lady Hume Campbell violet. In this experiment three beds were compared, the first containing 356 selected plants, the second 516 unselected plants, and the third 352 selected plants, and all received the same treatment throughout the season. In beds Nos. 1 and 3, containing selected plants, comparatively few of the plants had to be reset during the summer and fall, but in bed No. 2, containing unselected plants, fully 15 per cent were replaced. Besides this, the selected plants made a more vigorous and a healthier growth and produced a greater number of better-colored and longer-stemmed flowers than the unselected plants. The following is a record of the production of each bed during the season: Bed No. 1, 30,000 flowers, average per plant 84.2; bed No. 2, 31,200 flowers, average per plant 60.4; bed No. 3, 30,980 flowers, average per plant 88.

FIG. 94.—Unselected rooted cuttings of Lady Hume Campbell violet (from a photograph by P. H. Dorsett).

It will be seen by a comparison of the above data that "the average yield from the beds of selected plants is greater in both cases than from the bed of unselected plants, the plants in bed No. 1 producing on an average 23.8 and those in bed No. 3, 27.6 more flowers per plant than were produced in bed No. 2, a combined average of 86.1 from the selected plants as against 60.4 from the unselected, or a gain of 25.7 flowers per plant, and this with practically no additional expense."

The following table, from Mr. Dorsett's paper, gives the yield per month during the season of five selected plants from a parent which the previous season yielded eighty-five flowers:

Yield per month of five selected violet plants.

Plant number.	Number of flowers produced in—							Total.
	October.	November.	December.	January.	February.	March.	April.	
38 *a*	2	6	6	16	10	16	28	84
38 *b*	7	12	4	7	22	20	37	109
38 *c*	7	13	6	18	27	23	33	127
38 *d*	3	9	4	9	25	26	27	103
38 *e*	3	7	2	11	13	16	30	82

"The table shows that three of the five plants gave a much greater yield than the parent. The average of the five plants is 101, or sixteen flowers more than the original plant produced. The average yield is thirteen flowers more than that given by Mr. Galloway from ten selected plants during the previous season."

In some selection experiments with strawberry cuttings Goff obtained very beneficial results by taking cuttings from plants which had not yet been weakened by fruiting, and the ancestors of which had been free from leaf blight (*Sphærella fragariæ*). Cuttings taken from plants which had been weakened by leaf blight were tender, and many of them were winterkilled.

In the case of the so-called Ripley spike, a disease which attacks the Ripley Queen pineapple and causes it to "go blind," that is, advance to the end of its growing period and sucker from below without fruiting, the writer observed very marked results from selecting suckers from healthy plants. In September, 1894, a careful grower in south Florida took a number of suckers from diseased plants and planted them in a bed by themselves, and in an adjoining bed planted a number of suckers taken from apparently healthy plants. In March, 1896, the writer examined the plants in each bed, and found that in the bed of 348 plants grown from suckers taken from diseased plants 219 of them, or about 63 per cent, had contracted the disease, while in the bed of 244 plants grown from suckers taken from healthy plants only 9 of them, or slightly less than 4 per cent, showed the disease. This result from but one selection indicates that the disease

could probably be entirely controlled by a continuous selection of suckers from healthy fruiting plants.

Prof. L. C. Corbett, of the West Virginia Agricultural Experiment Station, informs the writer that he is succeeding to a great degree in breeding out the tendency in certain roses to produce blind branches by continuously selecting cuttings from flower-producing branches.

Another interesting illustration of modifications obtained by the selection of vegetative parts is the breeding out of thorns from citrus trees by bud selection. Seedling oranges and lemons are almost invariably very thorny, but nevertheless the majority of the standard varieties cultivated are now largely thornless, owing, it is said, to the continuous selection of buds from thornless branches. According to the testimony of orange nurserymen, it is quite certain that thorns can be bred out in this way in every case, and usually to do so requires but three or four bud generations. It is probable in the case of other fruit trees that by selecting buds or cuttings from branches that are thornless, or which have fewer thorns than usual, that the thorns could be entirely bred out, or at least the number greatly reduced.

Sufficient examples have been given to show conclusively that selection may play a very important part in the improvement of plants propagated by vegetative parts. Doubtless extremely valuable improvements, particularly increased productiveness and resistance to disease, can be secured by a careful selection of slips, cuttings, buds, etc. Equally as careful attention should be given to the selection of the mother plants from which these parts are taken for reproduction as is given to the selection of the plants used for seed production.

SELECTION AS A GENERAL AGRICULTURAL PRACTICE.

In the preceding pages attention has been directed to some exceedingly valuable results obtained by careful selection methods, for instance, the increased productiveness of cotton, corn, sugar beets, etc. The common methods of selection are simple and inexpensive and should become general practices in agriculture. Every farmer and horticulturist should devise for each crop a systematic method of selection similar to that described in the case of sea island cotton, so that the general crop may be grown continually from selected pedigree stock. All common agricultural crops respond to skillful selection, and in every case valuable results will doubtless reward the agriculturist's attention to this principle.

CAN PERFUMERY FARMING SUCCEED IN THE UNITED STATES?

By Edward S. Steele,
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COMMERCIAL DATA.

The statistics of the Treasury Department for 1896–97 show an importation of "alcoholic perfumery," that is, extracts prepared or partly prepared for use, amounting in value to $374,497.82. To compute the entire import of prepared perfumery it would be necessary to add trifling amounts for sachets, incense, and pastiles, and a sum which can not be specified for the perfume contained in imported soaps and other toilet articles. Adding to the above-mentioned sum the values of raw materials, animal and vegetable, imported for perfumery purposes the same year, aggregating $1,437,736.58, a total importation of $1,812,234.40 is obtained, exclusive of a lump sum of $213,216.92 for "all other essential oils and combinations," some portion of which certainly belongs to perfumery. To ascertain the entire consumption of perfumery, there should be added possibly $100,000 for materials of domestic production. It will thus be seen that less than one-fourth of the perfumery (the term is here used in its broadest sense to include all scenting materials) is imported in its manufactured forms, and that accordingly there already exists in this country an extensive industry in the way of compounding perfumes, while the production of raw materials is extremely meager. Attention, therefore, naturally turns to the question whether there might not be a development of the production of raw materials.

Excluding musk and civet, which are of animal origin, the materials of perfumery consist mainly of essential oils, which are extracted from the flowers, fruits, herbage, and wood of plants. Only substances of vegetable origin are considered in this paper, and the alcohol and greases which form the vehicles of perfumery are disregarded. Studying the reports of the Treasury Bureau of Statistics, fifteen perfumery oils can be selected which are the products of plants that may certainly or probably be grown within the limits of this country. To these are to be added the iris, source of orris root, itemized under another head, and at least the rose geranium, cassie, tuberose, and violet, not specified in the reports, but all standard perfumery plants and capable of being grown within our range. This is not to assert that all or any of these can be produced in this country as perfumery plants with commercial success. Conditions which admit the growth, even the thrifty growth, of a plant

do not necessarily secure the best development of its odor. The plants named are, then, to be regarded as candidates whose claims are to be considered, and which, if found promising, should be subjected to trial.

The commercial importance of sixteen of these plants as perfumery sources in general and relatively to one another can be judged from the following tables, which are compiled from the Treasury reports:[1]

Quantity, aggregate values, and values per unit of the imports of sixteen articles used as perfumery materials for the year ending June 30, 1897.

Articles.	Quantity.	Aggregate value.	Value per unit.
	Pounds.		
Almond (bitter) oil	10,471.90	$12,029.00	$1.15
Anise-seed oil	51,850	77,821.00	1.50
Bergamot oil	94,726.50	129,311.78	1.37
Caraway oil	9,525.35	9,501.00	1.00
Cedrat (citron) oil	571	2,539.00	4.45
Fennel oil	1,546.63	1,002.00	.65
Jasmine oil	9	398.81	44.31
Lavender (including spike lavender) oil	211,558.42	190,050.22	.90
Lemon oil	248,647.68	201,857.00	.81
Limes, oil of	1,910	2,096.00	1.10
Neroli, or orange-flower oil	1,899.78	24,015.02	12.65
Orange oil	56,623.22	68,166.82	1.20
Orris (or iris) root	311,430	30,141.00	.097
Rosemary, or anthoss oil	49,028.19	29,723.00	.61
Roses, attar (oil) of	48,384.49	293,495.93	6.07
Thyme (or origanum), oil of	44,326.99	37,931.00	.86

The alcoholic perfumery mentioned as imported contains largely the oils enumerated in the table. The oils of bergamot, citron, lemon, limes, and orange are obtained from the rinds of the respective fruits. The oil of lavender and oil of spike, or aspic, combined in the table, are distinct articles, the latter being much cheaper and used in perfumery only for adulteration. The price of true lavender is thus misrepresented. In general the prices here indicated must not be taken as a criterion of the value of good qualities of pure articles.

The importation for 1897 was a decided advance upon that of previous years. The following table will show the general tendency of the market through a period of years:

Aggregate value of importations of sixteen perfumery articles for two periods of three years each, with averages.

Year.	Value.	Average.	Year	Value.	Average.
1884	$882,385.54	$686,328.70	1895	$818,375.79	$935,249.54
1885	563,826.72		1896	880,983.25	
1886	612,573.74		1897	1,106,539.58	

[1] The Foreign Commerce and Navigation of the United States for the year ending June 30, 1896, Vol. II; same for year ending June 30, 1897, Vol. I.

METHODS OF EXTRACTION.

Before considering the candidate plants in detail it will be well to describe briefly the several methods commonly employed in extracting essential oils in order that the appropriate method may be referred to each plant in turn. While the descriptions here given can only be of the most scanty sort, they will at least indicate in a general way what must be calculated upon if one wishes to produce perfumery.

First to be mentioned is the application to the purpose of mechanical means, which is accomplished in various ways. This is practicable mainly in treating the rinds of the citrus fruits (orange, lemon, etc.), which are considerable in bulk and contain oil in comparatively large quantities. One process consists simply in expression, the material being put into a press and subjected to heavy pressure. Another is to rub the fruit in a metal cup lined with spikes (ècuelle à piquer, fig. 95,) the oil settling into a hollow handle, whence it is at length poured. An ècuelle on a larger scale, consisting of a drum lined with spikes, is also used. Another method consists in squeezing in the fingers sections of the peel turned inside out and taking up the oil with a sponge.

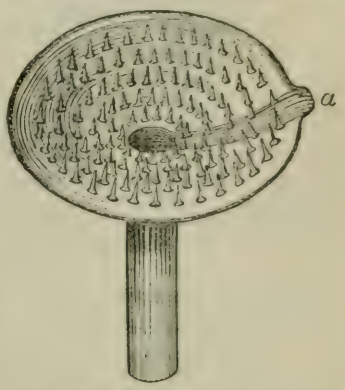

FIG. 95.—The ècuelle for lacerating the oil vessels in the rinds of orange, lemon, etc.; the oil collects in the hollow handle, whence it is poured off at *a*.

The second mode is that of distillation. This differs in no essential respect from the methods already in use in this country for the extraction of oil of peppermint, sweet birch, sassafras, etc. Of course an oil which is worth $5 or $6 an ounce demands finer apparatus and greater care than an oil not worth that much per pound. Further, it must not be assumed that all forms of still are equally good. The absolutely necessary parts of a still (figs. 96 and 97) are, first, a boiler in which the material is placed with water; second, some means of supplying heat, preferably steam applied in a steam jacket, but frequently merely a fireplace under the boiler; third, a worm or some equivalent form of tubing, immersed in cold water or otherwise cooled, to condense the steam; fourth, some kind of a receiver in which the condensed oil and water may be allowed to separate. Distillation is available for a large number of plants, as will be shown, but not for all.

The third method is that of maceration, in which flowers are immersed in melted grease, the charge being renewed ten or fifteen times at intervals of twelve to forty-eight hours. The product is either used as pomade, or digested in alcohol, which takes up the

perfume, making an extract. Lard and tallow thoroughly purified are used; also the fat of the deer. To make perfumed oils, olive oil is substituted for the fat.

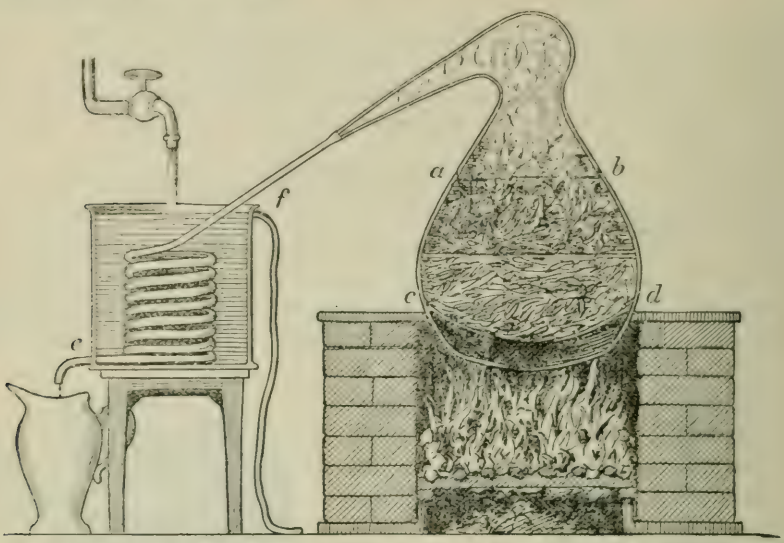

FIG. 96.—Sectional view of perfumery still: *a*, *b*, junction between head (which is lifted for admission and withdrawal of material) and pan; *c*, *d*, false perforated bottom to prevent material from burning; *e*, *f*, condenser (tub of cold water with coil, which discharges at *e*, and overflow pipe passing off at *f*).

The fourth method is that of enfleurage or inflowering or absorption, in which the flowers are placed on thin layers of grease spread on panes of glass in frames, the flowers being renewed from day to day. To obtain perfumed oils, coarse cotton cloths saturated with olive oil and laid on frames with wire gauze instead of glass are used. Enfleurage is the most delicate of the methods to operate and gives the finest results.

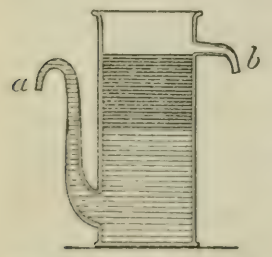

FIG. 97.—Florentine recipient in which the product of distillation is allowed to settle; the oil, if heavier than water, passes out at *a*, if lighter than water, at *b*.

By the two latter methods the odor obtained is nearly that of the living flower; that secured by distillation is often as different as if it came from another plant.

It should also be mentioned that various chemical processes for the extraction of perfumes have been proposed, though they have not hitherto superseded the methods described to any great extent.

Next to be considered is the availability of the plants which have been named in view of the natural, and incidentally the economic, conditions existing in this country. In this paper the capacities of our outlying dependencies are disregarded.

THE ROSE.

First, perhaps, in its claims on our present attention is the rose. Not only is attar of roses first among perfumery articles in value of importation, but our climate and soil over large areas appear to be highly adapted to rose growing, while the distillation of the attar can be begun without great outlay or extended experience. The question in respect to the rose is not whether, or even where, the rose will grow, but where the flowers will be rich enough in oil and at the same time easily enough produced to compete with other localities at home or abroad.

According to Sawer:[1] "It is perfectly certain that under no conditions is the odor [of the rose] fully developed except in very hot climates, where the power of the sun affords the maximum benefit of light and heat." Inasmuch as the American sun is a powerful agent in summer, even as far north as Canada, the outlook in this regard is not discouraging. When we examine, moreover, the climatic conditions of the great seats of rose farming in Europe, those regions do not appear to possess any advantage over large areas in this country. In Bulgaria, where Turkish attar of roses is mainly produced, the industry is carried on in fertile valleys on the southern slope of the Balkans. The climate here is far from tropical. There is cold and snow in winter, abundance of moisture in the spring and fall, and drought in summer. Wheat and the ordinary cereals are produced in the same region. The rose harvest begins about the third week in May and lasts about a month. A second great seat of rose farming in Europe is the space between the Maritime Alps and the Mediterranean, in the extreme southeast of France. The citrus fruits, cassie, and many other perfumery plants are here grown, and perfumery materials are also imported for manufacture. This is, in fact, the great perfumery center of Europe, the town of Grasse being the emporium of the district. The climate is genial, but not free from the visits of cold winds, and tender plants require protection from frosts. The climatic character of the region appears not to be very different from that of our Gulf coast.

Attar of roses is also produced in Asiatic Turkey, in Persia, and in India, but the great bulk of the European and American supply is furnished by the regions mentioned.

Of peculiar interest, as bearing upon the question of the adaptedness of this country to the production of oil of roses, is the enterprise in rose farming undertaken some years since by the distinguished firm of Schimmel & Co., at Leipsic. The extreme falsification of the Turkish article led this house to establish rose plantations in the home country in order to place a perfectly pure attar upon the market. This enterprise appears to have been maintained up to the

[1] Sawer, J. Ch., Odorographia [ser. 1], p. 24, 1892.

present time with some measure of success, though hampered by the difficulty of persuading dealers to pay the requisite price for a pure article.

It is manifest that if a rose industry can live at all in Saxony, it can, so far as depends on natural conditions, not only live but thrive over large areas in the United States.

These comparisons, together with the known luxuriance of the rose in the South and in California, justify the conclusion as highly probable that, so far as climate and soil are concerned, the production of attar of roses in this country is entirely feasible.

The delimitation of the area over which rose farming for this purpose can be successfully conducted is not at present possible. A few hints can be given to aid the judgment of an experimenter. In the East attar of roses could doubtless be produced well up toward the northern boundary; but the production in the North would labor under so great relative disadvantages that it can hardly be thought of as a commercial industry. The case is altogether different in the territory beginning, say, with South Carolina and extending south to Florida and west to Louisiana, and in the productive districts of at least the southern half of California. The abundant heat and sufficient but not excessive moisture of the South would seem to favor both the growth of the plant and the development of the odor. With respect to the vigor of the rose, it is not necessary to resort to probability; but the flowers never having been tested for yield of attar, their availability will remain slightly in doubt prior to special investigation. Not all lands within the area designated can be thought of for rose culture. The rose must have a rich soil, and the hammock lands of the coast belt and the fertile sections of the interior must be chosen to the exclusion of all sandy barrens and other lands unsuited to general agriculture. It is not impossible that the uplands somewhat removed from the coast may prove better adapted to the development of odor than the hot lowlands. The conditions which secure a rank vegetation do not always bring out the fine qualities of a plant; and there is evidence, in the case of the rose, that heavy manuring, while increasing the quantity of the yield, is prejudicial to its quality.

In California the experimenter should avoid the fogs and cold winds of the coast, but otherwise may be guided by what is already known of the thrift of roses as grown for ornament. There is room for question whether the dry air of that region will secure the best development of odor, even though the soil be abundantly moistened by irrigation. This doubt can only be settled by the trial of proper varieties treated in proper methods. Where the sun is hot, much depends upon the flowers being gathered before it rises. The indications are favorable enough to warrant patient experiment.

The roses employed for attar making in Europe are, in Bulgaria, the red damask rose (*Rosa damascena* Mill.), and in the south of

France the Provence rose, a hybrid[1] or variety of the hundred-leaf rose (*Rosa centifolia* L.), to which also belongs the well-known cabbage rose. There is a strong presumption that rose farming, if tried in America, should begin with these long-tried sorts. Yet they are both subject to the disadvantage of being spring bloomers only, except that the damask rose has a short autumnal season. The main period of bloom, accordingly, lasts only about a month. It is manifest that if a perpetual bloomer could be found having the necessary vigor and freedom of bloom, and yielding the requisite quality and quantity of oil, it would be an immense advantage, as it would enable a grower, especially in the South, to work his plantation five or six months in the year. The fact that no such rose has come into use in Europe can not be admitted as decisive proof that one can not be found or developed. Mr. P. J. Berckmans, of Augusta, Ga., a high authority, states that the variety of the Bourbon type known as *Gloire de France* has the true odor of attar, being at the same time a perpetual bloomer. It must be admitted, however, that this improvement would have to contend with the fact that perpetual bloomers generally flower less freely at any one time than do spring bloomers.

ROSE GERANIUM.

It seems most natural to refer next to the rose geranium, in view of the affinity of its odor to that of the rose. The oil of rose geranium is not separately itemized in the Treasury reports, but is undoubtedly imported in considerable quantity, partly in the capacity of an adulterant and partly, perhaps, among unclassified oils. Though unfortunately employed largely in a falsified attar of roses, the oil of geranium is in itself a legitimate perfumery material, agreeable even if not equal to true oil of rose. It is furnished by three well-known species of *Pelargonium*, namely, *P. capitatum* Ait., the common rose geranium of our windows and gardens; *P. radula* Ait., similarly cultivated and sometimes called skeleton-leaved geranium; and *P. odoratissimum* Ait., the nutmeg geranium, also grown in greenhouses, etc., and to be recognized by its fragrance and by its round, crenate, undivided leaves, which are velvety like those of a horseshoe geranium, though much smaller. (See fig. 98.)

The Pelargonium is grown for distillation in Algiers, the island of Réunion, Spain, Corsica, and Italy, and in the perfumery district of the south of France. The best oil is produced from plantations in dry ground, where the plants are stunted in growth; but for the sake of quantity they are now grown in low, moist, irrigated ground, where the growth is forced to 30 inches, and three crops a year can be gathered, though the product is much inferior. The plant is harvested "a little before the opening of the flowers, when the lemonlike

[1] According to Heuzé, Les Plantes Industrielles, Vol. III, p. 150, it is a hybrid between *Rosa centifolia* L. and *R. gallica* L.

odor which it at first possesses gives place to the odor of rose" (Sawer). The whole plant is placed in the still, and in Provence rose petals are sometimes added to improve the quality.

There can be no doubt that the rose geranium can be grown in abundance in properly selected locations in the coast belt of the South and in southern California. Mr. E. Moulie, of Jacksonville, Fla., who has personally investigated geranium growing in Algiers, believes that the advantages in Florida are quite superior, and that

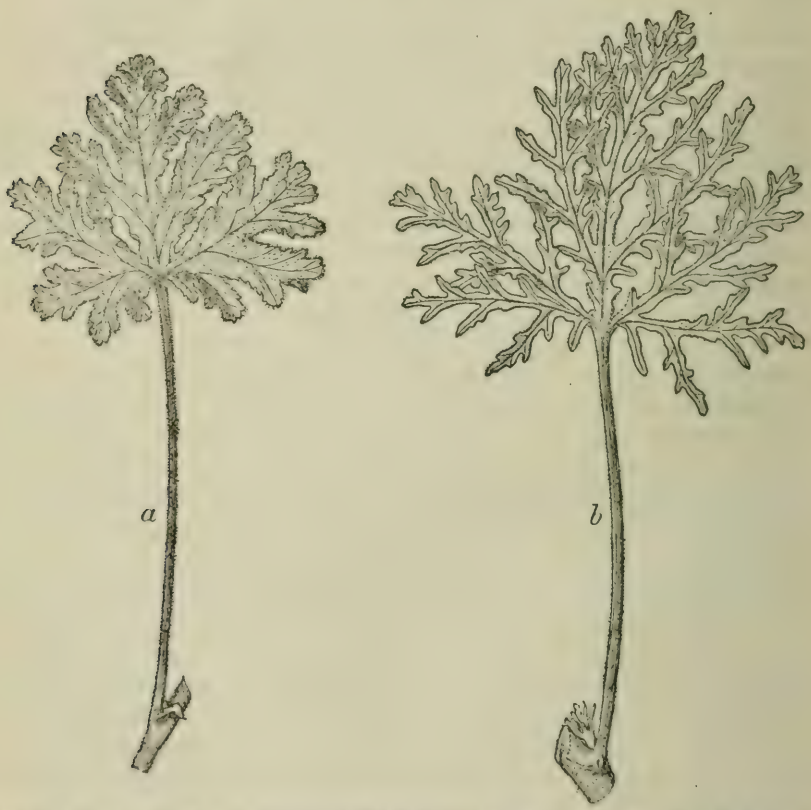

FIG. 98.—Geranium leaves: *a*, common rose geranium (*Pelargonium capitatum*); *b*, skeleton-leaved geranium (*Pelargonium radula*).

an oil of geranium can be produced there equal to the best French. He finds that the plants can be maintained through the winter by heaping up the earth a few inches around them, the stumps sprouting vigorously in the spring. If planted so far north that only one crop a year could be gathered, all hope of profit would be taken away. If the present growers must be imitated in preferring quantity to quality, the alluvial flats of the Southern rivers will no doubt furnish luxuriant crops. Even in that case there will be a demand for the dry-land product to mix with and ameliorate the lowland article.

CITRUS TREES.

The sweet orange (*Citrus aurantium* L.); the bitter or Seville orange, the *bigarade* (fruit) and *bigaradier* (tree) of the French (*Citrus bigaradia* Loisel., *C. aurantium bigaradia* Brandis); the bergamot orange (*Citrus bergamia* Risso, *C. aurantium bergamia* Wight & Arn.); the lemon (*Citrus limonum* Risso, *C. medica limonum* Brandis); the citron (*C. medica* L.); the sour lime (*Citrus acida* Roxb., *C. medica acida* Brandis); the sweet lime (*Citrus limetta* Risso, *C. medica limetta* Brandis); the shaddock, pomelo, or grape fruit, etc. (*Citrus decumana* Murr.)—all, or almost all, yield perfumes, some of them very important. The bergamot and cedrat (citron) oils and the oils of lemon, limes, and orange, mentioned in the list on page 378, are obtained from the rinds of the respective fruits by mechanical processes, or an inferior article by distillation; it is claimed, however, that a distilled oil of good quality may be obtained by removing the "rag" or spongy part of the rind. The neroli or orange-flower oil is extracted from the flowers by distillation. A finer and different product is obtained from the flowers by the maceration process. Orange-flower water comes over with the neroli in the distillation and represents the odor of the flowers much more closely than the neroli. It appears to be the unaltered oil of the flower dissolved in water. The orange flowers as they naturally fall from the trees are certainly utilized for some of these purposes, but it is explicitly stated[1] that at Vallaurie in Provence, one of the principal centers of the neroli industry, the buds are picked from the trees when on the point of opening and the green part of the flower removed by hand. It is altogether probable that the finest article is obtained in this way. Besides these products is to be mentioned the oil of petit grain ("small seed," as the name may be rendered), obtained by the distillation, originally of the abortive fruits which fall soon after the blossoms, but at present more of the leaves and young shoots of the bitter and sweet oranges yielded by pruning. The oil of bitter orange is superior to that of the sweet, as is also its petit grain oil; but the neroli of the sweet orange is considered finer than that of the bigarade. The oil of bergamot is far more valuable than the other orange-peel oils, but is not easily had in the market in a pure state. It is produced exclusively or mainly in the extreme south of Italy, at or near Reggio.

Piesse,[2] from a British point of view, writes as follows:

> No tree is so profitable to the flower farmer as the orange, and emigrants to any of our warm colonies should make a note of this and fix on their memory that the leaves of orange yield an otto worth 3 shillings an ounce; that the flowers yield an otto worth 10 shillings an ounce; that the blossom also yields, by inflowering, a fat worth 8 shillings per pound; that the rind of the fruit yields an otto worth 12 shillings to 16 shillings per pound, and that the fruit, if it can not be sold by the score in the market, is a relished food for cattle.

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[1] Sawer, Odorographia, ser. 1, p. 82.

[2] Piesse's Art of Perfumery, Charles H. Piesse, ed., p. 173, 1891.

The prices quoted in the table (p. 378) must not be taken as an index of what could be obtained for a pure article extracted according to the best methods. The oil of bergamot, according to Piesse, is so adulterated as to sell for 10 shillings per pound, though worth 30 to 40 shillings when pure. Neroli and doubtless all the more valuable oils are also largely adulterated.

Italy and the south of France furnish the bulk of the citrine perfumes of commerce; but the island of Chios produces much orange-flower water, the island of Trinidad yields a very fine oil of limes, and the island of Curaçao yields the best orange peel in the world, while both the bitter and sweet orange are distilled more or less in Jamaica.

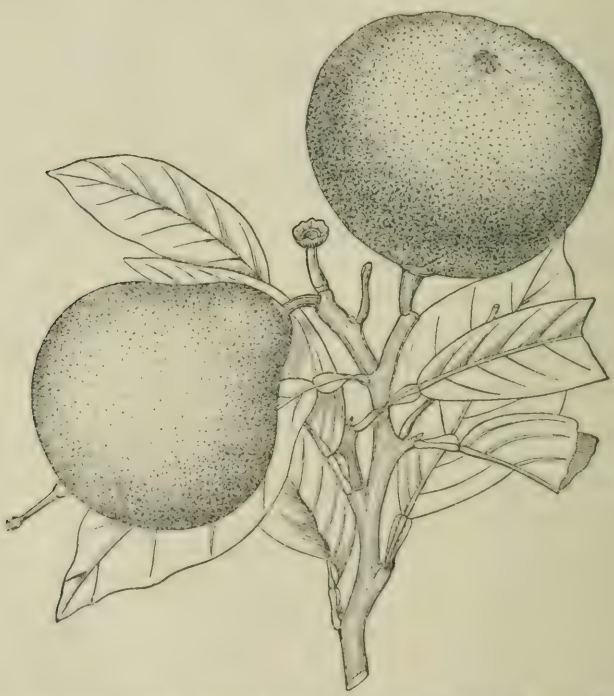

FIG. 99.—Bergamot orange, showing two forms of fruit (after Risso and Poiteau).

It is already settled that the citrus fruits will grow in this country, and the territorial limits of their success are approximately marked out, but how far their products are available for perfumery remains largely to be determined. The citron is not yet grown on a commercial scale and the bergamot (fig. 99) will be found only in gardens. Little as has been done with these trees from a perfumery point of view, there are a few data which may encourage and give direction to experiment. Mr. E. Moulie, of Jacksonville, Fla., started a perfumery farm at San Mateo of that State in the fall of 1880, and up to April, 1893, had extracted the oil from 150,000 fruits of orange and lemon, besides making use of a large amount of orange and other flowers. He

is a strong believer in the capacity of Florida for perfumery production. The flowers of the orange were long ago, and doubtless are still, collected at New Orleans and sold in the city for perfuming rooms. Mr. W. B. Rush, who made observations near that city upon the relations of weather and climate to the development of the fragrance of the orange flowers, writes:[1]

Orange flowers produced in the extreme southern borders [of Louisiana] are believed to possess a stronger odor and more oil [than those in other countries]. The difference is accounted for in this manner: In the tropics and semitropics the trees do not begin to bear very much until about twenty years old, while in this country they begin at about seven. The development is more rapid, the tree more vigorous, and it is reasonable to suppose a better development of odor in the flower. The writer was informed by an orange grower who had extensive observations in different countries and fully confirmed this supposition. The flowers are more fragrant and the fruit more juicy, but not so sweet as in some other countries.

It will be well to introduce here some observations from the same article, which will assist in the selection of localities for neroli production:

The humidity of the atmosphere materially affects the flowers: when too wet the pollen heads are injured and the secretions are imperfect. Dryness has a similar effect on the pollen and nectar, but does not affect the secretion of the oil. When the temperature is too low but few flowers are fructified, the oil cells are limpid, and no nectar is secreted. The most favorable temperature is about 68° to 76° F. Under 60° F. the flowers are blighted. When the busy bee is found collecting the nectar, the conditions are favorable for the development of the flowers and fruit, and then the flowers contain their most agreeable odor.

If this writer's statement that dryness does not affect the secretion of the oil can be extended indefinitely, the parts of California where irrigation is depended upon would be suited to this industry. Prof. E. O. Wooton, formerly of the Agricultural College of New Mexico, is of the opinion, however, that irrigation does not make up for atmospheric humidity at all, or only in a slight degree, and too severe drought might prove unfavorable to the development of odor. The question must be settled by direct observation and experiment.

Some valuable experiments with the citrus fruits have already been made in California. Prof. E. W. Hilgard states that certain attempts to manufacture oil of neroli at Santa Barbara and at San Gabriel in Los Angeles County failed on account of the low summer temperature due to the Alaskan current. A mere film of essential oil was obtained where several ounces should have been produced. A similar failure occurred at Santa Barbara with tuberose, violet, and rose, though the plants vegetated luxuriantly. This result agrees with Mr. Rush's observations upon the odor of orange flowers above quoted, as with other information, and no one should henceforth attempt the production of floral perfumes where the flowers are subject to cool breezes during the blooming season. The case may not

[1] American Journal of Pharmacy, 1879, p. 70.

be entirely the same with the oil of the fruit rind, or at any rate a moderate removal from the coast might obviate the difficulty. Notwithstanding these setbacks, Professor Hilgard states that "oil of orange and lemon have been made on a smaller or a larger scale for a number of years past, without appearing to maintain a permanent foothold as yet." This is perhaps the present state of the case; but Dr. S. M. Woodbridge, of Los Angeles, reports that he is successfully manufacturing oils of lemon, limes, and orange (also of eucalyptus) on a commercial scale, having a factory capable of using 3,000 pounds of fruit daily. If experiments at the present stage are even moderately successful this would seem to augur a full success when experience shall have been extended and economic conditions perhaps improved.

Mr. A. E. Zumbro, of Riverside, which is situated somewhat farther from the coast, has been experimenting with several perfumery plants, including citrus fruits, since 1894. His experience with the latter is stated as follows:

> Oil of lemon can be made from our cull lemons equal in quality to the imported article as it comes to us in pound copper cans.
>
> I have not yet made an oil of orange equal to the best imported oil of orange (sweet), but the improvement I have made since the first leads me to hope that a satisfactory oil can be made from our oranges.
>
> My experience with orange-flower pomade leaves but little doubt that a marketable article can be made from our flowers as soon as the cost of labor and supply of flowers make its manufacture possible.

It may be mentioned in passing that the same experimenter has successfully extracted the oil of lemon verbena (*Lippia* (*Aloysia*) *citriodora* H. B. K.), as has also Mr. Moulie in Florida. The odor is a choice one of a citrine character, but on account of its cost is little used by manufacturing perfumers, imitations taking its place.

LAVENDER.

The true lavender (*Lavandula angustifolia* Mill.) is a plant of the mint family, which furnishes a staple essential oil, imported in large quantities at a slightly increasing price. The spike lavender (*L. spica* L.) yields a far less valuable oil, used in veterinary medicine, in soap making, and by artists, but not in perfumery except for adulteration.

The true lavender (fig. 100) is a somewhat woody perennial herb, with slender, straight stems, bearing widely separate pairs of narrow leaves of a gray color and at the summit a spike of small flowers of the color known as lavender. Both the corolla and calyx of the flowers are covered with stellate hairs, among which are embedded glands which yield the fragrant oil.

The plant is a native of the Mediterranean region, and in the wild state seems to prefer arid mountain sides, where other vegetation is scorched by the sun; and though in these situations the plant appears

stunted, its perfume is richer and stronger than elsewhere. Notwithstanding its southern origin, lavender is a hardy plant, surviving with slight protection even at Upsala, in Sweden. It is further surprising to learn that lavender, having been introduced into England, has flourished there under cultivation in a remarkable manner. As grown at Mitcham in Surrey and Hitchin in Hertfordshire and some other locations in the south of England, the plant develops in favorable localities into a bush 5 feet in diameter and sending its spikes 5 feet high, and furnishes an oil which is claimed to be "far superior in delicacy of fragrance to that obtained from the wild plant, or from the same plant cultivated in any other country."[1] The English oil, in fact, has sometimes sold for ten times as much as the French. The relative value of these oils will presently be referred to again.

FIG. 100.—Wild plant of the true lavender (*Lavandula angustifolia*): *a*, *b*, calyxes of flowers, the chief source of the oil.

In the Eastern United States lavender, though grown in some gardens, is not cultivated to any great extent. In California it seems to be more commonly planted, and there can be little doubt that the conditions in that State are favorable for its production. It is true that the growing of lavender was undertaken at Riverside some years since and quickly failed, but for economic rather than climatic reasons. Mr. Zumbro, above quoted, believes that it can be grown on "dry land" there. The situation in that region more or less resembles that in which the plant naturally grows around the Mediterranean. It can not be expected, however, that California lavender will resemble the English. The character of the English plant is due to the special conditions under which it is grown, namely, the mild, moist air and the calcareous soil. The best French oil must be set up as a standard for California rather than the English. The two oils are so different in kind that it is considered hardly suitable to compare them. The superiority of the English oil, however, has recently been attacked by Schimmel & Co., supported by other authority,

[1] Sawer, Odorographia, ser. 1, p. 356.

who regard the best French oil as finer.[1] If this view should be generally accepted, the difference of price will disappear, except in so far as the peculiar quality of the English perfume may enable it to hold its place. In any case a fine lavender of the French type will command a good price; and the quality will depend not alone upon the plant, but upon the method of distilling. It is not impossible, however, that locations may be found in this country which will yield a lavender more resembling the English. The "Black Belt" or prairie region of Alabama and adjacent States, with its light limestone soil, would seem very inviting for experiments.

THYME.

Different species of thyme, but especially *Thymus vulgaris* L., garden thyme, and *T. serpyllum* L., wild thyme, are distilled for their aromatic oils. The lemon-scented thyme, said to yield the most agreeable perfume of all, is the garden variety *citratus* or *citriodorus* of the latter species. As a perfumery material the oil of thyme, according to Piesse, is suited only for use in soaps, but is well adapted to that application. It was formerly used as a source of thymol, but apparently is not at present. For whatever purposes used the production is considerable, some 90,000 pounds per year being distilled in the south of France, which furnishes the bulk of the world's supply. For the last five years the importation into the United States has averaged nearly 48,000 pounds, at a price of about 61 cents per pound.

The garden or common thyme is native in arid ground in Spain, Italy, and the south of France, and is grown in gardens in England. The French oil of thyme is derived wholly or largely from a copious natural growth of this plant, and hence competition may not be easy. It would naturally be experimented with in California along with lavender. The wild thyme is more hardy, growing naturally throughout Europe as well as in northern Africa. It has been sparingly naturalized from Massachusetts to Pennsylvania and in North Carolina.

ROSEMARY.

Another labiate plant, *Rosmarinus officinalis* L., is found along with the common thyme and distilled in considerable quantities. The oil is imported, though in less quantities than the last. "Otto of rosemary is very extensively used in perfumery, especially in combination with other ottos for scenting soap. Eau de Cologne can not be made without it, and in the once famous 'Hungary water' it is the leading ingredient."[2] The rosemary has a stimulating effect, to which is due the refreshing property of perfumes containing it.

[1] Schimmel & Co. (Fritzsche Brothers, New York). Semiannual reports, October, 1894; April, 1898.

[2] Piesse's Art of Perfumery, p. 206.

Rosemary should be tried along with lavender and thyme in the warm and dry parts of California and the adjacent region. It is grown to some extent in England, and the oil produced there, like that of lavender, is specially valuable; it may prove successful along with lavender in some Eastern State on a calcareous soil.

The sweet marjoram (*Origanum majorana* L.) is a plant similar in character and product to the last three, and worthy of trial together with them.

ORRIS OR IRIS ROOT.

Orris root has been imported for the last five years at the average rate of over 238,000 pounds, with an annual value of $28,889, at a price of 9.7 to 15 cents per pound, a price averaging much higher than for an equal period earlier. It is a standard article, affording a perfume resembling violet, and the demand is likely to continue. The root is the product of three species of iris, namely, *Iris germanica* L., *I. pallida* Lam., and *I. florentina* L. The first of these is the common, deep-colored, scentless flower-de-luce, or blue flag, of our gardens; the second is similar, but of a paler color; the third is a plant of similar size and habit, the flowers white with blue veins, faintly sweet-scented. The thick, knotty rootstocks are the useful part. When taken up and dried they slowly develop a perfume which does not reach its maximum in less than two years. Being extracted by distillation, it furnishes orris or iris butter. It is also ground up for use in sachets. The wild plant was formerly gathered, but cultivation is now resorted to, the vicinity of Florence and other parts of Italy being the seats of its production. The crop is gathered once in three years, the root being taken up and cut off just under the crown, which is returned to the ground to root again and spread for the next crop.

There is no doubt but iris can be grown in the milder parts of this country where it is not too dry. It appears to belong naturally to swampy ground, yet Henderson in his Handbook of Plants refers to the tuberous-rooted kinds (those in which we are here interested) as very apt to be destroyed by snails or to rot from too much wet.

Experiment with iris need not be expensive, but the grower can not expect returns for four or five years. By planting successive years, however, the crop would afterwards be annual. *Iris germanica* sometimes escapes from cultivation in Virginia, which would suggest its adaptedness to that region, and it might perhaps do better in still warmer latitudes.

BITTER ALMOND.

The oil of bitter almond has been imported of late years at the rate of about 6,000 pounds a year, the amount having risen to 10,000 pounds, however, in 1897–98. The import price was quoted at $2 to $3 per pound for several years preceding the last, when it fell to $1.15. The fall is probably due to the inclusion in the average of chemical

substitutes. In Merck's Index for 1896 the retail price is quoted as $6.59. The genuine oil of bitter almond seems likely to continue in demand. Messrs. Schimmel & Co., in their Semiannual Report, April, 1897, state as follows: "Almond oil, bitter, is very scanty and remains in brisk demand notwithstanding all substitutes. It is indispensable for articles of luxury and for the finer almond soaps."

The sweet and bitter almonds are varieties of *Prunus amygdalus* Stokes (*Amygdalus communis* L.), the bitter being distinguished as variety *amara*. The almond tree has a general resemblance to the peach, but its fruit is invested with a leathery coat instead of an edible flesh. The valuable part is the kernel, which in the sweet is the almond of trade and in the bitter is poisonous. In both, however, the kernel furnishes a valuable expressed oil which contains no poison, but is used in medicine and in a general way like olive oil. The oil of bitter almonds is obtained by maceration and distillation of the cake left after pressing the kernels of the bitter, but not the sweet, almond. It is not properly an essential oil, but a substance known to the chemist as an "aldehyde." It is a dangerous poison, but in very small amounts is in common use for flavoring as well as for scenting.

FIG. 191.—Cassie or opoponax (*Acacia farnesiana*): *a*, head of opened flowers; *b*, head of unopened flowers.

The sweet almond thrives in California and Florida, and at least survives the winter in favored districts in Michigan. The bitter almond appears not to have been grown in this country on its own account, but it has been introduced into California as a stock for the sweet almond and is also used as a pollenizer for the flowers of the latter, which does not fruit well without cross fertilization. It is equally hardy with the sweet almond.

The question of growing the bitter almond, then, in California and through the South is only a question of profit. The fact that it yields also the expressed oil might make the difference between commercial success and failure. The case seems to deserve experiment.

UMBELLIFEROUS AROMATICS.

Mention must be made in passing of several umbelliferous plants whose seeds yield to distillation oils used to some extent for perfuming. In the list (p. 378) occur anise, caraway, and fennel, the oils of which were imported in 1897 to an aggregate value of $88,000, of which by far the largest part belongs to anise. A fact, however, which has a bearing on the growing of these plants is that considerable amounts of their seeds are imported, caraway here forming the bulk, with a value of $96,000, making with the oil an importation of almost $100,000 worth of caraway products. This seems on the face an economic absurdity; but when it is considered that the price of caraway is so low that the production in parts of Europe has been reduced it seems doubtful whether it can be grown at a profit in this country, though the natural conditions are favorable in the cooler and moister parts. Fennel having run wild on the lower Potomac, the indications are that the domestic supply could easily be grown there or elsewhere, but the demand is small. The production of anise seed and oil is probably feasible, and the demand is large enough to make it worthy of consideration. Anyone undertaking the cultivation of this class of plants should consider also dill and coriander, which are moderately used in perfumery.

VIOLET.

The European or "English" violet (*Viola odorata* L.) is extensively grown in the south of France and in the vicinity of Florence for the extraction of its perfume. There are numerous varieties of this violet, of which the "Neapolitan" is one, and of which the "Double Parma" is said to be preferred for perfumery purposes. While *Viola odorata* is common in England and the cool countries of Europe, its odor is best developed southward; yet it can not bear the full brunt of the southern sun and consequently is grown under olive, orange, lemon trees, etc., though this practice seems to be on the decline.

The perfumery culture of the violet in this country can be thought of only for the warmer regions. Its culture for general purposes is already highly developed in California, where it is grown under great oaks and in other shade. But favorable as the natural conditions may be there and in the South, it must be considered that the expense not only of growing but of gathering so small a flower in the quantities required for extraction is very large. Thus, even in Europe the cost of the perfume becomes so great that true violet in a pure state, notwithstanding its attractiveness, is little used. A tincture of orris root or a composition of orris root with other ingredients is used in its stead. The cassie odor, next to be mentioned, may also be considered as to some extent a substitute. Lately a synthetic violet odor called ionone has been announced by Schimmel & Co.

Sooner or later violet perfume will probably be extracted to some

extent in this country in connection with other lines of perfumery production. An attempt to make it a main line under existing conditions would almost certainly fail.

CASSIE OR OPOPONAX.

A perfume with some affinity to that of the violet is yielded by the *Acacia farnesiana* (L.) Willd., known to the French and to the perfumery trade as cassie, but in this country in the South as opoponax. The name cassie and also that of "huisache" are known in Texas. Opoponax or opopanax is properly the name of an umbelliferous plant growing in Sicily, Syria, and India, which in the Orient affords a gum resin used in perfumery. Doubtless a resemblance in odor connects the cassie with this plant.

The *Acacia farnesiana* is a small tree becoming 20 or 30 feet high, armed with small spines and bearing pinnately compound leaves with extremely small leaflets. The source of the perfume is the flowers, which are borne in small round heads of a yellow color, singly or clustered in the axils of the leaves (fig. 101). The tree is either native or introduced through large parts of the tropical and subtropical regions of the earth. It is extensively grown in the south of France for its odor, which is extracted by maceration, also by enfleurage. The perfume belongs to the finer class, and is highly recommended by Piesse.

The cassie tree grows so naturally in southern Texas that Professor Sargent regards it as indigenous there. It is spontaneous thence east and west along our southern borders near towns, being planted for ornament. The flowers from the wild tree might be utilized in Texas, but it does not seem probable that that region is adapted to general perfumery farming. In southern California and in Florida it might be grown in connection with other perfumery crops. According to Mr. Moulie, an immense crop of flowers could be secured in Florida within a period of five years.

There are several other acacias that deserve attention from a perfumery point of view, but the limits of this paper forbid specific notice.

TUBEROSE.

The well-known tuberose (*Polianthes tuberosa* L.) is one of the staples of the flower farms at Grasse, in the south of France. There is no reason to doubt its success as a perfumery plant in Florida and other favored locations, so far as natural conditions are concerned. North Carolina now furnishes bulbs both for this country and Europe, the bulbs attaining a blooming size by the end of the second year. In Florida it is found difficult to prevent the bulbs from blooming the second year, but for perfumery purposes early bloom is no disadvantage. In the south of France, according to one account, the bulbs are housed during the winter, but another authority represents that

in some locality not specified a plantation will last seven or eight years. Mr. Moulie[1] in Florida finds it profitable to leave the bulbs in the ground three years before resetting. By setting out bulbs of different sizes in November he manages to have continuous bloom for at least nine months of the year, beginning with April or May. Mr. Moulie estimates a large profit; still, liberal allowance must be made for the cost of hand-picking and careful cultivation and for failures due to unskillful management. The perfume can be expected to bring a good price. It is extracted by the enfleurage process.

JASMINE.

The perfume of jasmine is regarded as almost the only one which can not be imitated, that is, by combination of other odors. It is highly prized and brings a high price. The oil of jasmine is itemized in the Treasury reports, although the importation is very small, ranging from 9 pounds to 1,610 pounds per year. The price per pound is quoted for one year as low as 64 cents, while in the report for 1896–97 the price named is $44.31. Of course, very different substances are here included under the same name. The perfume of jasmine is mostly extracted by enfleurage, but there is a very rare distilled article described by Piesse, to which the last-named price might belong. In no case could the true oil of jasmine be sold for a fraction of a dollar per pound.

Jasmine is extensively grown in the vicinity of Grasse, the species there used being *Jasminum grandiflorum* L., which is grafted on the more hardy but less odorous *J. officinale* L. The Arabian jasmine (*Jasminum sambac* (L.) Ait.) is highly esteemed for its perfume in India, and was recommended by Professor Flueckiger for trial in the south of France. Neither this nor the grandiflorum will withstand frost, a difficulty which is overcome at Grasse by banking the plants to a certain height during the winter. The production of jasmine in the warmest parts of this country would be practicable so far as climate is concerned. The cultivation of the plants and the gathering of the flowers would necessarily be expensive.

NATIVE PERFUMERY PLANTS.

The present paper barely admits of calling attention to the fact that a few American plants already yield perfume oils on their native ground, and that many others ought to receive attention from this point of view. Oils of sassafras and wintergreen are distilled in considerable quantities, the former in the South, the latter in the North. These are used for scenting, but probably more largely for flavoring. Both are in demand in spite of the existence of synthetic

[1] Am. Soap Journal and Perfume Gaz., February, 1891, and in a letter. At first Mr. Moulie replanted each two years.

substitutes. The oil of wintergreen is now produced mostly or exclusively from the sweet birch (*Betula lenta* L.), the oil being identical with that of true wintergreen and more cheaply obtained. The wood of the red or pencil cedar yields a finer perfumery oil than the cedar of Lebanon, and it is now distilled in this country as well as in Germany. The rootstock of the wild ginger (*Asarum canadense* L.), known in trade as Canada snakeroot, furnishes an aromatic oil which has a place in price lists. It is said to be used for strengthening other perfumes. The leaves of the sweet golden-rod (*Solidago odora* Ait.) furnish an oil with an anisate odor which is sparingly distilled. The perfume of the large-flowered magnolia (*Magnolia fœtida* L., or, as better known, *M. grandiflora* L.) appears to have been sparingly extracted in Europe, but it is more often imitated than drawn from the natural source. *Magnolia virginiana* L., the sweet bay, swamp laurel, etc., of Eastern and Southern swamps, exhales a powerful aromatic fragrance which might well be available for soaps and perhaps for finer purposes. Mr. Moulie, in Florida, has utilized the flowers of the yellow jasmine (*Gelsemium sempervirens* (L.) Ait. f., not to be confounded with true jasmine). No attempt can be made at present to furnish a list of plants worthy of experiment.

ECONOMIC CONSIDERATIONS.

The two points of difficulty in the way of producing perfumery materials in this country are lack of information and experience and the cost of labor. The first of these by itself is no great obstacle. The art of distillation is already practiced, not only in the cases mentioned above, but in the considerable industries of extracting the oils of peppermint and of eucalyptus. To grow lavender and distill its oil does not require a specially greater intelligence than to grow and distill peppermint. The processes of maceration and enfleurage can be learned independently, especially by persons of some chemical knowledge or acquainted with kindred arts; but anyone undertaking perfumery making on a large scale should certainly have expert assistance. To know what plants to grow, and where and how to grow them, requires experiment, which might well be conducted by the State experiment stations or by persons of means who are willing to risk a little capital for the public good. But persons of moderate means, who derive their support from other sources, may in suitable localities wisely conduct experiments on a small scale with the purpose of expanding their operations in case of success. Nothing good is to be expected from that class of experimenters who, without capital, knowledge, or patience, are merely seeking bonanzas.

The relation of the perfumery business to the labor question depends somewhat upon the manner in which it is undertaken. Three types of method may be distinguished:

(1) A company or a capitalist may procure land, set up a plant,

and hire labor to grow and harvest the crop, as well as to extract the perfume. This enterprise might confine itself to the production of raw material, or might add the preparation of perfumes for the market.

(2) An extracting plant might be established with the purpose of securing its material from adjacent growers, whose product at first might be contracted for in advance. Such an enterprise would follow the same general method as a creamery, and might be conducted cooperatively. A modification of this type would be the plan somewhat followed in the peppermint business, under which the producer of the herb hires his product distilled at an establishment making distilling its business.

(3) Farmers, gardeners, etc., can grow perfumery plants together with their other crops, and extract their own perfumes. In this case the perfumery crop would be a side line, at least at the start.

The first of these plans would have the advantages of system and operation on a large scale and presumably of suitable appliances and expert direction. It would, however, have to encounter the problems presented by the labor question in their fullest strength, while the impatience of capital for quick returns would stand in the way of the gradual surmountal of difficulties. An undertaking of this type pure and simple would be the least encouraging of all. If, however, the capitalist were himself an expert and capable of managing the business the outlook would be much improved.

The second plan would have the great advantage over the first that small growers would probably accept a less price for their crop than it could be grown for with hired labor on the capitalist's farm. The small grower could often afford to do this, because by utilizing his own labor and that of his family more fully he could make an addition to his income without increasing his expense, and in other cases, because the returns from his farm by this means, if not large, would at least be larger than he could gain from other crops. This plan, conducted cooperatively or otherwise, is a good one, but could be entered upon more safely where some individual has already proved by experiment the possibility of commercial success.

The third plan has much to recommend it, though not as final and exclusive. The success of individuals on their own farms would almost surely be followed by enterprises of the second, and perhaps of the first type. Yet the assumption is to be deprecated in advance of experience that perfumery making can not in some situations be profitably conducted as a domestic industry. A small still is not expensive, nor is the apparatus for enfleurage. A considerable item of attar of roses, for instance, might, aside from the rough work of growing the bushes, be produced by the women and children of a family. A woman occasionally would be able to produce perfumery when no other productive industry was available to her.

The case should be mentioned in which wild material or waste

material of other industries can be had for the gathering. A few wild plants are already, and more may be, used for this purpose, while the fallen orange flowers may be had gratis or for a small sum by picking up—a labor to be expedited by spreading cloths. That class of labor, which digs ginseng and gathers berries and nuts for the market, would be forthcoming upon a demand of this kind.

While the cost of labor will still create difficulty, especially for capitalistic enterprises, the time seems ready for some advance in the matter of perfumery farming. Several essential oil industries are already in existence, and it will doubtless be found, as the overcrowding of other industries is more and more felt, that new activities of this class are feasible in particular localities.

THE MOVEMENT AND RETENTION OF WATER IN SOILS.

By Lyman J. Briggs,
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SURFACE TENSION OF WATER.

All liquids, when perfectly free to move, tend to assume the form of a sphere, which presents the least surface area for any given volume of the liquid. This tendency is illustrated in the spherical form of the raindrop and in the spherical water particles of fog and escaping steam. The phenomenon is due to the fact that the surface particles of the drop are more strongly attracted by the particles in the interior of the drop than by the surrounding air. When a liquid is brought in contact with a solid which it wets, we have the reverse condition, that is, the attraction between the liquid and solid particles is greater than between the liquid particles, and the liquid spreads over the surface of the solid. In both cases, however, the attraction between the

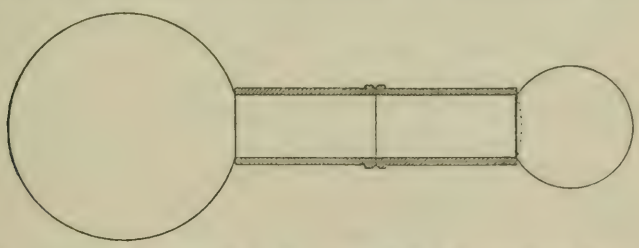

Fig. 102.—Two soap bubbles connected by a tube showing the movement which takes place due to the difference in curvature.

liquid particles exists, tending to bring the liquid into a spherical form. The action is the same as if the surface of the liquid consisted of a stretched elastic membrane having a uniform tension. The tension per unit area which this imaginary membrane must possess to bring about the observed phenomena is called the surface tension of the liquid. This surface tension changes with the temperature and with the substances dissolved in the liquid, but it is practically independent of the form and extent of the surface.

CAPILLARY MOVEMENT OF WATER.

Since the action of surface tension is to reduce the surface as much as possible, a curved surface will exert a pressure in the direction toward which contraction is moving the surface. It is this capillary

pressure which causes the movement of water in soils. It is important here to distinguish between the surface tension, which is independent of the form of the surface, and the pressure of the capillary water surface resulting from the surface tension, but which is highly dependent upon the form of the surface.

FIG. 103.—Capillary water held between two soil grains (greatly enlarged).

If a large soap bubble is blown on the end of a tube and a smaller one blown on a similar tube, and the two tubes brought together so as to have a clear air passage from the interior of one bubble to the interior of the other, as in fig. 102, it might be supposed that the larger bubble, having more surface, would contract and blow air into the smaller one until the two were of equal size, but the reverse takes place. Each bubble has the same tension per unit area of surface, but the smaller one, having the greater curvature, exerts more pressure and contracts until it is but a mere film across the end of the tube, with the same radius of curvature as the large bubble, when equilibrium is established and all movement ceases. This pressure, which is dependent upon the curvature of the surface, is the real cause of the capillary movement of water in soils.

Fig. 103 represents two grains of soil greatly exaggerated in size, with a film of water around and between them. Fig. 104 represents that portion of the water between the grains in more detail. It will be seen that there is double curvature—a curvature from *c* to *d*, while the figure has also a narrow waist bounded by the lines *a b*. This double curvature plays an important part in the capillary movement of water in soils. If there is very little water attached to the grains, the curvature of the lines *c d* will be very great, and the resultant pressure outward will be greater than the inward pressure along *a b*. If there is much water between the grains, the pressure due to the curvature of the lines *a b* may be greater than that resulting from the diminished curvature of the lines *c d*. From the direction of the curves the pressure due to the curvature of the waist *a b* always tends to operate in the opposite direction from the pressure on the curve *c d*. If the curvature of the waist is exactly equal to the curvature of the line *c d*, they will exactly balance each other, and such a surface is called a surface of no pressure, or a catenoid.

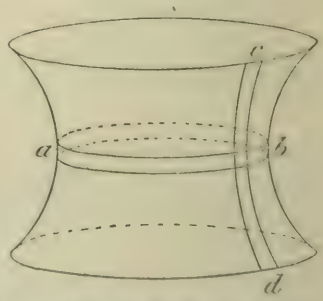

FIG. 104.—Form of the capillary water surface.

Fig. 105 illustrates in detail the direction of the resultant and efficient pressure due to the curvature of the surface, as shown by soap

bubbles supported between two parallel wire rings. The middle curve in the figure is drawn so that the curvature of the waist is exactly equal to the curvature from top to bottom. This is a surface of no pressure, equivalent to a plane surface of water, and there is no tendency for the water to move in or out. The outside curve in broken lines has a greater curvature in the waist than from top to bottom, and there is consequently a pressure inward, as indicated by the arrow, and water tends to be squeezed out from between the grains if the waist is free to contract. That there is a pressure inward is seen from the fact that the films across the rings at the top and bottom bulge out. When the waist is small, as indicated by the inner curve in the figure, the vertical curvature will be increased and the pressure will be outward, as indicated by the arrow and as seen by the bulging inward of the films at the top and bottom.

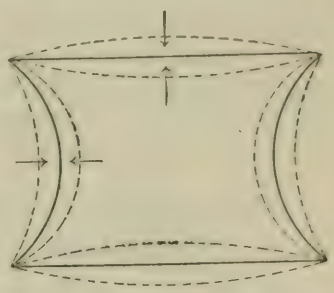

FIG. 105.—Variation in the direction and magnitude of the pressure of the capillary surface due to the form of the surface.

In fig. 106 it is easy to see the application of this to the capillary movement of water in soils. The figure represents three grains of soil with a film of water surrounding them. For the purpose of illustration, less water is shown in the space on one side of the middle

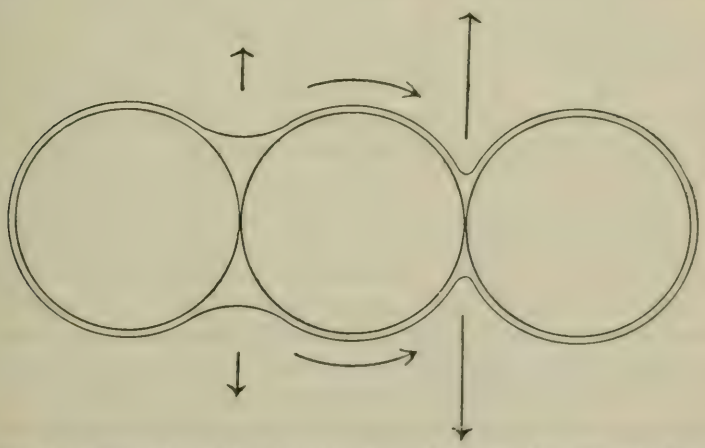

FIG. 106.—Diagram showing three soil grains surrounded by water films: Straight arrows indicate direction and magnitude of the pressure of the capillary water surfaces; curved arrows indicate movement of water resulting from difference in pressure.

grain than on the other side. In the capillary space where there is little water, the waist is small and the curvature is great; consequently there is a pressure outward, and the waist tends to enlarge until it has the same curvature as the other surface. In the space where there is

more water the waist is large, the curvature is small, and there is a pressure inward. The waist tends to become smaller until the curvature is the same as on the other surface. These pressures, therefore, may act together, one to pull and the other to push water through the thin film surrounding the middle grain until the curvature of the waists in each space is the same, when equilibrium is established and movement of water ceases. The one important factor, therefore, which determines the capillary movement of water in soils is the curvature of the capillary water surface. If two soils are placed in contact, one being wet and the other drier, water will move from one to the other if there is any difference in the curvature of the capillary water surfaces, and this movement may be from the wet to the drier soil or the reverse, as will be explained.

FIG. 195. Uniform distribution of the water content of an orchard soil at Niles, Cal.

If two soils in contact have the same texture and the same compactness, the curvature of the capillary water surfaces in the drier soil will be the greater and water will be drawn from the wet soil until the curvature of the surfaces is the same, when each soil will contain about the same amount of water. With 10 per cent of water in a coarse sandy soil the waists will be relatively large and the curvature slight. In a fine-grained silt or clay soil the same amount of water would be contained in a great many capillary spaces, as there are many more grains in a unit volume, and the curvature of the water surfaces would be much greater. Therefore water may move by capillary action from a comparatively dry soil of coarse texture into a fine-grained soil actually containing more water. Further, a loose soil has a less number of grains and of capillary spaces than a compact soil of the same texture. With the same percentage of water the capillary water surfaces in the compact soil will have the greater curvature and will draw water from the loose soil. Hence follows the efficiency of surface cultivation and of the "dust mulch" in preventing evaporation and loss of water from the surface of the ground. The dust has little or no power to draw water up from below, and, conversely, this explains the efficiency of rolling to draw water to the surface for germinating seed.

In fine-textured soils there are not only more capillary spaces, but they embrace a larger proportion of the whole interstitial space, and

when the soil is of considerable depth they have a greater capacity for water. This is important in its relation to drainage and seepage, a subject which can not be developed in the limits of this paper.

INFLUENCE OF TEXTURE OF SOILS UPON MOVEMENT OF WATER.

Three illustrations will be given to show the influence of the texture of the soil upon the movement of water.

Hilgard and Loughridge describe, in Bulletin 121 of the California experiment station, the conditions in two apricot orchards at Niles, Cal. The orchards are separated only by a road, and the soils are believed to be exactly similar, and, like many of the western soils, are very uniform to a great depth. During the excessive drought of the summer of 1898 one was continuously cultivated, and the growth was very satisfactory. The other was not cultivated, as it was considered unnecessary. The growth in this case was very small and unsatisfactory. In July the moisture content of the two soils was determined to a depth of 6 feet. The cultivated soil, notwithstanding the luxuriant growth, contained on the average 6.3 per cent, while the other contained only 4.2 per cent.

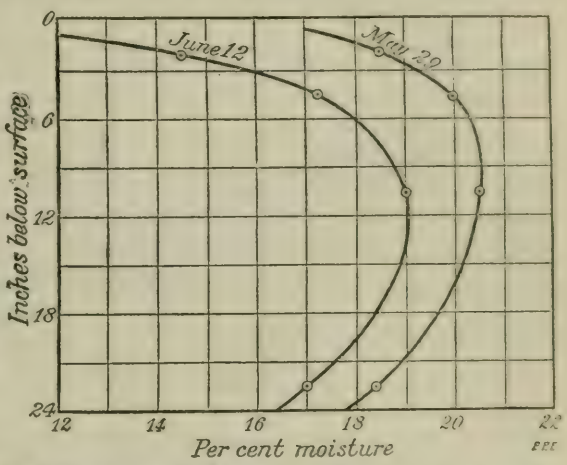

FIG. 108.—Movement of water from the subsoil up into a layer already containing a higher percentage of moisture.

Fig. 107 gives a diagrammatic representation of the water content of the two soils at the time of the observations. The water content of the different depths in each soil was so nearly the same that the line representing the water content of each soil is vertical, indicating that the water has moved steadily and readily upward and the distribution of the water has been uniform throughout the depth of the investigation. A quick adjustment, therefore, must take place through the capillary spaces to supply the loss due to evaporation from the surface. Such a quick adjustment is plainly of great advantage in supplying crops with water and tiding them over periods of drought, provided the surface is cultivated to conserve the water for the use of the plants.

Fig. 108 shows the moisture conditions in the soil at Takoma Park, District of Columbia, during a dry period of about two weeks. The top soil is a loam, resting on a subsoil of rather heavy clay, and this, in turn, is underlaid at about 20 inches with a gravelly loam. The right-hand curve represents the moisture conditions after a period of

frequent rains. There is about 19 per cent of moisture 3 inches below the surface, about 20.5 per cent in the clay subsoil, and 18 per cent in the gravelly loam below. After a rainless period of two weeks the water content near the surface had been reduced to 15 per cent. The water contained in the clay subsoil had also been lowered several per cent, while the water content of the gravelly loam below had lowered nearly as much, showing the seemingly anomalous fact of water passing up from a relatively dry subsoil into a layer containing more water, to supply loss due to evaporation. This is readily understood from the principles already described, according to which such capillary movements are determined by the relative curvature

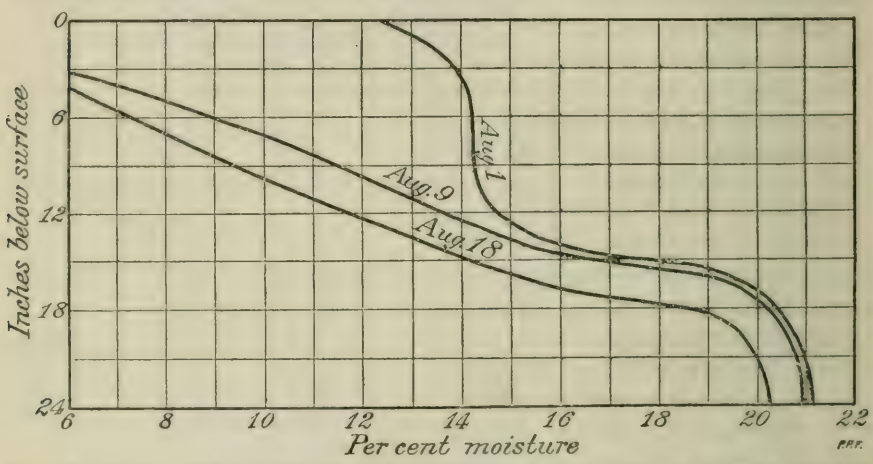

FIG. 109.—Movement of water from a heavy subsoil into a light surface soil during a period of extreme drought.

of the capillary water surfaces, the adjustment of which often causes, as in this case, an apparently anomalous movement in a direction the opposite of what might be expected from superficial observations.

Finally, fig. 109 illustrates still another type of condition in the soil at Lexington, Ky. This soil becomes continually finer in texture down to the lowest depth of observation. The diagram represents a period of seventeen days of dry weather following a period of wet weather. The right-hand curve again represents the moisture conditions at the beginning of the dry period. In eight days the conditions had changed, as indicated by the middle curve, showing that up to this point most of the loss had been from the surface foot. By this time the curvature of the capillary water surfaces was the same as in the heavier clay below, and thereafter the loss was felt throughout the full depth of 2 feet and the curves became nearly parallel, showing a nearly proportional loss of water. The curvature of the water surfaces in this case is seen to be equal only when there is about twice as much water below as above.

SAND-BINDING GRASSES.

By F. Lamson-Scribner,

Agrostologist.

INTRODUCTION.

In many parts of the world, particularly near the coasts, there are areas of greater or less extent covered with drifting sands. Some of these sand-covered areas are of such extent as to constitute real deserts and to be practically unreclaimable. There are others, however, which, with comparatively little expense, may be brought under cultivation or covered with forests. The most notable instance of reclaiming a barren and sandy waste is that of Gascony, on the west coast of France. Here some 300 square miles of territory, which offered nothing to the eye but a monotonous repetition of mountains of sand, perfectly destitute of vegetation, has been reclaimed; forests now occupy this once desert waste, and the land affords, through the introduction of new industries, steady and remunerative employment to a comparatively large population. This work in France was undertaken by the Government in the early days of the present century, and required many years for completion.

FORMATION OF SAND DUNES.

In the United States areas of drifting sands occur along the Atlantic and Pacific coasts, along the shores of the Great Lakes, along some of the larger rivers, and at various points in the interior. (See Pl. XXVIII, figs. 1 and 2.) In some places the drifting of these sands is a serious menace to profitable agriculture, and along the coast there is often danger, through the shifting of the sands, of seriously interfering with navigation. Very little has been done in this country in the way of binding or fixing these sands. Some work of this nature has been carried on in the vicinity of San Francisco, Cal., but the most interesting case of the kind is that now being conducted in Massachusetts, near Provincetown. The Province Lands on Cape Cod are practically covered with a succession of great sand dunes, upon which there is a sparse growth of beach grass and various small shrubs and weeds peculiar to such locations. The formation of these dunes results from the action of the winds and waves. The sand is thrown up along the shore by the waves and tides, and as soon as it has become dry, high winds carry it inland and over the surface of the country until arrested by some fixed object, where a mound is soon formed, which is gradually increased by fresh additions of sand; thus, the dune is formed, sometimes reaching a height of 200 feet or more.

The natural formation of these dunes is by no means regular. Breaks occur here and there in the line, and through these gaps the sand is driven to form dunes ahead, until the country may present the appearance of seas of sand, with the crest of the waves more or less parallel to the seashore and at right angles to the prevailing wind. (Pl. XXIX.) The whole mass moves slowly forward under the influence of the strong winds, fresh sand making good the loss from behind. The rate of movement is variable; sometimes it is as much as 70 feet per annum and at other times the advance is scarcely perceptible.

WORK FOR HOLDING THE SANDS IN PLACE.

These statements in regard to the formation of dunes on the seacoast are taken from a published account of the sand dunes of Gascony, known as the "Landes," but they apply equally well to the Cape Cod region. The moving of the sands at Cape Cod has been a menace to the harbor of Provincetown, and attempts have been made to hold the sands in place. The United States Government undertook to do this nearly seventy years ago, but owing to lack of system in the work very little was accomplished, and no evidences remain of the work then done. Four years ago the State of Massachusetts began operations for holding the sands in place, and a brief account of the work so far accomplished is given under "Beach grass or Marram grass." It may be well to mention here the general system employed in the work conducted on the coast of France, and the following description of the method pursued in cutting off the supply of sand is from the Agricultural Journal (Cape Colony), Vol. VIII, February, 1895:

CUTTING OFF A FURTHER SUPPLY OF SAND.—As has already been said, the source of the sand is at the seashore, and it is therefore necessary to adopt some measures to intercept the fresh supplies of sand from the shore to the dunes. The measure adopted is based on the fact that while air currents are capable of moving this sand along level or gently sloping ground, they are unable to raise it above a certain height. It is therefore necessary to construct an artificial barrier of sufficient height to intercept the advance of the sand from the shore. This artificial barrier is known as the "*Dune Littorale*," and its construction is our first point.

Formation of the Dune Littorale.—The old official system of constructing the protecting dune may be briefly described as follows: At a distance of from 150 to 200 yards from high-water mark a wattle fence some 40 inches in height is erected, parallel to the general coast line and at right angles to the direction of the prevalent wind. The drifting sand in its forward movement is arrested by this fence, and mounting up to windward forms a gradual slope toward the sea (fig. 110, *a*).

After some little time this fence is overtopped, and a second is put up some 6½ feet from the base of the steep leeward slope formed partly by the sand which has been forced through the interstices of the first fence, and partly by the sand which has blown over the top and parallel to the first fence. The space between these two fences is soon filled up, and the embryo dune assumes the profile shown in fig. 110, *b*. Midway between the two fences a palisade is erected. This palisade is formed of pine planks, sharpened at one end, 5 feet long, 7 inches to 8 inches wide, and 1¼ inches thick. These planks are driven into the ground some 20 inches and three-quarters of an inch apart, their breadth being at right angles to

FIG. 1.—PLANTING BEACH GRASS AT CAPE COD, MASS.

FIG. 2.—NATURAL GROWTH OF BEACH GRASS AT CAPE COD, MASS.

FIG. 1.—VIEW AT CAPE COD, MASS., SHOWING GENERAL APPEARANCE OF THE COUNTRY.

FIG. 2. VIEW AT CAPE COD, MASS., SHOWING SAND DRIFTS BURYING FOREST TREES.

the direction of the wind. As the sand drifts up to the windward or west slope of the dune it is again arrested by the palisade, though part of it filters through the interstices between the planks and forms a steep slope to the leeward, which serves as a support to the planks. The sand now gradually mounts up, and when nearly flush with the top of the palisade (fig. 110, *c*), the latter is levered up some 24 inches. This process is continued until the dune is some 25 to 30 feet high, when a cordon of fagots is planted on the summit of the dune just to windward of the palisade (fig. 110, *e*). The palisade is now left in this position until a third fence, which has been erected some 5 or 6 feet to the east of the leeward slope, is overtopped, and the base is increased, without affecting the height, by the sand blowing over the tops of the palisade and cordon (fig. 110, *f*). When this fence is covered the palisade is moved back a few feet (fig. 110, *g*), and the sand coming over the tops of the cordon fagots fills in the space between them and the palisade. The latter is again levered up, and the process continued until the dune assumes the final profile required, shown in fig. 110, *h*. The formation of the artificial dunes usually requires a period of from fifteen to eighteen years. The growth is naturally irregular, being dependent on the season. Steady, strong winds are the most favorable. On the completion of the dune the surface is consolidated by half burying, in a vertical position, fagots composed usually of pine branches. These fagots have usually a circumference of some 14 to 16 inches and a length of 30 inches, and are planted from 14 to 16 inches apart. Between these fagots is sown the seed of the beach grass "Gourbet" (*Ammophila arenaria*), in quantity about 13 pounds to the acre. The consolidation is naturally only requisite on the summit and windward slope. This old system, which is merely a modification of that of Bremontier, has lately been superseded by the much cheaper and equally effective method of M. Grandjean. The difference between the two systems is that under M. Grandjean's system beach grass is the only instrument employed to fix the "*Dune Littorale*," save when neglect or accident necessitates the employment of cordon or fascinage. The method of employment is extremely simple, and under good management and careful supervision the work done is very regular, though without this good results can scarcely be looked for. The beach grass, of which a description is given further on, and which is eminently suited to give that flexible form of resistance so desirable, arrests or lets slip the sand according to the density of the planting; the greater the density the more is the movement of the sand impeded, and vice versa. By regulating the planting carefully, the formation of the dune is kept under control, unless, of course, in case of accident. As the sand gradually rises, the beach grass, growing vigorously and putting out fresh rootlets at the nodes as they become covered, keeps pace with it. Of course, it would be difficult to give a detailed description of the system, and it could only be done by numerous examples of the method of treatment. It may suffice to say that beach grass is put out in tufts of some four to five plants each, at a distance apart dependent on the special requirements of the work, and that care and attention in preserving this density and immediate repair of any damage, and protection against any threatening danger, is all that is requisite; nature does the rest. M. Grandjean's system is perhaps not so rapid in its work as the older, but still it possesses undoubted advantages in economy and regularity.

This quotation is made here simply to afford suggestions to those who may have to undertake a work of a similar kind in this country. The purpose of this paper, however, is not to deal with the final holding of the sands by forest trees or other means used in the work of sand binding, but to call attention to the various grasses which have been used for fixing shifting sands and which may be classed as sand binders.

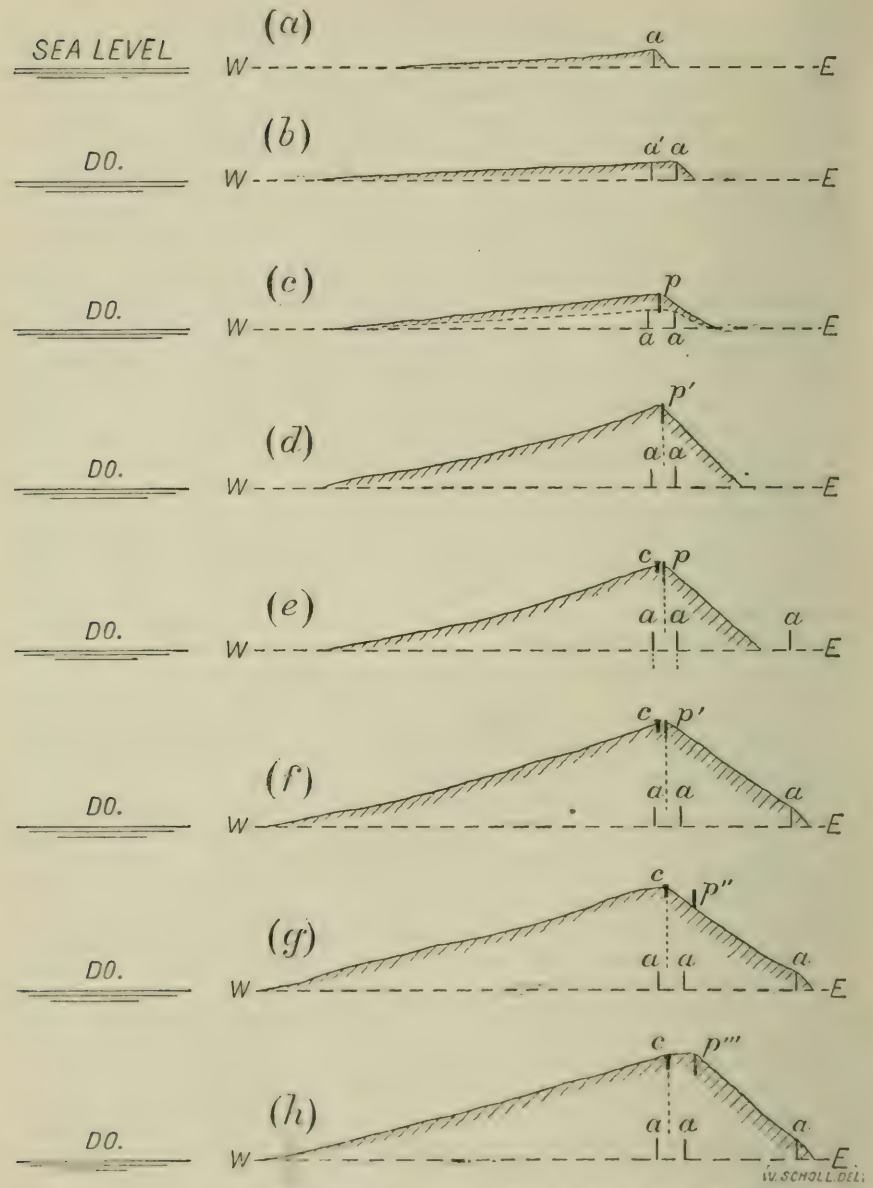

FIG. 110.—Formation of "littoral" sand dune by the use of palings and fagots: *W*, west; *E*, east; (*a*), *a*, position of first wattle fence; (*b*), *a*, position of second wattle fence; (*c*), *a a*, wattle fences, with *p* palisade; (*d*), *a a*, wattle fences, with *p'* palisade when raised; (*e*), *a a* wattle fences, with *c* cordon of fagots to windward, *p* palisade, and *a* third wattle fence on extreme right; (*f*), *a a*, *a*, wattle fences, with *c* cordon of fagots, and *p'* palisade elevated; (*g*), *a a*, *a*, wattle fences, with *c* cordon of fagots, and *p''* palisade moved to right or leeward; (*h*), littoral dune complete, with *c* cordon of fagots, and *p'''* palisade.

NATIVE GRASSES ADAPTED TO ALMOST EVERY SOIL AND CLIMATE.

Among the 800 species of grasses native to the United States, there are kinds adapted to almost every condition of soil and climate. There are some which are found only on the mountain tops or in the arctic regions; there are others which do not extend north of the Gulf coast; some are found along the Atlantic coast region, while others are only met with in the Pacific slope; there are some which grow in dry and almost desert regions, others which are found only in low and marshy places; there are some which thrive only in heavy clay soil, and others which seem to flourish in soils of almost pure sand. It is this last group—the grasses of sandy soils—which will form the subject of this paper. That this subject is an important one is manifest by the frequent inquiries addressed to the Department for information respecting grasses of this class. One of these grasses has played an important part in reclaiming the land along the west coast of France and in defending the coast of Denmark and Holland from the encroachment of the sea. It also has been especially valuable in the work that is being conducted in Provincetown, Mass. Some of these sand-loving grasses are natives of the sands of the seacoast and are rarely found far inland, while others are confined to the interior regions of the country. All have deeply penetrating roots and a more or less creeping habit, either by rhizomes (rootstocks) or by prostrate stems, which take root at the joints. They nearly all seed freely, and are propagated either by seed or by root cuttings or by transplanting.

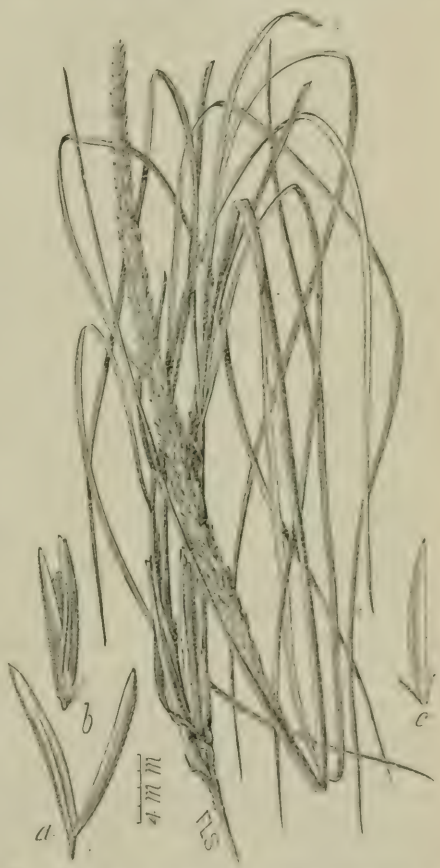

FIG. 111.—Beach grass (*Ammophila arenaria*): *a*, empty glumes; *b*, floret; *c*, palea.

BEACH GRASS OR MARRAM GRASS.

Beach grass or marram grass (*Ammophila arenaria*, fig. 111) is the best known of the true sand-binding grasses, and the one which has been most employed for holding the sand along the coasts, both in

this country and in Europe. It has been regarded as of so much value in some localities that laws have been enacted for its protection and preservation. It is probably the best grass cultivated as a sand binder, its peculiar habit of growth making it especially well adapted for such a purpose. It grows from 2 to 3 or 4 feet high. Its long, tough leaves are not cut or injured by the blowing sands. The flowers are in a close, spike-like panicle, terminating the stem; the creeping underground roots or rhizomes extend horizontally, often for a considerable distance, and their course is indicated by a succession of plants which spring from them and which diminish in size as the rhizomes extend from the parent stock. The peculiar habit of this grass, and one which especially adapts it for binding sands, is this power to continue the upward growth when partially buried, sending out new roots from the nodes as these are covered by the sand. In fact, this partial burial caused by the sifting of the sand in and around the stems, seems to be necessary to the existence of the grass, for it is often noted that in locations where for some cause the sand no longer shifts this grass gradually dies out. The summer growth is often buried one-half or two-thirds by the sands which are blown over the grass during fall and winter seasons, and in the spring there is a new line of lateral roots sent out from the upward growth of the main stock. This main rootstock, which carries the successive growth through the seasons, is often of remarkable length, sometimes extending downwards 30 to 60 feet or more into the sand, the grass having grown up with the dunes in their formation.

Beach grass is a native of the sandy shores of the Atlantic coast, both of this country and Europe, and also occurs along the shores of the Great Lakes. It is especially abundant on the sandy coasts of New Jersey, and the natural growth of the grass at Cape Cod (see Pl. XXVIII, fig. 2) has doubtless done much toward preserving Provincetown and its harbor from the encroachment of the sands from the north and west. Virginia appears to be the southern limit of beach grass, its place being taken by grasses of other species from that State southward. It has been introduced around San Francisco and, strangely enough, the propagation there was made from seeds imported from Australia, where the grass was carried many years ago from Europe.

Beach grass is propagated by seed and by transplanting. The latter method is, perhaps, most practiced and the most economical. If seed is used, it is necessary to cover the sand with brush or fagots in order to hold it in place while the young plants are starting into growth, otherwise the seeds are apt to be either very deeply buried or entirely blown away. When propagated by transplanting, vigorous plants are selected, pulled up by hand, and set out in locations where desired. Usually a bundle of half a dozen plants is held together by one man, while another with a long spade makes an opening in the

sand, into which the beach grass is inserted considerably below the crown, when the spade is withdrawn and the sand pressed around the grass. The manner of transplanting on the Province Lands of Massachusetts is shown in Pl. XXVIII, fig. 1.

Experience at Cape Cod has demonstrated that transplanting is most successful if made in the fall, as at that season the growth of roots is greater and the chances of success consequently increased. There has been very little loss of grass in the transplantings at Cape Cod, which have been under the immediate supervision of Capt. James A. Small. The sand has been held in place over the entire area planted, now amounting to some 90 acres. The first planting at Cape Cod was made in the spring of 1895, but, owing to lack of experience in selecting the plants, the area covered by planting at that date does not present so good a showing as that planted in succeeding seasons, or even that planted in the fall of the same year. Captain Small states that no sand has moved where he planted the grass, and now it is possible for him to scatter seeds of shrubs or trees over the planted area with a full assurance that a growth may be secured. The object of planting the grass is to hold the sands in place until they can be firmly fixed by the growth of trees.

The cost of transplanting beach grass at Cape Cod has been from $60 to $65 per acre, and it requires fifteen men and one horse about two days, working nine hours per day, to cover an acre with plants. The grass is not planted in rows, but in quincunx or irregular order, 1 to 2½ feet apart, according to the slope. It may be added here that Mr. Small has now in the grass-planted areas a growth of fine young pines of various species, including the native pine (*Pinus rigida*), Scotch pine (*P. sylvestris*), seaside pine (*P. maritima*), and Austrian pine (*P. austriaca*), and he has successfully grown Scotch broom (*Genista scoparia*) and bayberry (*Myrica cerifera*), the latter a native shrub of the cape.

There is such an extent of natural growth of beach grass at Cape Cod that seed sufficient for general distribution or for the markets might readily be harvested. The grain or seed itself is very small, but it is inclosed in rather large chaff, so that the "commercial seed" is very light. The seed may be sown either in the fall or spring, according to the local conditions or the requirements of the case. If sown in spring, there is danger of the young plants drying out or burning up during the summer months. In any case, the sands must be held in place while the young plants are making their first growth and developing a root system. This can be done by laying on brush, or by any arrangement which will accomplish the end in view. The manner of growth of beach grass is shown in the illustration, and it will, of course, be seen that it is not at all adapted to covering sandy soil where turf is desired, although it may be utilized to hold the sand until a turf can be secured through the growth of other grasses, seeds

of which may be sown with the beach grass. For most grasses the addition of some soil would be necessary even then.

Cattle will graze on beach grass when other vegetation is scarce, and they will eat the grass with apparent relish early in the season when the plants are young, or during very wet weather when the stems and leaves are somewhat softened. It can not be recommended for fodder, however, although it makes excellent litter, and is used for this purpose as well as for thatch.

FIG. 112.—Sea lyme grass (*Elymus arenarius*).

UPRIGHT OR SEA LYME GRASS.

Sea lyme grass (*Elymus arenarius*, fig. 112) is nearly as valuable as beach grass and almost as well known in northern Europe. This grass is common along the northern coasts of Europe and on both the Atlantic and Pacific coasts of North America in the higher latitudes. On the Atlantic coast it does not occur south of Massachusetts. On the Pacific coast it is found as far south as Oregon, where it occurs in great abundance, growing on the sand dunes along the coast in Clatsop County (Pl. XXX). This grass grows to the height of from 3 to 8 feet. It has long, narrow leaves, the uppermost, however, being very short, and a dense spike, 6 to 12 inches long, terminating the stem. The habit of growth closely resembles that of beach grass, but the leaves are softer and the seed head is more or less downy. The spikelets also are two to three flowered, while in beach grass they are only one flowered. The habit of growth is precisely like that of beach grass. As the sand fills in around isolated plants there is the same upward growth of the main culm, and plants occur on the tops of the highest dunes, with the rise of which they have kept pace, their main rootstocks penetrating to its very base. This grass also produces lateral

FIG. 1.—SAND DUNE ON THE PACIFIC COAST. (SEA-LYME GRASS COVERING THE TOP OF THE DUNE AND LARGE-FRUITED CAREX IN THE FOREGROUND.)

FIG. 2.—SAND DRIFTS ALONG THE COLUMBIA RIVER, OREGON, IN PEACH ORCHARD.

creeping rootstocks, which serve to spread the growth. The manner of handling this grass in propagation is the same as that described for beach grass. The seed product is rather more reliable, although the best way of propagation is by transplanting, by which more certain and immediate results are secured. This grass is not found away from the seashore, and no record is at hand of its ever having been successfully propagated inland. Attempts are being made by the Division of Agrostology to determine whether it will be possible to utilize this grass in binding the sands of interior districts by transplanting it from the coast of Clatsop County, Oregon, to the drifting sands along the Columbia River in the eastern part of the State.

This grass is not regarded as having any value for forage. The seeds, however, are used for food by the Digger Indians of the Northwest.

There is another species of Elymus (*E. mollis*) which grows in the sand dunes along the Pacific coast, as well as on the northern shores of the Atlantic. It closely resembles sea lyme grass, but the stems and flowers are somewhat softer in texture and more downy, and the spikelets are five to seven flowered.

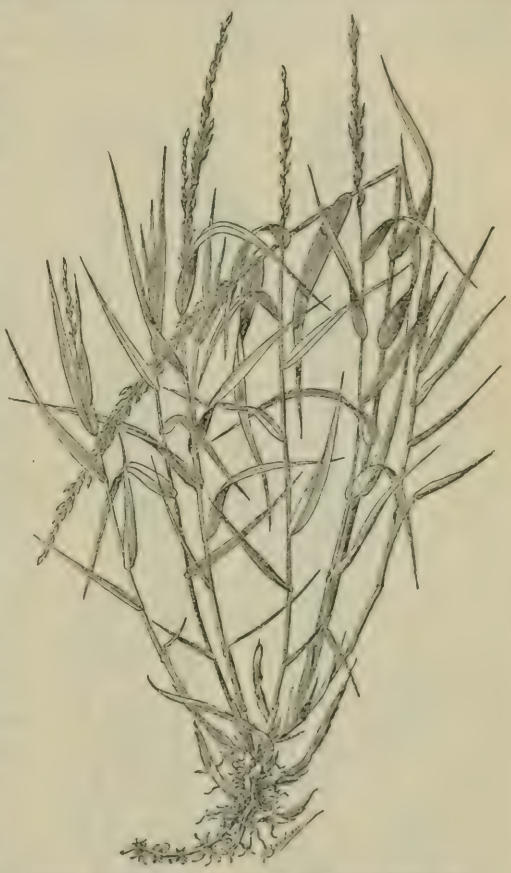

FIG. 113.—Bitter panic grass (*Panicum amarum*).

BITTER PANIC GRASS.

Bitter panic grass (*Panicum amarum*, fig. 113) is a native of the sandy shores of the Atlantic and Gulf coasts, extending northward as far as Connecticut. At Sandy Hook it grows in large patches in apparently pure sand, which it effectually holds in place. There appear to be two forms of this grass, the northern form being much more slender and smaller in every way than the form found from Virginia southward. It has coarse, hard stems, 1 to 5 feet high, a strong, creeping rootstock, and rather broad and comparatively soft leaves.

In the northern form the inflorescence is composed of a strict panicle from 6 inches to a foot in height, while in the southern form the panicle is much larger and more open. This grass seeds freely, and although no attempts have been made to cultivate it, it doubtless can readily be propagated by seed as well as by its jointed and extensively creeping rootstocks. It does not possess the habit of growth which makes beach grass so valuable in building up sand dunes, the rootstocks being more horizontal in their growth and the stems less inclined to send out roots from the nodes. This grass might well be used in connection with beach grass in holding drifting sands, and the two combined would be very effective in securing the sands from the force of the winds. As bitter panic is a more southern grass, it may be substituted for beach grass in the locations along the shores of the Southern States, where sand binders are required. This grass will not make a turf such as is required for lawns, nor is it likely that it has any value for forage, but it will cover the unsightly sandy soils with more pleasing verdure than either beach grass or sea lyme grass.

FIG. 114.—Creeping panic grass (*Panicum repens*): *a*, *b*, *c*, spikelets; *d*, *e*, *f*, florets.

CREEPING PANIC GRASS.

This little sand binder (*Panicum repens*, fig. 114) is widely distributed in tropical and subtropical regions of both hemispheres. It is found along the shores of the Southern States bordering on the Gulf, extending westward to Mexico. It has strong, creeping rootstocks, rather stiff, upright stems, 1 to 2 feet high, and small spreading panicles. It has no agricultural value, but it is a good sand binder, and on the sand dunes of the islands off the coast of Mississippi it occurs associated with bitter panic grass, growing with it upon the outside of the sand dunes, which are from 20 to 30 feet high, protecting them from the winds and waves.

There is another species of panic grass native to this country which

is occasionally found in the sands near the seacoast. It is the switch grass or *Panicum virgatum*. It is not, however, so distinctly a sand-binding grass as either bitter panic or creeping panic grass. Switch grass has very strong, scaly rootstocks, which hold the sand quite firmly, but they are not extensively creeping. The grass is seen growing in clumps of greater or less diameter. It attains a height of 3 to 5 feet, and in some localities is regarded as a fairly good grass for hay. By the time it reaches maturity, however, its stems are quite tough and woody.

SEASIDE OATS.

From Virginia southward and along the Gulf coast seaside oats (*Uniola paniculata*, fig. 115) is not an uncommon grass, growing in the sands. It is an excellent sand binder, and at the same time is a highly ornamental grass. The stems grow to the height of 4 to 8 feet; it has very long, tough, and narrow leaves and a handsome open panicle, 2 feet long, composed of large, flat, and showy spikelets. These panicles are gathered and sold for dry bouquets, and are very nearly as large as those of pampas grass, but are not at all woolly. This is probably one of the best sand binders for the more Southern States. Its tough leaves are not injured by the blowing sands, and it has the habit of throwing out roots from successive nodes as the sand drifts in and among the stems, in this respect resembling beach grass. On the coast of southern and Lower California there is another species of Uniola or seaside oats, *Uniola condensata*, which very closely resembles the Atlantic coast grass and is valuable for the same purpose. The leaves of *U. paniculata* possess a very strong fiber, and the grass may have some value as a fiber plant. The propagation of this grass can doubtless be readily effected either by seeds or by transplanting, although there is no record of any attempts being made to cultivate it.

FIG. 115.—Seaside oats (*Uniola paniculata*).

SEASIDE BLUE GRASS.

Growing in the sands along the Pacific coast of Oregon and Washington, and often covering the summits of the highest sand dunes, is a species of Poa (*P. macrantha*, fig. 116), which may be called seaside blue grass for lack of any other English name. This grass attains a height of 1 or 2 feet. It has leafy stems, which are branched near the base and rather small, densely flowered panicle of comparatively large spikelets. This grass is a most excellent sand binder. It has the same habit of root growth as beach grass, which accounts for its presence on the higher sand dunes. It is an excellent sand binder, adapted, perhaps, for the interior, and possesses the advantage over beach grass of forming more tender leaves and stems, which could be made available for grazing purposes if so desired. It belongs to the same group of plants as Kentucky blue grass and is doubtless equally as nutritious, although no chemical analyses have yet been made of it. It has the peculiar habit of emitting stolons or lateral slender branches, which are often 4 to 6 feet long, lying prostrate on the sands. These prostrate branches are so unlike the upright flowering stems that at first they may be mistaken for stems of some other grass. When buried by the sand these branches develop roots at the nodes, and new plants are thus formed. Underground creeping rootstocks are sent out from the main rhizome, and the length of the latter is often indicated by the height of the dune. It may be 10 to 20 feet or more in length. The writer saw this grass on the sand dunes near Seaside, Oregon, where its valuable character as a sand binder and its possible value for forage were noted. Whether it will be possible to propagate this grass successfully away from the seacoast remains to be

FIG. 116.—Seaside blue grass (*Poa macrantha*).

determined. To settle this question, experiments are now being made in eastern Oregon, both by seed and by transplanting from the coast.

REDFIELD'S GRASS.

The sand-binding grasses which have been described above are all species belonging to the seacoast. Whether these maritime grasses will be successful in interior regions has not been determined, but should they fail to be, we are not without resources in the way of sand binders. Redfield's grass (*Redfieldia flexuosa*, fig. 117) is probably one of the best grasses for binding loose or drifting sands in inland regions. It has a rather upright stem, 2 to 4 feet high, with long, narrow leaves, and very diffusely spreading panicles. It grows in the sandy districts of Nebraska, Colorado, and Kansas, where the spontaneous growth often does much service in holding the shifting sands by the deeply penetrating and widely spreading rhizomes or rootstocks. It is regarded as a characteristic grass of the sand hills of central Nebraska, and is a conspicuous and almost the only grass found on the sand dunes south of the Arkansas River, near Garden City, Kans. The stems and leafage are too tough for use as fodder except when quite young, and probably the grass will never have much value as a forage plant, but its usefulness as a sand binder is unquestioned. Those in the interior looking for a grass for holding the sands in place will do well to propagate this species.

FIG. 117.—Redfield's grass (*Redfieldia flexuosa*): *a*, spikelet; *b*, floret; *c*, flower.

SAND GRASS.

In the sands bordering the shores of the Great Lakes and throughout the Missouri Valley, extending southward to Kansas, sand grass (*Calamovilfa longifolia*, fig. 118) is of common occurrence. It has strong, creeping rootstocks, with stout upright stems 2 to 5 feet high.

The leaves are very long, narrow, and rather firm in texture, and the terminal many-flowered panicles are usually spreading, at least when in blossom. As a sand binder, it is fully equal to Redfield's grass, and being much more common and more widely distributed, it is much more easily obtainable. No attempts have been made to cultivate this sand grass, but in its natural habitat, the sandy borders of the Great Lakes and the Missouri River, it plays a very important and useful part in holding the loose sands of these regions. It produces seed in abundance, and doubtless could be propagated either by seed or root cuttings. It is recommended for trial wherever a strong sand binder is needed. This grass can have little value for forage, but the long, tough leaves suggest a possible value for paper making. In the eastern portions of Oregon and Washington are areas of considerable extent which are strongly sandy. In some places the soil consists of pure sand, which has been blown out of the Columbia River. The drifting of this sand in many places has covered arable lands, buried fruit trees, and been a source of much annoyance to railroads by continually settling upon and covering the tracks to such an extent as to stop traffic. The entire area east of the Cascades belongs to the so-called arid regions, and possesses a grass vegetation in some respects peculiar to itself. Among these grasses are several which are specially well adapted for binding sands, and, as in the case of those already mentioned, these species are serving an exceedingly valuable purpose in fixing sands which otherwise would be blown about, threatening the destruction of valuable property.

FIG. 118.—Sand grass (*Calamovilfa longifolia*): *a* spikelet; *b* spikelet, empty glumes removed.

YELLOW LYME GRASS.

Chief among the sand-binding grasses of this region is yellow lyme grass (*Elymus flavescens*, fig. 119). This grass grows upon the sand

hills, where it attains a height of from 2 to 3 feet: the stems are rather stout, and clothed with long, somewhat rigid leaves, terminated by slender, usually unbranched straw-colored spikes, 5 to 10 inches long. The spikelets are clothed with rather long, soft, and usually yellowish hairs, which have suggested the name given to it. The rootstocks are long and creeping, and the grass has the habit of forming dunes in the same manner as beach grass. As the sand piles up around the stems new roots are thrown out at the joints and the growth is continued upward. This grass makes good hay and is readily eaten by stock.

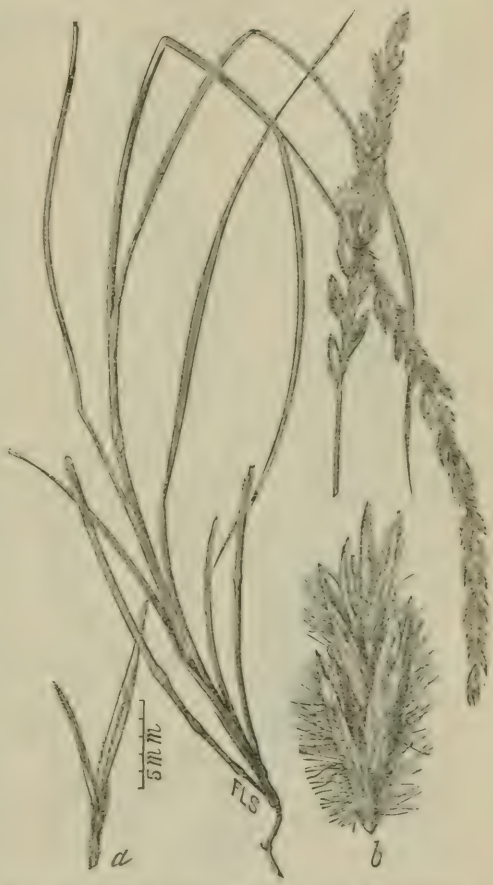

FIG. 119.—Yellow lyme grass (*Elymus flavescens*): *a*, empty glumes; *b*, spikelet, empty glumes removed.

Another species of lyme grass found in the same region (*Elymus arenicolus*) is equally valuable as a sand binder. Mr. A. B. Leckenby says of this grass that it is one of the best native species for sand binding along the Columbia River where there is good drainage. It will not stand being submerged, but will grow through sand drifts, even when very dry. It is readily transplanted, and is best propagated either by transplanting or by root cuttings. These two species of Elymus are the best among the lyme grasses for holding mobile sands in the drier regions of the interior, and possess, in addition to their value as sand binders, considerable forage value where forage is apt to be scarce.

SAND BLUE GRASS.

As in the moist regions along the coast there is a blue grass which is a most excellent sand binder, so in this dry interior region we have a species of Poa (*Poa leckenbyi*, fig. 120), which has all the habits and characters of a grass well suited for holding moving sands. It grows from 2 to 3 feet high, is very leafy, usually much branched near the

base, and has long, narrow, soft panicles, 6 to 10 inches long. This grass is less tough and wiry than other sand binders, and doubtless would prove a valuable grass for grazing in regions too sandy for the growth of ordinary cultivated varieties. The writer has received specimens of this grass from Klickitat County, Wash., where by its natural growth it is very useful in preventing the drifting of the sands.

FIG. 120.—Sand blue grass (*Poa leckenbyi*): *a*, empty glumes; *b*, spikelet, empty glumes removed; *c*, floret; *d*, palea and stamens; *e*, pistil.

CONCLUSION.

In the foregoing the principal grasses which are distinctively sand binders have been described, both those which grow naturally near the seashore and those which are natives of the interior. There are other grasses which are useful at times in preventing the blowing of sands, but they are not truly sand-binding species. Among these may be mentioned Johnson grass, which will grow in very dry sandy situations, true reed (*Arundo donax*), and some of the bamboos. One of the wheat grasses, native to eastern Oregon and Washington, is a fairly good sand binder, and may eventually become a popular grass for cultivation in the sandy districts of those States, as it affords excellent forage. In the Yearbook for 1894 was published an account of sand and soil binders, and some of the species not mentioned here are included in that article, such as Bermuda grass and St. Augustine grass for the South, Japanese lawn grass, which has been sparingly imported into this country, and several others of less importance. In this paper it has been the intention to include only those species which are distinctly sand-binding species.

KEEPING GOATS FOR PROFIT.

By Almont Barnes,
Of the Division of Statistics.

VALUE OF GOATSKINS IMPORTED.

Goatskins, from which is derived the greatest amount of the profits of goat keeping in regions where the largest numbers of these animals are usually raised, were in so little demand in the United States prior to 1864 that they were not separately classified for duty on importation, but were included with "hides and skins" of all kinds, except fur, which together were valued that year at $7,505,238, and paid an import duty of 5 per cent ad valorem. In 1864 goatskins were first separately classified, being valued at $1,799,166, while the imported "hides" were valued at $6,177,512; and this is the starting point of their distinct and officially stated invoice value. In 1865, with the duty doubled, importation diminished; but under succeeding demand and rates of duty, or, as now, duty free, up to June 30, 1898, importation had increased in value to $15,776,601, and the increase of the fiscal year 1898 over 1897 was 28.2 per cent.

The foregoing are, as stated, invoice valuations, that is, those declared as the cost to the shipper at the foreign ports of shipment. For various reasons, as of insurance, handling, freight, commissions, profits to the shipper, etc., they are much below the valuations in our own markets. The average invoice value of desirable skins in 1898 appears to have been 24.3 cents per pound—$15,776,601, the invoice value, being divided by the invoice weight of 64,906,485 pounds. But the average market price (the price to purchasers for home use) of these skins in New York during the year of their importation was about 39.3 cents per pound, or about 62 per cent higher than the invoice value; so that the gross value of the year's importation, upon the basis of the average price in our home market, and at 62 per cent above the invoice value, was $25,508,249. This is what the consumers really paid, and it is therefore the real value of the skins imported, rather than that expressed in the invoices.

Practically all the goatskins entering into the commerce and manufacture of the United States are imported. With the exception of that portion of the population and its increase mostly upon territory derived from Spain and Mexico, the people of this country have not usually evinced any interest in goat herding for profit, either of

skins or other products. There have been for centuries small herds in the sparsely populated western territory indicated, and, besides, a not inconsiderable number of goats in the aggregate has been kept for milk in the suburbs of cities.

NUMBER OF DOMESTIC GOATS.

Although omitted from the censuses, the goat is remembered in the assessment lists of several States, separately or included with sheep, so that an approximate knowledge of the number in the country may be obtained. Latest data from such sources yield the figures of the following statement, to which an estimated surplus is added to show the probable whole number of goats in the United States:

Number of taxed goats in specified States and the estimated number included in returns with sheep and in cities of the United States.

	Number.
Arizona	6,258
California	30,892
Colorado	9,492
Florida	15,768
Nevada	3,497
New Mexico	55,777
Texas	251,585
Virginia	1,711
Total enumerated	374,980
With sheep and unenumerated	125,020
Total in the United States	500,000

Montana, Oregon,[1] and Wyoming enumerate "sheep and goats" together for assessment, and a few other States include goats with minor "other stock," as they surely possess but do not name them. Those possessed by persons in cities, and making a considerable aggregate, if assessed are not numbered for statement. The estimate of 125,020 for these classes is probably not excessive.

DOMESTIC SUPPLY SHORT OF THE DEMAND.

If all goats in this country were kept with the single object of supplying skins for market, they would fail to supply a small fraction of the present demand and at the same time remain at their present number. At 4 pounds to the skin, which is not far from the average weight of dry skins, it requires the slaughter of 16,226,621 goats and kids to yield the skins imported during the last fiscal year. This represents live flocks of foreign goats aggregating from twenty-five to thirty millions at least for our present supply of marketable skins alone.

Very few of the goats in the United States are raised for the

[1] The Oregon Agriculturist of September 15, 1898, estimates the Angoras in that State at 65,000.

purpose of marketing their skins. In addition to the large proportion of the common stock kept, as stated, in the suburbs of cities, many are kept in parts of the West with sheep for protection against other animals, as dogs, wolves, and coyotes; while the increasing flocks of Angoras are kept principally for their valuable yield of mohair, though some account is now taken of the meat. It should be noted that something like two-fifths of all goats in the United States, and a much larger proportion of those kept in flocks, are not the common goats which supply such skins as are imported for leather, but are in part descendants of these, modified by successive infusions of pure Angora blood; and in part, but to a less extent, pure Angoras, kept in California, Texas, Oregon, Idaho, Iowa, Georgia, and South Carolina in flocks sometimes numbering thousands, and in other States in smaller numbers. The profitable commercial product of these pure and high-grade animals is the silky fleece.

GOAT PRODUCTS.

In goat keeping on a large scale it is not alone the skins and fleeces which enter into the account of profit, although these are primary, especially for distant markets. If the skins, which represent over fifteen millions of invoice and twenty-five millions of market value in importations, represented native stock, there would be taken additionally into the home market and possible profit account nearly the whole animal—the flesh, tallow, bones, hoofs, horns, and perhaps the intestines and their contents, which together may constitute half or more of the entire marketable value. In addition there may be derived from the mature females (always the principal portion of the flock) during much of their lives a considerable value in milk for household uses or for market, or which can be converted into the most salable cheese, such as the Roquefort, Mont D'Or, Le Sassenage, and Levroux of France and Switzerland. So fully is the goat available as a dairy animal, when bred to that object, that it is sententiously described as "the poor man's cow," because of the combination of value with economy of keeping. A female goat is relatively one of the most profitable of domestic animals. Herded goats, under suitable and usually convenient conditions, whether for skin or fleece and by-products, are as surely profitable.

However, it is not intended in this paper to go into particulars relating to goats or their products, which may be obtained from books and essays already published, but rather to direct attention to the nature and extent of market demands now met from abroad, and to stimulate by pertinent information, as far as possible, efforts to meet them with a home supply. This information as further presented relates to climate, land, and labor suitable and available for the raising of goats upon a large scale, and incidentally to the classes of goats most profitable to keep.

SUITABILITY OF CLIMATE.

As to climate but little need be said. The goat is easily adaptable to all countries, and thrives in all climates except that of the polar regions. Evidently, however, it will tend to be most profitable in those localities where the expense of keeping is the least the year round. Hardy, agile, enterprising, it always thrives, if unconfined, in heat or cold, on mountain or plain, but prefers rough, rocky, wild, and elevated land. Species of the family naturally or intentionally modified to any large extent require in consequence more restricted areas. Thus, the long wool or hair of the Cashmere or the Angora makes a covering unfavorable to the hardiness of the animal where there is exposure to cold rains and sleet. A uniformly hot climate would reduce their fleece product as naturally as a uniformly cold climate would increase it. But as far as climate alone is concerned, most of the area of the United States outside, possibly, of Alaska, is favorable to the goat family generally, and much of the Pacific coast, the Southwest, and the South to the long-fleeced varieties particularly. At the same time, it does not appear so far from experiments in places more exposed to weather inclemencies in the whole extent of the country that the latter will not thrive equally with sheep with the same care. It is, in fact, proved that the Angora, with some of the characteristics of the sheep, thrives in Montana, Idaho, and several other States where the climatic variations are severe. Mr. G. A. Hoerle, corresponding secretary of the American Mohair Growers' Association, and author of a pamphlet entitled "The Angora goat: Its habits and culture," published in 1886, says:

> There is hardly a State in the Union where Angora goats can not be raised advantageously if properly cared for (which, of course, has to vary according to the local conditions). We know that on farms they have done well in Massachusetts, Connecticut, Illinois, and other Northern States. Whether in those States they will do as well under a herder has yet to be learned. The excellence of winter pastures is more important where herded than where they are kept within fences in but small numbers and easily taken care of in winter. But south of the Ohio River they should do well everywhere, both on farms and ranches.

As to the South, and especially its rough, elevated regions, there can be no doubt of its suitability to the Angora, and therefore even more to the common or short-haired goat, both in climate and food. Mr. J. T. Henderson, commissioner of agriculture of Georgia in 1885, in his annual report for that year, states:

> Experiments in the raising and keeping of the Angora goat in these mountain pastures are making a very favorable impression. It is thought, with some reason, that this particular branch of stock raising may be easily carried to a very large and important development in our mountain counties. The adaptedness of this locality to the raising and support of the Angora has been so marked that those accustomed to the care of this valuable animal are sanguine that we shall see in the near future a very important source of profit in this branch of industry. * * * It is hardly possible that the native habitat of the Angora is better adapted to its keep and development than are the mountain counties of this State.

These observations hold good for all parts of the South of a similar character in climate, topography, and feed resources. As to more even lands at less elevation, Texas, where half the goats in the country are now kept, including large and thrifty flocks of the Angora, presents apparently complete demonstration of suitable conditions.

What may be considered a trial of extreme conditions is now being made in northern Maine, according to the Textile World of September, 1897, an industrial journal published in Boston, Mass. It reports the leasing of wild lands, from which the valuable timber has been taken, but leaving the lands still uncleared, with wild raspberry and blackberry bushes spreading over vast areas. Upon this land experiment is to be made at first by the introduction of five hundred goats, with an intended increase to one hundred thousand. Angoras are the variety to be kept, graded up from Angora and common stock.

AVAILABLE PASTURAGE.

Relative to areas suitable for goat keeping upon any scale, from a few for milk or cheese to large flocks for their fleeces or skins, it may be confidently asserted that wherever there is a suitable climate there are also suitable uncultivated lands. Over 42 per cent of the land in farms in the United States is unimproved; how much of it is uncultivable is unknown. The total unimproved land amounts to 265,600,000 acres, against more than 375,600,000 improved. This presents a vast field for selection of favored localities in every part of the country; and much of the field invites the primitive occupation of herding, which preceded and prepared the way for agriculture in many countries, with inestimable benefit to the soil.

It is true that considerable portions of the unimproved farm land is in valuable forests, which invite preservation as such for various economic reasons; but it is equally true that a large proportion is useless as a present or prospective timber reserve, and can be utilized only in some such way as is herein suggested. In the aggregate, millions of acres of poor, rough, rocky, or bushy land, distributed through all the States, call for subjugation and enrichment through animal occupation, preferably of the goat, which would not only destroy the growth that invites recurrent conflagrations, but would result ultimately in the introduction of nutritious grasses.

In order to present the areas of unimproved land in farms in true relation with the improved, and to show the farms of which they are a part, and at the same time the wide basis upon which the interest herein considered may be established, reference may be made to the report on agriculture of the Eleventh Census.

The State of Maine, for instance, has 6,000,000 acres in farms, of which 3,000,000, or 50 per cent, are improved and an equal number uncultivated; there are 62,000 farms therein, averaging 100 acres

each. A logical deduction is that there are about 62,000 farmers in Maine who have, on an average, 50 acres each of unimproved land. Observation shows that portions of such land are useless for farming purposes, and often are in extended areas defined by natural limits. They are, however, well adapted to goat herding even when good for nothing else, and would almost invariably be made better thereby.

Relative to Georgia, it may be said that there is an acreage in farms of over 25,000,000, of which 9,500,000 are improved, and over 15,500,000, or nearly 62 per cent, unimproved, with 171,000 farms, and an average of 147 acres to the farm. The evidence of the former commissioner of agriculture of that State as to the fitness of its mountain lands for goats of the Angora breed has been cited, and the same holds good over most of the other lands of the State for the common goat, including the average of 73½ acres per farm of unimproved land. Similarly, the lesson may be applied to each State, according to fitness, without material change.

There is, however, in the United States a large, continuous area, embracing over one-third of the States and Territories, which invites particular attention in connection with this subject. It includes the South Atlantic and South Central divisions and a part of the Western division of the Census groupings,[1] or twenty States and Territories, which, together, contain nearly 285,000,000 acres in farms, of which over 122,000,000 are improved and over 162,000,000, or 57 per cent, unimproved. The average size of farms and the average amounts of unimproved land are greater in this area than elsewhere, and the climatic conditions are more uniform.

This area includes nearly all the central and a part of the western mountain regions, and lies principally within the belt of least or no snow. It is in general the most temperate region of a temperate zone, and peculiarly suitable for wintering all kinds of farm and range stock, not only as to climate, but as to subsistence. It furnishes in abundance such forage as is suitable and preferable for goats, available to them in most parts during the entire year. Under such circumstances and conditions whatever profit can be derived from herding them comes nearest to a net profit. There is the additional incidental benefit that whatever foul land is regularly pastured by these animals for a few years becomes clean, weedless, and bushless, and usually, being evenly fertilized by them also, runs into nutritious native grasses. (See Pl. XXXI.)

[1] South Atlantic division, Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida; South Central division, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas; Western division, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, California.

FIG. 1.—ANGORA KIDS.

FIG. 2.—GOING TO PASTURE. (SEPARATION OF DAMS FROM KIDS BY MEANS OF BRIDGE.)

SUPPLY OF LABOR.

As to the question of suitable and sufficient labor so far as it enters into this subject, the fact that the utilization of unimproved or surplus farm lands is being considered as the food basis of goat herding will readily suggest that whatever labor may be required must be distributed through the country at least as evenly as the labor required for the accompanying improved lands. Goat herding is proposed only as another and very simple rural industry where others are already established, and therefore where the labor element is already available. Its cheapness depends upon the usual considerations to a certain extent, though not wholly, for herding requires neither the maturity nor the skill on the part of the attendants that usual farm occupations demand. Ordinarily, goats need less attention than sheep, but where permitted to range an attendant is necessary. It is apparent that this attendant need not be an expensive one.

But in making marketable whatever is derived from the keeping of goats, as the skin, wool or hair, meat, or, during life, the milk and its product, more and varied care is required, calling for average labor compensation. This labor is in no case continuous, however, for the principal products, but seasonal, like the harvests. As to the employment of herding, to a large number this would prove congenial and even recreative compared with other rural occupations. It seems probable that a large portion of the country considered best for goat herding on a large scale because of suitable climate and feed range is equally fortunate in an economical and well-distributed labor element. In the South Atlantic and South Central States the negro population is abundant, and in the Western division States there is a considerable Spanish-American population already accustomed to the care of sheep and goats. As the latter is least determinable and important, it may here be passed without special consideration. But the presentation of the figures of the negro population of the first two divisions, in conjunction with the details of their unimproved farm lands, State by State and according to the official reports, will prove interesting in showing the distribution and amount of generally unskilled labor upon which dependence must be placed in profitably utilizing, as suggested, Southern unimproved farm lands.

Area of unimproved farm lands and negro population in certain States in 1890.

South Atlantic division.			South Central division.		
States.	Unimproved farm land.	Negro population.	States.	Unimproved farm land.	Negro population.
	Acres.			*Acres.*	
Delaware	293,037	28,386	Kentucky	9,593,347	268,071
Maryland	1,569,482	215,675	Tennessee	10,799,028	430,678
Virginia	9,979,406	635,438	Alabama	12,154,657	678,489
West Virginia	5,767,326	32,680	Mississippi	10,723,157	742,559
North Carolina	14,823,327	561,018	Louisiana	5,769,551	559,193
South Carolina	7,929,415	688,934	Texas	30,660,722	488,171
Georgia	15,617,569	858,815	Oklahoma	1,042,695	2,973
Florida	2,528,793	166,180	Arkansas	9,416,313	309,117
Total	58,473,355	3,187,126	Total	90,159,470	3,479,251
			Total both divisions	148,637,825	6,666,377

An even distribution of this negro population would give one person to each 23½ acres of the unused farm lands, or over 27 to the square mile of such lands. However reduced by city and town population and other than rural occupations, it is evident that there is help enough of this class, and especially as indefinitely augmented by the coextensive rural white class, to establish economically, extend, and conduct this simple but profitable industry all through the favoring region specially considered.

No further or closer collection or analysis of statistics is needed to show the concurrent elements favorable to the growth of this particular branch of rural enterprise in the United States, in response to a large, regular, and steadily increasing demand, now met almost wholly by importations, upon which the consumers pay, besides the necessary cost of production, preparation, and transportation, the charges of commercial manipulation and the export duties of foreign countries.

NUMBER OF GOATS IN THE WORLD.

The foregoing considerations relate to goat keeping in general as a business or branch of business for profit, and apply to it in almost every form. Details of keeping for special purposes, as for skins, mohair, or for dairy purposes, need not find a place in a paper not intended for instruction in details; but it is not out of place to show here the extent and importance of the goat-keeping industry in all its branches, particularly as in this country it has been generally underrated or ignored. A tabular statement of the number of domestic goats of all countries, so far as enumerated, is herewith given, with an additional estimate. The table is based upon one published by the Department of Agriculture in 1896, in Miscellaneous Bulletin No. 11 of the Division of Statistics, giving a census and estimate of the farm animals of the world, but amended as to Europe from Pegler's "Book of the goat" (London); as to the United States, from the numbers

taxed in States, etc., and as to Latin America, from official publications and from estimates based upon the number of skins annually exported. But as the statements for different countries are often for different years, at the best only a proximate determination of the number at any stated time can be arrived at. The tendency, admitting undoubted increase, is toward underestimation.

Number of domesticated goats of all countries.

Countries.	Number.
North America:	
United States	560,000
British North America	[1] 200,000
Mexico	[1] 1,000,000
Central America	200,000
Leeward Islands, West Indies	150,000
Total North America	2,050,000
South America:	
Argentina	[1] 1,000,000
Brazil	500,000
Chile	20,000
Colombia	610,147
British Guiana	[1] 1,000
Dutch Guiana	817
French Guiana	337
Ecuador	[1] 10,000
Bolivia	[1] 10,000
Paraguay	14,656
Uruguay	16,827
Venezuela	[2] 1,560,956
Peru	[1] 10,000
Windward Islands, West Indies	108,098
Total South America	3,862,838
Europe:	
Austria	1,035,832
Hungary	[3] 308,810
Croatia-Slavonia	96,862
Bosnia-Herzegovina	740,287
Total Austria-Hungary	2,181,791
Servia	509,738
Roumania	209,990
Bulgaria	1,453,500
Greece	2,500,000
Europe—Continued.	
Italy	1,800,000
Spain	[4] 4,531,228
Portugal	973,119
France	[5] 1,509,502
Switzerland	416,323
Germany	3,091,287
Luxemburg	13,426
Belgium	218,755
Netherlands	164,526
Denmark	25,322
Norway	272,458
Sweden	76,045
Russia (European)	1,407,537
Malta	10,120
Ireland	[4] 413,551
England	[1] 15,000
Total Europe[6]	21,823,218
Asia:	
Russia (Asiatic)	711,560
Turkey (Asiatic)	[7] 1,540,408
Ceylon	148,122
Hongkong	721
Cyprus	325,198
French East India	19,119
Total Asia	[8] 2,745,128
Africa:	
Algeria	3,829,740
Tunis	681,636
Cape Colony	[9] 5,631,351
Natal	346,099
Orange Free State	[10] 858,155
Lagos	2,035
St. Helena	929

[1] Estimated numbers.
[2] Annual statistics of Venezuela, 1894.
[3] Agricultural statistics of Hungary, 1895.
[4] Pegler's "Book of the goat."
[5] Agricultural statistics of France, 1895.
[6] Except Turkey in Europe, Montenegro, Scotland, and Wales.
[7] Census of Turkey, 1893; of this number there were 1,230,052 Angoras.
[8] The area and figures here indicate but a small portion of Asia.
[9] Bulletin of the National Association of Wool Manufacturers for September, 1898; of this number 2,811,206 are Angoras.
[10] In Schreiner's "The Angora goat," published in London in 1896, as cited in the bulletin of the National Association of Wool Manufacturers for September, 1898, the number is said to be "several millions."

Number of domesticated goats of all countries—Continued.

Countries.	Number.	Countries.	Number.
Africa—Continued.		Australasia—Continued.	
Réunion	13,368	Western Australia	4,367
Senegal	40,000	Tasmania	1,610
Mayotte, etc	1,857	New Zealand	9,055
Cape Verde Islands	46,029	Total Australasia	110,146
Total Africa	11,451,859	Oceanica:	
Australasia:		Marquesas Islands	4,500
Fiji	2,860	Tahiti and Moorea	1,794
New South Wales	34,147	New Caledonia	4,808
Victoria	44,482	Tubai Islands	2,000
South Australia	13,625	Total Oceanica	13,102

RECAPITULATION.

Goats:		Goats and sheep:	
North America	2,050,000	British India	32,283,701
South America	3,862,838	Egypt	957,599
Europe	21,823,218	Montenegro	500,000
Asia	2,745,128	Total goats and sheep	33,741,300
Africa	11,451,859		
Australasia	110,146		
Oceanica	13,102		
Grand total	42,056,291		

The foregoing table shows, from the best statistics to be obtained and from moderate estimates, the aggregate number of goats in the countries mentioned to be apparently over 42,000,000. But to approximate the true aggregate for the world, this number must be increased by additions from omitted areas and from those where sheep and goats are reckoned together. Asia, the native home of the principal varieties of domesticated goats and known to possess them in abundance, is represented by a less numeration than Algeria or Germany, and not much larger than diminutive Greece. China, Persia, parts of Asiatic Turkey, including Arabia and Turkestan, Siam, Corea, Japan, most of the East India Islands, and even British India, with more than 32,000,000 sheep and goats together, are not counted; in fact, for the greatest goat-raising regions there are no official figures or estimates.

Of the countries reporting nearly 34,000,000 sheep and goats, British India exports over 20,000,000 pounds of "skins" a year, distinguished from "hides." These must be principally of goats, and they represent an annual slaughter of four to five millions, with probably fifteen to twenty millions alive. Considering the extent of country not reported, the number and habits of the people, and the antiquity and prevalence of the use of goats among them, it seems safe to estimate the aggregate of their herds as at least as great as that of those parts

of the world represented in the table, and to place the total for the world at eighty to eighty-five millions—first after sheep and second after cattle, or third in number of the classes of stock of all countries. This position and importance indicate at once a great permanent and productive value.

OBJECTS OF GOAT KEEPING.

As already indicated, the useful objects of goat keeping are distinctly three, viz, for the production of skins, so extensively known to the commerce of manufacturing countries; for the production of fleeces of hair or wool, used also in increasing quantity in the manufacture of clothing fabrics, and for the production of milk, mostly for home consumption, and of cheese for home use and market. Often these objects of production are combined to some extent and with varying prominence; for goats best suited economically for skins for leather or for hair or wool products may also be bred as serviceable dairy animals, while those bred particularly for dairy purposes are secondarily valuable, at least, for the final products (skins, meat, etc.), especially where kept in considerable numbers.

These specified objects roughly, but perhaps sufficiently, indicate the classes of domesticated goats prevalent in various countries, and inferentially the conditions attending their prevalence. As the greatest market demand is for skins, the largest herds in various countries are kept to meet that demand, and as the demand relates less to breeding than to abundance, the common goat (that least modified from the native stock) most economically and profitably meets the requirement. Common goats need the least care and require only the cheapest and most primitive pasturage—bushes and weeds. They furnish a product of world-wide use, not dependent upon any kind of culture for its availability or excellence. Wherever they can be stocked upon unused or otherwise unusable lands, with the rude and slight care required, they are almost gratuitously profitable. Thus, the price paid for imported goatskins is less representative of cost of production than of the commercial sagacity of the producers and their appreciation of the needs of the market, and suggests an enviable margin of profit. The price above cost paid by consumers of this country is the gratuity paid to foreign producers, importers, etc., because of lack of enterprise, ignorance, or wasteful prejudice. The market price of an article is sensibly affected by nomenclature. In coffees, for instance, an additional price is paid for the names of "Mocha" and "Java," though official statistics show, and facts of production and movement confirm, that not a pound of Mocha coffee has been introduced into this country for at least fifty years, and, compared with the supposed consumption, but little of Java for twenty-five years. So also are paid higher prices for so-called "Curaçao" kid and goat skins and goods, while the arid island of Curaçao,

not 15 miles long nor 4 miles wide, having but two fresh-water springs and not 5,000 goats, receives its supplies of skins from adjacent parts of Venezuela and Colombia, which make Curaçao their foreign shipping port.

Common goats are, of course, the most numerous class wherever skins are the principal object sought, and they furnish, besides, the milk and meat required by their owners or keepers. Next to these in aggregate number are the goats kept primarily for dairy products, in flocks or singly, over a large part of the world. This class includes select common stock, just as numbers of American dairy herds are made up wholly or in part of select cows from stock not artificially modified; but in particular it includes certain strains naturally possessing high milking qualities, as the Nubian, and kindred or similar breeds of Bengal and China, to which must be added classes bred with continuous care to the same end, as the goats of Malta, France, Switzerland, and, in recent years, of England. The Nubian and Bengalese goats are said to be much alike and most excellent dairy breeds, but unfit to stand exposure in cold countries. Some have a record of nearly a gallon of milk per day while in full milk. Of the celebrated Malta goats, the United States vice-consul, Mr. Joseph F. Balbi, of Malta, wrote in 1891 as follows:

> The Malta goats are famous for their milk qualities as well as for their hardiness. They supply all the milk required here by a population of about 170,000. They are exported in fair quantities to Gibraltar, Sicily, and the Levant. Their daily yield is from 1½ to 2 quarts, some goats yielding as much as 2½ quarts.

The third class includes goats kept primarily for their valuable fleece products, such as the Angora and the Cashmere, the first producing a moderate fleece of fine, long, silky hair, generally about 5 pounds per year, and the other a few ounces of soft downy wool. (Pl. XXXII.) The first alone need be considered, the Cashmere having only local value and its product a narrow utility and restricted demand. On the other hand, the mohair of the Angora has an increasing demand and wide utility.

The Angora is supposed to have originated in Thibet, although now unknown there. All the stock outside of Asiatic Turkey having been drawn therefrom, the species takes its name from Angora, in Asia Minor, where it is kept pure and in considerable numbers. Importations from there have been made from time to time, at great cost, into Europe, the United States, and more recently into Africa, in which latter country the production of mohair for the English market has become a prominent industry. As the Angora is the goat now attracting particular and increasing attention in many parts of this country, more information as to its history may be desirable than for the other classes, premising that wherever the Angora will thrive the others will certainly do as well.

In the pamphlet already cited, written by Mr. Hoerle, it is stated

FIG. 1.—YOUNG MALE GOATS, 8½ MONTHS FLEECE.

FIG. 2.—FEMALE GOATS, 5 MONTHS FLEECE.

that the first importation of Angoras into the United States was made in 1849 by Dr. J. B. Davis, of South Carolina, and consisted of two bucks and six ewes. Later importations were made by C. W. Chenery, of Massachusetts; Messrs. Diehl and Brown, of Texas; John S. Harris, of Idaho; Col. Richard Peters, of Georgia; W. D. Parrish, and others. From these, and by crosses and grading up on the common goat, have come large herds, now profitably kept in several States, principally Texas and California. Messrs. W. G. Hughes & Co., of Hastings, Tex., successful breeders, under date of October 21, 1897, in reply to inquiries from the Division of Statistics, state as follows:

There are probably about 200,000 Angora goats that could be reasonably classed as such in the United States. They can be raised almost anywhere in the States except in swampy districts; but seem to do best where the climate is dry and the altitude not less than 500 feet. On the Pacific coast, notably in California and Oregon, Angora goats are raised very successfully and in large numbers, and farther south, in New Mexico and Texas, in which latter State are some of the finest and oldest established flocks in America. Much interest has of late been taken in the industry in Iowa, where many farmers are handling small flocks in connection with other stock on their bushy lands. Good foundation herds can be purchased for about $2 per head and upward, and males from $10 to $25 each. A thousand head can be run in a flock, where the nature and size of the range permit, but these should be divided up at kidding time.

The handling of Angora goats is somewhat similar to that of sheep, but as they are far more active and travel more than sheep, the kids have to be left behind in the pens when the goats go out until they are about six weeks old.

Hilly, bushy lands are best suited to the needs of the Angora goat. In a pasture of this kind they can be kept in reasonable number without interfering with other stock, as they will live on what the other stock do not eat.

A statement relative to the Angora in the South, incidental to the subject of fitness of large portions of that region for goat raising in general, has already been quoted. In the occasional treatment of such matters in books, papers, and letters the various phases of the subject are necessarily combined. Thus, in "Sheep husbandry in the South," by Mr. John L. Hayes, 1878, there is this mingling of testimony from gentlemen of experience, already noted as importers of valuable stock. Col. Richard Peters, of Atlanta, Ga., wrote in 1878 to Mr. Hayes as follows:

In this connection, I may say a few words about the Angora goat, very improperly termed the "Cashmere." I have owned these animals from six different importations, those brought over by Dr. J. B. Davis in 1848 proving to be superior in many respects to any of the more recent importations. One of the most valuable, interesting, and remarkable traits of the Angoras is the rapidity with which fleece-bearing goats can be obtained by using thoroughbred bucks to cross on the common short-haired ewe goats of the country. * * * I have had great success with the Angoras and regard them as one of the most valuable acquisitions to the resources of our husbandry. They have yielded me more substantial pecuniary profit than any other of my extended stock investments. * * * There can be no doubt that in the range of the Blue Ridge, extending from Alabama to Virginia, they would find all the requirements of their nature, utilize a vast country, and prove a source of great benefit and profit to all interested.

Mr. J. W. Watts, of Laurens County, S. C., also wrote to Mr. Hayes in December, 1877, as follows:

Even here, 75 miles from the mountains, I have for six years grown most successfully the Angora goat, whose flesh I regard as superior to any mutton, and whose fleece properly handled could there [in the Blue Ridge Mountain region] be made more profitable than any wool growing. This I can say from actual careful experience with Angoras, which are of Asia Minor stock, meeting here few obstacles to their profitable breeding, and which in the Blue Ridge just beyond me would find an exact counterpart of their native soil and climate. Aside from their flesh and wool there is another advantage they offer, which in the mountains beyond would be most valuable. In a cross I have made with a pure Angora buck and a Maltese ewe goat I have raised a ewe goat that will give 4 quarts per day of as good milk as any cow on my plantation. The feed of one of my cows will keep twelve goats. My cows must have certain food or they will not thrive. My goats will eat anything, almost, and do well; and with this advantage, also, that their milk and butter are not in any way affected by their diet.

It is not therefore at all an open question with me after years of practical experience whether the Angora, alpaca,[1] and kindred races of the goat tribes would thrive in our Blue Ridge. They would be more profitable in that locality than any other branch of industry.

Mr. F. S. Fulmer, of Spring Mills, Appomattox County, Va., also is reported by Mr. Hayes in his work upon sheep husbandry as writing of the Angora as follows:

My Angora goats, fifty in number, pure bred, got their living all last summer in a pasture where grass (other than broom straw) and clover never grow. So far this winter I have fed them nothing but coarse cornstalks. In fact, up to this time, they have kept in a thriving condition almost entirely on acorns, of which they seem very fond. I treat them as to shelter, etc., just as I would sheep, except I am rather more careful to keep them out of cold rains. From my experience I am led to conclude that the Angora goat, aside from first cost, can be made to pay better than sheep, especially in the Southern States, where they can have large range over poor land.

In the Annual Report of the Department of Agriculture for 1863 is an article upon the goat, treating, however, of Angoras particularly and of supposed Cashmeres, which were really Angoras. The article, which was written by Mr. Israel S. Diehl, who had been United States consul to Batavia, Java, East Indies, showed that interest had already been awakened in the business of goat keeping, but which was then nearly extinguished, apparently, by the events of that era. Some of the letters contained in this article, giving testimony favorable to the industry, are here reproduced, as follows:

Col. R. H. Scott, a farmer and stock raiser of Frankfort, Ky., states:

I have a flock of eighty head (of Angoras) of all grades from half-bloods to pure breds, and there is not a single sickly one among them, and few if any that are not fat enough for mutton. Their food, except in winter, is obtained exclusively in the pastures, and they are so fond of weeds, bushes, and briers that they will

[1] Later it has been determined that the alpaca is not of the goat species.

eat them chiefly if they are accessible, and in this way are valuable in clearing out fields and pastures of noxious weeds and shrubs. * * * I intend to keep about a hundred full bloods, assured by the experience so far that they will greatly exceed sheep in the value of their fleece, which is from 4 to 8 pounds in weight annually.

Mr. John Walker, farmer and stock raiser, of Fayette, Mo., wrote concerning his superior flock of seventy:

They are very hardy and increase rapidly. The does take great care of their young. The cost of keeping these goats is less than for any other animal. They graze upon coarse herbs that are not eaten by any other stock, such as ironweed, dock, mullein, briers, buds, and broken sprouts. Their wool possesses the highest felting qualities. My buck sheared 9¾ pounds and my pure-bred ewe 5 pounds.[1]

Gen. J. S. Goe, of Brownville, Pa., wrote of his flock of twenty that "they stood the severe winter well and are promising, and I am encouraged with the experiment and prospect."

The United States Agricultural Society, which antedated the Department of Agriculture, at its exhibition in Philadelphia in 1856, in giving a premium of $100 to Col. R. Peters, of Georgia, for the excellence of his exhibit of Angora goats (then usually misnamed Cashmere), reported in part as follows:

The fleeces from the matured bucks weigh from 6 to 7 pounds, those from the ewes from 3 to 4 pounds. The flesh of the crosses is superior to most mutton, tender and delicious, making them a desirable acquisition to our food-producing animals.

The ease with which they can be kept, living as they do on weeds, briers, browse, and other coarse herbage, fits them for many portions of our country where sheep can not be sustained to advantage, while their ability and disposition to defend themselves against dogs evidence a value peculiar to the race. They are free from all diseases to which sheep are liable, hardy and prolific, and experience has proven that they readily adapt themselves to all portions of the United States. The bucks breed readily with the common goats, the second cross yielding a fleece of practical utility, while the fourth is but little inferior to that of the pure breed. A flock of valuable wool-bearing goats can be raised in a few years by using grade bucks.[2]

As the only branch of the goat-keeping industry which has so far attracted the attention and directly enlisted the capital of many enterprising citizens of this country is the one which relates to fleece

[1] In Schreiner's "The Angora goat," London, 1898, occurs the following statement: "As regards the weight of fleece of goats in Turkey, rams clipping over 14 pounds and ewes over 8½ pounds at twelve months, when full grown, are considered exceptionally good, yet these weights are often obtained." And again: "It would seem that 14 pounds for rams and 8½ pounds for ewes are about the maximum weights of really first-class fleeces, and that if these weights are much exceeded the quality of the hair is inferior," etc. It seems evident that the possibilities of average weight of fleece is nowhere overestimated for well-bred American Angoras.

[2] The fleeces of the Angora and Cashmere were indifferently classed as wool, long after the first importations, and these distinct classes of goats were also confounded. Thoroughbred bucks are now considered essential to good crosses.

production, testimony concerning goat raising here relates, of course, directly to a particular class of goats under particular circumstances.[1] But in so far as the evidence is favorable to this class and its uses it is equally favorable to goats in general and their varied uses. For admittedly good reasons, it is assumed to be even more favorable to such as adhere with the least modification to the general and simpler characteristics of the goat family. Evidence that the Angora finds conditions suitable to its existence in most of the States of the Union is even stronger incidentally as to the common short-haired goat, the breeding of which has no object which modifies its nature generally. This has, moreover, been demonstrated by actual test in different localities and varying climates where herds ranging from small to large have been and are kept in constant vigor and usefulness.

IMPROVEMENT OF PASTURAGE.

Thus far goat keeping has been considered only in relation to the commercial and direct profits promised in the varied or combined branches which yield skins for leather, fleeces, and dairy products, though minor sources of gain have been indicated, such as the meat, hair, bones, etc. But there is still another source of incidental but sure profit, which would be sufficient in thousands of cases, even if the others be largely lost sight of and goats be kept simply as goats, and therefore differing in habits from other domesticated animals. The goat, of whatever class, is a reliable and life-long scavenger, and can be depended upon to destroy the many undesirable products of cultivated and fallow lands, the abundant and persistent weedy vegetation which so incessantly besets the cultivated crops. Other domestic animals prefer the cereals and grasses which depend upon the labor

[1] The total number of Angora goats in the United States is estimated by Col. William L. Black, general manager of the Fort McKavett Tanning Company, Menard County, Tex., as quoted in the Bulletin of the National Association of Wool Manufacturers for September, 1898, to be 247,775, distributed as follows:

Texas	75,000	Tennessee	250
California	59,000	South Carolina	200
New Mexico	52,000	North Carolina	200
Oregon	[1] 15,000	Colorado	200
Nevada	11,500	Mississippi	150
Idaho	8,000	Louisiana	150
Wyoming	7,000	Connecticut	150
Arizona	5,700	Alabama	75
Missouri	5,200	Arkansas	75
Utah	2,000	Florida	75
Montana	1,500	Iowa	75
Kansas	1,200	Virginia	75
Indian Territory	900	Nebraska	50
Georgia	750	Washington	50
Kentucky	500	West Virginia	50
Pennsylvania	400		
Illinois	300	Total	247,775

[1] As previously stated, a home authority estimates the Angoras in the State at 65,000.

and care of the husbandman. What these reject goats prefer and cheerfully pass by growing grass and grain for a constant dessert of wild carrot, burdock, mullein, or for thistle or cactus. Goats thus voluntarily clean fields of their vegetative refuse before it ripens and scatters its seed; and so persistently and impartially is this done that the latent seeds of valuable grasses, improving the chance thus given them to sprout and thrive, often follow the second or third year of goat pasturage with a uniform carpet, clean as if made to order. Of this unique value of this animal something is shown in some of the quotations previously made. More directly to the point is the statement headed "Goats as clearers," made by Mr. C. P. Bailey, of San Jose, Cal., a successful raiser of Angora goats in California and in other States, in the Pacific Rural Press of August 28, 1897, as follows:

The animals are hardy, good rangers, and long lived when compared with sheep, and do well on land where other animals find it hard to live. Their value as brushwood cleaners can hardly be estimated; but Mr. Stanley, of Iowa, writes as follows: "To a person who has never seen the results of the application of Angoras to brush land a ride through my blue-grass pastures is a revelation. Where three years ago the ground was densely covered with undergrowth of hazel, crab tree, oak, buckberry, and other brush, it is now growing the finest blue grass. At the present time I have over 600 acres which have been reclaimed, and a conservative estimate would be that the value of the land has thereby been enhanced at least $10 per acre."

CONCLUSIONS.

The principal facts so far shown essential to the objects of this paper may be summarized as follows:

(1) The United States imports a large and steadily increasing amount of goatskins for necessary use in home manufactures and produces comparatively none. The invoice value of these imports is at present over $15,500,000 a year and the market value probably over $25,500,000.

(2) There is an aggregate area of over 265,000,000 acres of unimproved farm land outside of Alaska and recently acquired dependencies (more than the area of the original States and the Louisiana Purchase), a large proportion of which is suitable for the maintenance of goats. Being surplus farm land relative to present cultivation, this land is distributed evenly with the regular rural labor of the country. It also, according to location, embraces the climate of all the country except, as stated, Alaska and the new dependencies, which nowhere is detrimental to animal industries generally or to goat keeping in particular. The general features of land, labor, and climate, therefore, and of distribution are singularly favorable.

(3) Over 162,000,000 acres of this unimproved farm land, or over 61 per cent (nearly as great an area as that of Texas) is the agriculturally unproductive surplus of farms of a continuous area having more than average favorable conditions as to relative amount, distribution of labor, and climate. This area is contained in the South Atlantic and South Central and a part of the Western divisions of the

country. It now contains nearly all the herds of common and specialized breeds of goats kept by the people.

(4) All the favorable conditions are emphasized in much of the large area containing the densest negro population by reason of the class and abundance of the labor element and circumstances which render the adoption of an additional or new rural industry easy and undisturbing. They are also strongly emphasized by the prevalence of mountain chains through much of the area, and these are the favorite pasture ranges of the goat.

(5) The general and special favorable conditions herein shown are verified by all the testimony of goat raisers, some of which has been given, relating to Angoras and to goats for milk. Altogether the evidence seems conclusive that it would be easy and relatively inexpensive to furnish the home market with the increasing millions of dollars' worth of skins demanded year by year in our manufactures and so far furnished by countries which buy little from the United States. As the by-products of goat keeping may be made to cover all its cost, the value of the goat products now imported (more than $25,000,000 per year) is a clear premium offered to their home production, a premium to rural industries.

In connection with these facts, it is worth noting that goat raising for much or little profit correspondingly diversifies rural industries in ways which are distinctly favorable to unskilled labor—a need in this era of the prevalence of labor-saving implements and machinery, especially in portions of our country not schooled to higher agriculture. It also adds inexpensively, through meat and dairy products, to food resources of many, especially those connected with rural life.

The only impetus given to the goat-raising industry in this country which has resulted in organization up to the present time seems to have shown itself in Oregon and California. In the former the Oregon Angora Goat Breeders' Association was organized in 1896, with J. H. Hawley, of Monmouth, as president. The California association has a similar name, with C. P. Bailey, of San Jose, president, who is extensively engaged in breeding and importing.

No concerted movement is yet noted in this country in the interest of the systematic raising of goats for dairy purposes. In England this business has been entered upon as systematically and scientifically as any branch of stock breeding, and as much regard to registry is exacted in it. Many people of rank and influence are engaged in breeding and keeping milch goats, not as a pastime, but for the benefit of themselves and others. Among these is the Baroness Burdett-Coutts, whose goats are exhibited at fairs and compete for premiums.

SOME RESULTS OF DIETARY STUDIES IN THE UNITED STATES.

By A. P. Bryant,
Of the Office of Experiment Stations.

INTRODUCTION.

The results of numerous experiments in the feeding of domestic animals made at the agricultural experiment stations and elsewhere have been widely disseminated among the farmers. They are not so familiar with the fact that similar investigations on the food and nutrition of man have been made in this country and abroad. The problems relating to the nutrition of man are in some respects more complex and difficult of solution than those relating to the feeding of animals. The general principles on which the investigations are based are, however, the same in both cases, and it has been found that advance in the methods of investigation of the food of man or in the knowledge of the principles of human nutrition has been of great advantage in the studies on the feeding of animals, and vice versa. For example, the results of studies of the chemical composition of cereals can be utilized in investigations on the nutrition of both men and animals. Recently an improved form of apparatus called a respiration calorimeter has been devised in connection with studies on the nutrition of man, in which the Department of Agriculture is engaged. With the aid of this apparatus the knowledge of the effects of food on the nourishment of the human body and in the production of the energy necessary to the performance of different amounts and kinds of work is being advanced. But it is believed that a similar apparatus will be equally useful in the study of the same problems as related to the feeding of different kinds of domestic animals, and therefore the Department has taken steps in cooperation with one of the experiment stations to have this improved respiration calorimeter adapted to use in experiments with animals. It will then be seen that studies on the nutrition of man are important not only as aiding in the improvement of the food habits of the people, but also as contributing to better methods for the feeding of farm animals.

In 1886 the Massachusetts Bureau of Statistics of Labor, under the direction of its chief, Hon. C. D. Wright, began an investigation into the actual food consumption of factory operatives, mechanics, and other people with moderate incomes. The statistics from this investigation were sent to Prof. W. O. Atwater, at Wesleyan University,

under whose direction and supervision the results were put in form for comparison with the results of similar studies elsewhere. At the same time similar work was being done by Professor Atwater in the vicinity of Middletown, Conn., with the assistance of students in the university. With the cooperation of Mr. Wright as chief of the Massachusetts Bureau of Statistics of Labor and later of the United States Department of Labor with Professor Atwater as director of the Storrs (Conn.) Agricultural Experiment Station, the enterprise became well established, so that in 1894, at the suggestion of the Secretary of Agriculture, Congress made an appropriation to be applied to the study of the food and nutrition of man, which has since been continued. The supervision of this work was assigned to the Office of Experiment Stations, and Professor Atwater was made the special agent in charge. In carrying out its plans the Department of Agriculture has had the cooperation not only of Wesleyan University and the Storrs station, but also of a large number of colleges, experiment stations, and social settlements in various parts of the country. In this way a considerable amount of accurate data regarding the nutritive value and relative cost of the diet used by people of different occupations in this country has been obtained.

METHOD OF MAKING DIETARY STUDIES.

The part of these investigations which has to do more particularly with the actual food consumption of people may be described as a study of dietaries. The method employed in these experiments is, in brief, as follows: A certain family is found who is willing to allow such a study to be carried on. Just before the beginning of the study an inventory of the amounts and kinds of food materials on hand is made. Everything edible is weighed, and, in many instances, the beverages, condiments, etc., such as coffee, tea, spices, salt, and vinegar, are also weighed. During the study all food materials, as they are purchased, are weighed and their weight added to the amount of the same materials on hand at the beginning of the study. The cost of the food is also taken into account. The study continues for a certain period (a week, ten days, or even a month) and at the end another inventory is taken of the weights of all food materials on hand. The weight of any material on hand at the beginning added to that purchased during the study, less the amount in the house at the close, gives the weight of that material actually used as food during the dietary study. Not all the nutrients in the food purchased are necessarily consumed. There is a certain amount of table and kitchen waste which, in accurate studies, must be recorded and the amount of nutrients therein determined and deducted from those in the food purchased.

A careful record is kept of the attendance of the different members of the family at each meal and of any visitors who may be present. In this way a record is obtained of the age, sex, and occupation of

the different members of the family, the number of meals taken by each, and the total nutrients consumed by the family. Of course, the different members of the family will not eat the same amount of food. Not only will the individuals of the same age and sex vary, but women will, as a rule, eat less than men, and young children less than women. Using the best available data, certain factors have been deduced which represent more or less accurately the proportional amount of food different persons will, on the average, consume as compared with an adult man at ordinary manual labor. Thus, it is estimated that a man with severe manual labor will need about 1.2 times as much as the average man at ordinary labor, such as is performed by the carpenter, machinist, mill workman, etc. A moderately active woman will eat about 0.8 as much as her husband who is at work at some active employment. A man sitting at a desk all day, a bookkeeper, for example, also requires only about 0.8 as much as the carpenter or plumber who is at moderately active manual labor. Children at different ages require from 0.3 to 0.8 as much as the average man.

By use of these factors the total number of meals eaten by the different persons is calculated to the equivalent number of meals for one man. Dividing this latter quantity by the number of meals per day, usually three, the equivalent number of days for one man is obtained.

From actual analyses of samples of the different food materials used or from the average composition of these food materials the actual nutrients in the food eaten are computed, and the results divided by the equivalent number of days for one man give the nutrients per man per day.

The object of such studies as those just described is to determine the kinds, amounts, and relative cost of food materials and of nutrients consumed by different classes of people under different conditions of age, sex, health, occupation, and environment. It will be noticed that a distinction is made between food materials and nutrients. The term "food materials" is used to designate the different articles of food as they are purchased. The term "nutrients" refers to the particular ingredients in the food materials which serve to nourish the body. These ingredients are chiefly protein, fats, and carbohydrates. Protein (nitrogenous material) is required to build and repair the tissues of the body, to make blood, muscle, bone, and brain, and incidentally to furnish energy. Familiar examples of protein are found in lean meat, white of egg, casein (curd) of milk, and gluten of wheat. Fats and carbohydrates are to the body what coal is to the engine. They are consumed in the body to yield heat, to keep the body warm, and to furnish the power required for the internal and external work of the body. Familiar examples of fats are fat of meat, butter, and olive oil. Familiar examples of carbohydrates are starch of flour and potatoes, sugar, and cellulose or woody fiber.

The most convenient way of measuring energy is in terms of heat. The amount of energy furnished by a pound of a given food material, or in the total food consumed by a family, is conveniently measured in calories, just as the weight of the protein consumed is measured in grams or pounds. A calorie is, in round numbers, the amount of heat required to raise the temperature of 1 pound of water 4° F.

NUMBER OF DIETARY STUDIES MADE.

The total number of dietary studies made in this country and elsewhere is large, numbering many hundred. Of these, over 200 have been made by the Department of Agriculture in cooperation with colleges, experiment stations, etc., as previously mentioned. Many of these studies have been conducted with the utmost care and thoroughness. They are, however, still too limited in number and variety to furnish all the information needed about the habits of the people of different occupations and incomes in different parts of the country regarding the purchase and use of food. Nevertheless the work is sufficient to warrant some general conclusions, and it will doubtless be possible to formulate scientific laws of nutrition as the data accumulate from these and other investigations on the food and nutrition of man.

SIMILARITY OF FOOD CONSUMPTION AMONG PEOPLE LIVING UNDER SIMILAR CONDITIONS.

In the following paragraphs some of the results thus far obtained through the studies of dietaries are briefly noted. It is interesting to learn that families in about the same financial condition and performing equivalent amounts of work do not, on the average, differ materially in their food consumption. Of course, individual families may differ to a considerable extent from the average, and if we had the individual dietaries of the members of the family we would doubtless find there were still greater fluctuations. For example, in nine dietary studies made among families of carpenters, machinists, etc., in Connecticut, the protein in the food actually consumed varied from 99 to 119 grams, averaging 106 grams, and the energy or fuel value from 2,965 to 3,670 calories, averaging 3,420 calories. In three studies among mechanics in Tennessee the protein varied from 95 to 110 grams, averaging 101 grams, and the energy from 2,820 to 4,090 calories, averaging 3,660 calories. The food actually consumed by a tinsmith in Indiana contained 90 grams of protein and 3,285 calories of energy, and that of a skilled mill workman in New Jersey 100 grams of protein and 3,435 calories of energy. The average of all the mechanics' families studied, 14 in number, showed 103 grams of protein and 3,465 calories of energy in the food per man per day. It is probable that if sufficient data of the food consumption of individuals were available, it would be found that persons of the same age and sex and performing about the same amount of manual labor

would, on the average, consume food containing approximately the same amount of protein and energy. A notable exception to this statement is found among the negroes of the South, as shown by the studies made at Tuskegee, Ala. The negroes consume large quantities of bacon and corn meal, both deficient in protein, so that their daily diet is deficient in tissue-building material while furnishing about the same amount of energy as the average workingman elsewhere has in his food. A similar deficiency may exist in the dietary of many white people of limited means in the South, especially in the mountain regions, where their diet is quite similar to that of the negro.

DIFFERENCES IN FOOD CONSUMPTION AMONG PEOPLE OF DIFFERENT OCCUPATIONS.

It has been shown that people at hard work consume considerably more food than people engaged in sedentary occupations. As illustrations of this fact, several dietary studies may be cited. The first was of a builder's family in New York City. The husband was a very large and strong man, who, it was said, could perform the work of about two ordinary men. His wife was also large and active. The average food consumed per man per day by this family contained 195 grams of protein and 5,955 calories of energy. In the family of a blacksmith residing in Middletown, Conn., the food consumption per man per day amounted to 109 grams of protein and 3,640 calories of energy, and that in a carpenter's family in the same place to 101 grams of protein and 3,365 calories of energy. The family of a teacher in Lafayette, Ind., having a comparatively small amount of muscular exercise, consumed food furnishing 106 grams of protein and 2,780 calories of energy per man per day. These examples illustrate the difference in food consumption by people with different amounts of labor.

EFFECT OF CHANGE OF LOCATION ON THE DIETARY.

As a result of dietary studies carried on among families of foreign birth or parentage in Chicago, it was found that they continued to a considerable extent the dietary habits learned in their native countries. All the different nationalities quite generally patronized markets kept by their own countrymen and purchased the kind of food materials to which they had been accustomed. The Italian families cling to the use of macaroni and oils, wines, and cheese, because they were accustomed to them in Italy. They use little milk, and have little idea of the value of American vegetables. Macaroni, which forms one of their chief articles of food, is now made in this country and forms a nutritious and fairly inexpensive article of diet. The oil, wine, and cheese are largely imported, and hence much more expensive here than in Italy. They seem to be actually in dread of American foods, instead of taking pains to adapt their

tastes to foods which are easily and cheaply secured. Among the families of Russian Jews it was noticed that the orthodox class held firmly to the ecclesiastical laws governing the mode of slaughter of animals for food, and that even among the unorthodox few had overcome their antipathy to pork, and this article of diet appears to be very little used among them. It was found, however, that extended residence in this country gradually produced changes in the food consumption, so that the families born in this country of foreign parents did not seem to differ materially in their food purchases from other native Americans in the same region.

DIETARY STUDIES IN FARMERS' FAMILIES.

A dietary study was made of a farmer's family in Vermont. It was in winter, and the family lived at such distance from available markets that it was not always convenient to obtain fresh meats; consequently the amount of such food used was small as compared with that found in the ordinary dietary. The vegetable foods were largely those produced on the farm. Large amounts of flour, corn meal, potatoes, beans, and onions were used, together with crackers, sugar, and molasses. The total protein in the food amounted to only 69 grams and the energy to 2,960 calories per man per day. A dietary study of this same family in the summer, when all were engaged in rather active exercise and the markets were perhaps more accessible, showed not only an increased food consumption but a larger proportion of meats. The food consumed per man per day then furnished 89 grams of protein and 3,300 calories of energy. In general, it may be said that, as compared with corresponding studies of people with a moderate amount of work living in towns and cities, the diet furnished an excess of fuel ingredients (carbohydrates and fat) in proportion to tissue-building material (protein). The average of ten dietary studies among farmers' families, chiefly in Connecticut, shows that the daily food furnished 97 grams of protein and 3,915 calories of energy per man; rather less protein and more energy than have been found in the average food consumption of the carpenter, machinist, and blacksmith. This same difference is found in the diet of the farmer as compared with professional men. The teacher living in a large town or city consumes on the whole rather more meat and less flour and vegetables than his friend on the farm. This difference in food habits is largely due to difference in the opportunities for the purchase of food. People living in towns have a much wider range of choice than those in the country, especially as regards meats. On the other hand, owing to the abundance of vegetables, grains, and other farm products, and the difficulty of obtaining fresh meats in convenient quantities, the farmer's diet is apt to be deficient in nitrogenous foods as compared with the food consumption of other classes of people. Whether this is a disadvantage physiologically, is a

question that can not be definitely answered at the present time. It would seem that a larger proportion of protein would be desirable. This deficiency could be readily made up by consuming more eggs, milk, and cheese.

DIETARY STUDIES AMONG MEXICANS AND NEGROES.

Another illustration of the fact that the most available food supply usually determines the dietary habits is afforded by dietary studies made in New Mexico and in the Black Belt of Alabama. It was found that Mexicans living on the ranges of New Mexico consumed very little meat, and that the food consisted almost entirely of flour, corn, chili pepper, and legumes raised at home. The average food consumption of four families residing in this region showed 94 grams of protein and 3,550 calories of energy, results agreeing very closely with those obtained in studies of the Eastern farmer, although the cost of the food in the case of the Mexicans was much smaller, amounting to but 7 cents per man per day. The negro in the South is accustomed to living upon a very simple and inexpensive diet, consisting of food materials which will keep almost indefinitely in a warm climate without deteriorating. The diet is largely made up of bacon and corn meal, and the amount of protein furnished is very small compared with the energy. In this case there can be no doubt that the diet is one-sided.

It is interesting to note that in negro families who had come more or less under the influence of such educational institutions as those at Tuskegee, Ala., and Hampton, Va., the diet became more or less modified. To illustrate, a family which may be regarded as typical, living on a plantation in Alabama and coming in no way under educational influences, had a diet consisting of fresh pork, bacon, buttermilk, corn meal, and sugar. This diet furnished 52 grams of protein and 3,235 calories of energy per man per day. Not very far away there lived another family, two of the members of which had come under the influence of the Tuskegee Institute. The diet here consisted of bacon, eggs, milk, butter, wheat flour, corn meal, sugar, and molasses. The food per man per day furnished 92 grams of protein and 3,270 calories of energy, or nearly twice as much protein and the same energy as was obtained by the preceding family. In the outskirts of Tuskegee lived a colored carpenter who had learned his trade at the institute and was quite skillful. His diet contained beef round, mutton leg, bacon, lard, chicken, eggs, butter, milk, wheat flour, corn meal, rolled oats, sugar, molasses, evaporated apples, and strawberries, a diet as varied as is found in many families in comfortable circumstances in other regions. The food furnished 97 grams of protein and 4,060 calories of energy per man per day. These results show more energy than is usually found in the food consumed by persons at moderate labor. The protein compares quite closely

with that found in the diet of the average mechanics' families. The larger amount of energy is due perhaps to the fact that more muscular work was performed.

ANIMAL AND VEGETABLE FOODS IN DIETARIES.

Different food materials differ widely in the kinds, proportions, and amounts of nutrient ingredients they contain. It is customary to group these materials into two general classes, animal and vegetable foods. The animal foods, such as beef, veal, mutton, pork, fish, poultry, eggs, cheese, etc., contain, as a rule, little or no carbohydrates. Exceptions to this rule are chiefly found in milk and products manufactured from milk. With the exception of butter, lard, and all but the leaner cuts of pork, animal foods are essentially a source of protein rather than energy. In such materials as veal, young chickens, and fish there is almost no fat, protein being practically the only nutritive ingredient. The presence of animal food in the diet is due not only to custom and desire for variety, but also to the fact that with most people it is one of the most important sources of protein or tissue-forming material. At the same time animal foods are more expensive than a large number of the vegetable food materials. Among vegetable foods we usually distinguish between cereals and their manufactured products, sugars, starches and the like, vegetables, and fruits. Of these subclasses the cereals are most important. The cereal foods (corn, wheat, barley, buckwheat, etc.) and their manufactured products (flours, bread, crackers, etc.) not only furnish a very large proportion of the actual nutrients in the ordinary diet, but furnish these nutrients most economically. Ten cents expended for wheat flour or corn meal will purchase a much larger amount of nutriment than if expended for any other food material, unless it be dried beans and peas.

With the exception of a few of the more common vegetables, such as potatoes, turnips, beets, and onions, the green vegetables and fruits, such as cabbage, lettuce, squash, string beans, tomatoes, apples, oranges, bananas, strawberries, etc., contain a comparatively small proportion of actual nutrients. Their value in many cases lies not so much in the actual amount of nutrients they contain as in the variety and palatableness they give the diet, and in the organic acids and the mineral matters they contain. When used in considerable amounts they largely increase the cost of the food while adding comparatively little to the actual nutritive value of the diet. As an illustration of this latter statement, the case of a skilled mill workman in New Jersey may be cited. The number of meals taken by the different members of this family during the study was equivalent to one man one hundred and twenty-seven days, or practically four months. During this time $2.16 was expended for oranges and $3 for celery, making a total of $5.16 for these two articles, which

between them furnished 150 grams of protein and 6,445 calories of energy. During the same time $5.16 was also expended for cereal foods and sugars, and 3,375 grams of protein and 184,185 calories of energy were obtained, or about twenty-five times the amount furnished by the oranges and celery. The amount expended for vegetables and fruits aside from the oranges and celery amounted to $5.75 and furnished 1,909 grams of protein and 58,000 calories of energy, or, in round numbers, ten times as much as was obtained in the oranges and celery.

SOME EFFECTS OF DIFFERENT COMBINATIONS OF FOOD ON DIETARY.

Results of dietary studies show a great difference in the kinds of cereal foods, meats, vegetables, and fruits purchased by different families, so that one family may obtain more nutrients for the same money or the same amount of nutrients for less money as compared with some neighbor. Dietary studies were carried on in the families of a teacher and of a tinner living in Lafayette, Ind., during the spring of 1895. An examination of the details of the two studies shows that the teacher obtained per man per day 75 grams of protein and 1,425 calories of energy at a cost of 12 cents; the tinner, 62 grams of protein and 1,640 calories of energy at a cost of 13 cents. In other words, the actual nutritive value of the diet was not notably different in either case. The proportion of beef, veal, eggs, etc., in the two diets was, however, quite different. The teacher's family used large amounts of beef, round and shoulder, and some loin steak, which was purchased at a low price. The tinner's family used rather less beef, but the cuts that were used were, on the whole, more expensive. The teacher's family used more veal, which was relatively costly; less eggs, more than twice as much milk, and less butter than the tinner's family. On the whole, the former got a little more protein and a little less energy than the latter in the animal foods purchased.

However, the great difference in the two dietaries lies in the kinds of cereal foods purchased. The teacher's family had homemade bread and cakes, while the tinner's family bought bakers' bread and occasionally cakes. The former obtained his bread at about half the cost to the latter, even when a reasonable allowance is made for the cost of all the ingredients in the bread and the heat required to bake it. The teacher's family used more cereals and less vegetables and fruits than the tinner's family. In these ways the former family obtained in their vegetable foods 36 grams of protein and 1,485 calories of energy for 6 cents per man per day, while the latter spent more than twice the amount (13 cents) per man per day and obtained 44 grams of protein and 2,200 calories of energy. In other words, the teacher obtained for 18 cents as much protein and nearly as much energy as did the tinner for 26 cents.

DESIRABILITY OF CONSIDERING NUTRITIVE VALUE IN THE PURCHASE OF FOOD.

The circumstances of some families are such that they can afford the higher-priced meats and the costlier vegetables and fruits, while other families have to calculate closely in order to make both ends meet. The man with an income of $5,000 a year can pay 25 or 30 cents a pound for his steak and buy large amounts of celery, oranges, etc., but the man with an income of $500 a year can ill afford such expenditures. In such cases it is frequently of the greatest importance that the purchases of food shall be guided rather by the amount of nutrients they will furnish than by their palatability or bulk. It has been found that the inexpensive foods are often as nutritious as the costly; in fact, cost is not regulated by nutritive value. Skill in preparing food will render many inexpensive articles very appetizing while the most expensive articles are often ruined by poor cooking.

Examples of the effects of the lack of knowledge of the value of different food materials for nutriment were shown in some results obtained in the study of dietaries among families in New York City. In one instance a family depending more or less of the time upon charity consumed food furnishing 40 per cent more protein and 16 per cent more energy than is found in the average diet of the mechanic with an income of $2 to $3 a day. In another case the total income of the family, consisting of the father, mother, and five daughters, the oldest 21 years of age, was about $24 a week, but through carelessness and ignorance they were insufficiently nourished. At the time of the study they were obtaining 85 grams of protein and 2,235 calories of energy per man per day. The diet was afterwards changed for the better, and a few months later the family had greatly improved in health.

Nine cents a day is a very small allowance for a man at moderate work, and yet several instances have been observed in connection with the dietary studies made in this country in which the food per man per day has been purchased for this sum or less. A family living in New York City may be cited. The daily food of this family furnished but 54 grams of protein and 1,500 calories of energy, less than half the protein and energy found on an average in the diet of a man in more comfortable circumstances. Even with this small sum the family might have fared much better had the mother known more about the nutritive value of the different foods. For instance, they might have used more wheat flour and less cake. As a matter of fact, a mill workman's family in Pittsburg, for the same sum, obtained 77 grams of protein and 2,440 calories of energy per man per day. In other words, they obtained 50 per cent more nutrients for the same money and the diet seemed equally palatable. Similar cuts of meat were bought more cheaply and other cuts were selected which cost but half the price per pound that was paid by the New York family.

All vegetable foods were purchased by the Pittsburg family at a smaller price per pound. Stale bread was also purchased for 2.5 cents per pound that actually furnished more nutriment, pound per pound, than the fresh bread purchased by the New York family at 4 cents. The results of a considerable number of dietary studies made among families with very limited incomes in different parts of the country indicate that through ignorance of the real nutritive and pecuniary value of different food materials either more is spent for food than can well be afforded or the family is insufficiently nourished on the sum expended. Often a considerable sum is wasted by purchasing food in very small quantities.

Many people have the impression that milk is an expensive food. In some instances this is undoubtedly true. At other times its introduction into the diet in larger amounts than customary may actually serve to lessen the cost of food. In a series of dietary studies made at the Maine State College the experiment was tried of allowing a free consumption of milk, of substituting milk for other foods, and finally of reducing the amount allowed each man. It was found that the cost of the diet was slightly greater when the milk supply was limited, and that the unlimited use of milk actually made the cost of the diet a trifle less. The amount of other foods was reduced as the amount of milk was more liberal. It should be said that these changes were not marked enough to render the diet unpalatable in any case.

IMPORTANCE OF AVOIDING WASTE OF FOOD.

In all that has been said thus far the term food consumption has been used. The food actually consumed is usually less than the food purchased, owing to waste in the kitchen and on the table. By the term waste is not meant the inedible portions of the food materials, such as bone, tendon, vegetable parings, etc., unless these are very large in proportion, but those portions of the food, which though edible, are thrown away. The actual amount of such waste varies greatly in different families. In some cases investigated it has amounted to practically nothing, and in other cases it has been nearly one-fifth of the total food purchased. Generally speaking, the amount of waste has been found to be greatest in those families who can best afford it. This is not always the case, however, and occasionally an unusually large proportion of waste has been observed in the diet of those who can least afford it. This is illustrated in the diet of the family in New York City previously referred to. As stated, they had only about one-half the amount of nutrients found in the average diet of the man at moderate work, and yet nearly 6 per cent of the total food purchased was wasted. The average waste found in fourteen mechanics' families in such circumstances that they were not necessarily restricted in their choice and use of food, amounted to 6 per cent of the total nutrients purchased; that in professional men's

families to a little over 3 per cent. It is of interest to note that, while the professional man was paying 28 cents per day for his food and the mechanic 19 cents, the former only wasted half as much as the latter.

SUMMARY OF AMERICAN DIETARY STUDIES.

In the following table the results of the more important dietary studies which have been referred to in the preceding pages are summarized:

Comparison of the average food consumption of people of different occupations or in different conditions of life.

[Per man per day.]

Families studied.		Cost.	Protein.	Fat.	Carbohydrates	Fuel value.
		Cents.	*Grams.*	*Grams.*	*Grams.*	*Calories.*
Average of ten farmers' families in Vermont, Connecticut, and New York	Food purchased [1]	.....	101	136	483	3,655
	Food eaten	.....	97	130	467	3,515
Average of fourteen mechanics' families in Connecticut, New Jersey, Tennessee, and Indiana	Food purchased	.....	110	161	425	3,690
	Food eaten	[2] 19	103	150	402	3,465
Average of fourteen professional men's families in Connecticut, Pennsylvania, Indiana, and Illinois	Food purchased	.....	108	132	429	3,435
	Food eaten	[3] 28	104	125	423	3,325
Average of fifteen college clubs in Maine, Connecticut, Tennessee, and Missouri	Food purchased	.....	130	187	519	4,390
	Food eaten	.....	107	148	459	3,690
Average of above fifty-three studies	Food purchased	.....	113	156	463	3,810
	Food eaten	.....	103	138	436	3,500
Average of twelve laborers' families in New York City	Food purchased	.....	103	119	356	2,950
	Food eaten	19	101	116	344	2,905
Average of eleven poor families in New York City	Food purchased [4]	.....	95	98	414	3,005
	Food eaten	15	93	95	407	2,915
Average of two laborers' families, very poor, in Pittsburg, Pa	Food purchased	.....	81	98	311	2,525
	Food eaten	11	80	95	308	2,485
Average of two laborers' families, more comfortable circumstances, in Pittsburg, Pa	Food purchased	.....	121	148	534	4,055
	Food eaten	19	120	147	534	4,045
Average of twelve negro families in Alabama	Food purchased [5]	9	67	134	453	3,375
Average of four Italian families in Chicago, Ill	Food purchased [5]	16	103	111	391	3,090
Average of five French Canadian families in Chicago, Ill	Food purchased [5]	22	118	158	345	3,305
Average of four families of Russian Jews in Chicago, Ill	Food purchased [5]	19	120	101	406	3,095
Average of eight Bohemian families in Chicago, Ill	Food purchased [5]	12	115	101	390	2,885

[1] Including all food raised on the farm.
[2] Average in nine studies.
[3] Average in five studies.
[4] Including some of the families in preceding average.
[5] Waste not represented.

WAYS IN WHICH THE RESULTS OF DIETARY STUDIES MAY BE USED.

Some of the more important and more noticeable results of dietary studies have been noted in the preceding paragraphs. How can these results be applied to the benefit of the individual, the class, or the human race? There are many ways in which this can be done. Perhaps one of the most important of these is in instruction concerning the nutritive value of the different food materials and their pecuniary economy. People should be taught how to improve their diet by the economical purchase of those materials best adapted to their physical needs. It will be found that by exercising care in the purchase and preparation of food a palatable and relatively inexpensive diet may often be obtained. Much is already being done along this line in many of the large cities, where the cost of many food materials must always be relatively large.

When the true character of the different kinds of food materials is more thoroughly understood diet will almost of necessity become more rational. With the advance of knowledge as to the physical requirements of the body it will become possible to establish standards which shall indicate the approximate amount of the different nutrients required. By this it is not to be understood that any definite rules for the consumption of food can be laid down, but simply that it will be possible to furnish a reliable guide for the purchase and use of foods.

The proper nourishment of the inmates of institutions where large numbers must be fed, such as schools, reformatories, prisons, and hospitals, is a subject that is attracting no little attention at the present time. In several instances studies have been made of the actual food consumption in such institutions, and at the present time an extended study of the food requirements of the insane is being carried on by one of the States. In many instances dietary studies have been made in schools, college clubs, etc., and the information obtained has been of much use. That such studies have been found to have a practical value and that the interest in them is widespread is shown by the fact that a considerable number have been undertaken by instructors and others interested, aside from those carried on by the Department of Agriculture.

When it so happens that large bodies of men are to be fed, as in the case of armies, or where the transportation of large amounts of food is difficult, the results obtained from dietary studies and similar investigations are of the utmost advantage in the selection of the food ration. It also becomes possible to select condensed rations which for emergencies shall furnish within the smallest space sufficient food for sustenance.

These are some of the more important uses that can be made of the results of dietary studies and similar investigations. They are sufficient to show the advantage to be obtained from extended research

in this direction. At present only a beginning has been made, but every year adds to the data obtained.

In general, the object of dietary studies is not to limit the amount or variety of food to be used by the people, but rather to discover ways and means in which their dietaries may be improved and the available food supply be most economically used to maintain the body in good health and to make it an efficient instrument for the different forms of labor required by our complex civilization.

It is not the purpose of food chemists to prescribe weighed amounts of different foods as a physician prescribes medicines, but rather to show the actual nutritive value of different food materials and their relative economy as sources of nutrients, leaving the application of the knowledge to individuals. Although dietary standards are suggested, it is not necessary that the food each day should contain exactly the kind and amounts of the different nutrients required by the standards. A slight deficiency one day will be made good by an excess the next, the body serving as a storehouse for reserve material. Experience has, however, shown that the body is best nourished when through long periods the food approximates the requirements of the so-called standards. Individual requirements and individual peculiarities will always affect the choice of foods. In the purchase of other things their value for the purpose for which they are intended is considered as well as their cost. Without doubt the same principle may be advantageously applied to the purchase of food. By the exercise of a wise economy, based on a knowledge of the real nutritive value of foods, a more satisfactory diet can be obtained for a less sum than is at present expended in many cases, or the cost of the diet may be diminished without lessening its nutritive value.

CATTLE DIPPING, EXPERIMENTAL AND PRACTICAL.

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INTRODUCTION.

By the term cattle dipping is meant the immersion of cattle in solutions of various chemical preparations for the purpose of destroying parasites which infest their skin. The purpose of this paper is to consider the practice of cattle dipping, with particular reference to freeing the cattle of the parasites known as ticks, especially the *Boophilus boris*, the tick which causes Texas, or Southern, fever.

Southern, or splenetic, fever (usually called Texas fever) is an infectious disease caused by a microparasite. This parasite, when it enters the system of susceptible animals (those animals which have been reared in sections of the country where the tick is not indigenous), destroys the red corpuscles of the blood to such an extent that the blood becomes thin and watery. The disease is always accompanied by high fever, and the course is, as a rule, acute, reaching the climax on the fifteenth or sixteenth day after infection, when death generally results.

Considered as a parasite, the Texas fever tick, so long as it is confined to cattle which are reared in sections of the country where the tick is native, is less injurious than those which are the cause of itch, mange, and other cutaneous diseases. But when by any means, natural or artificial, the ticks come in contact with cattle from other parts of the country, they produce the fatal disease commonly known as Texas fever. Therefore, when cattle from a territory infected with these ticks are to be taken into a noninfected territory, it is of the greatest importance that they first be freed of all ticks. So far as known at this time, the only remedy is to dip the cattle in a strong disinfecting solution. This is the process which will be discussed in this paper.

ESTABLISHMENT OF QUARANTINE LINE.

As early as 1889 Dr. D. E. Salmon demonstrated that the district from which cattle carried the contagion of Texas fever was identical with the territory in which the cattle tick was found, and although it was not until a few years later that the true relationship between the tick and Texas fever was finally established, a precautionary measure against the spread of the disease was taken in the form of a rigid quarantine, which excluded all cattle of the Southern tick-infected

country from the uninfected district, where cattle were known to contract the fever and die when they came in contact with Southern cattle. As experience had proven that during cold weather the danger of infection was greatly diminished, if not entirely eliminated, the quarantine regulations were suspended during the coldest part of the season, that is, from December 1 to February 15. This period, the so-called open season, was later changed to November 1 to December 31, during which time all cattle from the infected territory were allowed to pass into the uninfected territory without any restrictions whatever. During the remaining ten months, however, cattle from below the quarantine line could only be shipped north of it when intended for immediate slaughter, and rigid precautions were taken to prevent the spread of the disease from such animals.

That these measures worked great hardships to the cattle raiser south of the quarantine line is evident. The Southwest is and always will be the breeding ground of the whole country, from which the great majority of stock cattle and feeders are furnished to the central grain-producing States, as well as to the vast maturing ranges of the Northwest. Cutting these cattle off from the market for ten months in each year naturally results in a glut during the open season, with correspondingly lower prices. Furthermore, the cattle must be shipped North from the mild Southern climate at a season of the year when they are frequently exposed to extreme cold weather, for which they are entirely unprepared and which often causes heavy loss among them. On the other hand, the Northern buyer is compelled to purchase the feeders which are to consume his surplus of grain at a season when it is difficult to acclimate them, and which is always far behind the time when he is ready to receive them.

In the immense pastures of the Northwest cattle develop to a greater size on the nutritious grass than anywhere else, but owing to the long and severe winters a sufficient number of calves can not be raised to keep these pastures stocked. Calves that are born late in the summer and fall are difficult to winter, and the precautions necessary to bring them through are more costly than to purchase stock cattle from the South and mature them on the rich grass.

In view of these important facts, all efforts were concentrated to devise some means whereby the Southern feeders and stock cattle might at all times of the year be brought to the large stock centers and feed lots in the grain-growing States or the maturing ranges of the Northwest. Experience soon showed that this object might be attained if a satisfactory dipping solution could be found.

THE CATTLE TICK THE TRANSMITTER OF TEXAS FEVER.

In a bulletin issued by the Bureau of Animal Industry in 1893 it was shown that the cattle tick is the sole transmitter of Texas fever, and that when Southern cattle had been completely freed from ticks they

might be brought into the noninfected territory without danger of communicating the disease to the Northern cattle. The same bulletin suggested a means to free the cattle from ticks, namely, to pass them through a disinfecting bath, or, as it is now termed, to dip them.

THE FIRST DIPPING VAT.

The first dipping vat to be built in this country was constructed by Mr. R. J. Kleberg, manager of the Santa Gertrude's ranch, in Nueces County, Tex., who used it for treating his stock for mange and itch. For this purpose the cattle were dipped in a strong solution of carbolic acid, and it was soon noticed that a large number of the ticks which infested the cattle became severely affected by the dip. Mr. Kleberg then placed his dipping vat and also his ticky cattle at the disposal of the Bureau of Animal Industry, and during the following five years, with the object of testing the tick-destroying properties of various disinfecting preparations, there were dipped at this ranch more than 25,000 cattle. The important fact was learned during these experiments that the ticks were better able to resist the effects of these preparations than the cattle. When the solution was strong enough to destroy all the ticks it injured the cattle, and when sufficiently diluted not to irritate the skin and eyes of the cattle the ticks would survive. As an instance showing the resistance of the tick to strong disinfectants, it may be mentioned that a solution of corrosive sublimate in water (1 to 250) does not in the least affect the tick when left in it for several minutes. The same is true of carbolic acid, arsenic, lime-and-sulphur, and a great number of proprietary sheep dips.

THE OIL BATH.

Dr. M. Francis, of the Texas Agricultural Experiment Station, was the first to suggest the use of an oil dip. It is common experience that any kind of grease or oil will destroy the ticks when applied to cattle infested with these parasites. Dr. Francis suggested the use of crude cotton-seed oil. A layer of 2 or 3 inches was floated on water, which filled the dipping vat to a depth of about 5 feet. When cattle were immersed in such a bath they would, as a rule, come out well covered with oil; but it was soon found that many ticks survived the dipping, even when 10 to 15 per cent of crude carbolic acid was added to the oil. Besides this drawback, the oil had a very heating effect on the cattle, especially during the hot summer months. Nevertheless, the oil dip was a step in the right direction, and various kinds of oil and oil emulsions with soap and carbolic acid were tested at Santa Gertrude's ranch; but none of them proved satisfactory. It was evident, also, that a lighter oil must be found in order to avoid the heating effect on the cattle, and one which at the same time would have a more decided effect on the ticks. Dr. Francis then

suggested crude black mineral oil, which also proved too severe on the animals, and, besides, a double dipping, with an interval of several days, did not destroy all the ticks.

EXPERIMENTS AT FORT WORTH.

About the middle of 1897 great interest was being taken in the dipping question in various States, and stockmen everywhere began to realize that it would be of immense economic importance if a satisfactory dip could be discovered. In August, 1897, the Fort Worth Stock Yards Company built a large dipping plant and placed it at the disposal of the Bureau of Animal Industry.

The results previously obtained indicated that a light mineral oil would be most likely to have the desired effect on the ticks, and hence experiments were inaugurated at Fort Worth in order to test some of the so-called paraffin lubricating oils. These oils, which are derived from crude petroleum after the more volatile substances, as benzine, gasoline, and kerosene, have been distilled over, were used in a layer varying in depth from a few inches to 1 foot on water in the dipping vat, and it was found that their effect was superior to anything which had hitherto been tried. It was observed that while the vegetable oils, as well as the crude mineral oil, had merely a mechanical effect, in that it closed up the pores of the skin of the parasites, the paraffin oil had in addition a decided chemical action.

After the cattle had passed through a paraffin-oil dip many of the ticks would immediately drop off and die. Within a few hours those that remained on the cattle showed violent contractions, changed in color, and shriveled up. These effects were produced in some cases in a few hours, but the majority of the ticks did not die until from twenty-four to forty-eight hours after dipping, and some after even a longer period. The effect on the cattle was less severe than was observed in the experiments with other oils. On warm days, when shelter from the sun was provided, the cattle did not pant as when dipped in black mineral oil or cotton-seed oil. It was only by use of a thermometer that a rise in temperature (from 2° to 5° F.) could be discovered. Some of the animals showed a stiffness and swelling of the legs and reddening of the skin, while the eyelids of some became slightly swollen. These effects, however, passed off in the course of a few days.

These very encouraging results, which were given wide publicity through the press, caused a greater interest to be taken in the dipping question, especially by those States which were desirous of obtaining stock from Texas at all times of the year. The management of the Fort Worth Stock Yards, in reply to numerous inquiries, agreed to furnish the necessary cattle and oil to demonstrate to representatives of State live-stock sanitary boards the feasibility of employing the dipping process for commercial purposes. A convention

was called in September, 1897, at Fort Worth, which was attended by delegates from Illinois, Missouri, Nebraska, Kansas, Colorado, Oklahoma, and Indian Territory, as well as from many parts of Texas. A number of cattle were dipped, 1 foot of paraffin oil being used on the water. A small amount of animal oil was added to the paraffin oil, as it was supposed that this would tend to allay the irritating effect on the eyes and skin, but no noticeable improvement was observed. The delegates were pleased with the manner in which the cattle were put through the vat, and the effect of the oil on the ticks was equally gratifying. However, a small number of ticks survived, and, the weather being extremely warm, the oil had a more severe effect on the cattle than had hitherto been experienced. For these reasons the experiments could not be considered an unqualified success.

This convention commended the Bureau of Animal Industry for the work it had done, expressing the belief that the experiments carried out rendered "the transmission of Southern fever no longer a matter of dread," and requested that the Bureau carry on the work another year, in the hope that the question might be brought to a successful conclusion as early as possible. It was of importance that the method should be perfected early enough the following spring to permit the dipped cattle to be exposed in the various States north of the quarantine line for a period of two months during the hottest part of the summer, in order to demonstrate that the dipping had deprived them of their ability to transmit the fever. The representatives from the various States signified their willingness to cooperate with the Bureau of Animal Industry in this exposure test, and the dipping vats at Santa Gertrude's ranch and Fort Worth were placed at the disposal of the Bureau.

EXPERIMENTS AT SANTA GERTRUDE'S RANCH.

On the first of April, 1898, the experiments were therefore resumed at Santa Gertrude's ranch, where it was less difficult to obtain ticky cattle. A paraffin oil lighter than the one which was used at Fort Worth the previous season was procured. This was a clear lubricating oil of a slightly less specific gravity than the one used at Fort Worth. This lighter oil was considerably thinner than the kind used at Fort Worth, and it was believed that it would drain off the cattle more quickly than the latter, and perhaps also lessen the heating effect. Experiments were made with this oil in a layer of 6 inches on the water in the vat. As was expected, a number of cattle dipped in this bath emerged with a thinner coating of oil; otherwise there was not much difference in the effect on either the ticks or the cattle. Some of the animals became slightly stiff and others had swollen eyelids, and though the greater number of full-grown ticks were destroyed, a number of medium size survived. The ticks which were not killed were located principally on the lower parts of the body—the brisket, abdomen,

legs, etc. This fact gave rise to the suggestion that the ticks which became steeped in the water while the animal was swimming through the vat passed through oil only as the animal made the plunge and at the moment of leaving the vat, when oil and water as a rule are very much agitated, and consequently left these ticks covered with less oil than those on the upper parts of the animal. (See figs. 121 and 122.) It was therefore decided to make a test of dipping in a vat of oil alone. For this purpose a small vat was constructed, with a capacity of 250 gallons, being large enough for the complete submersion of a good-sized yearling. A number of animals were then dipped

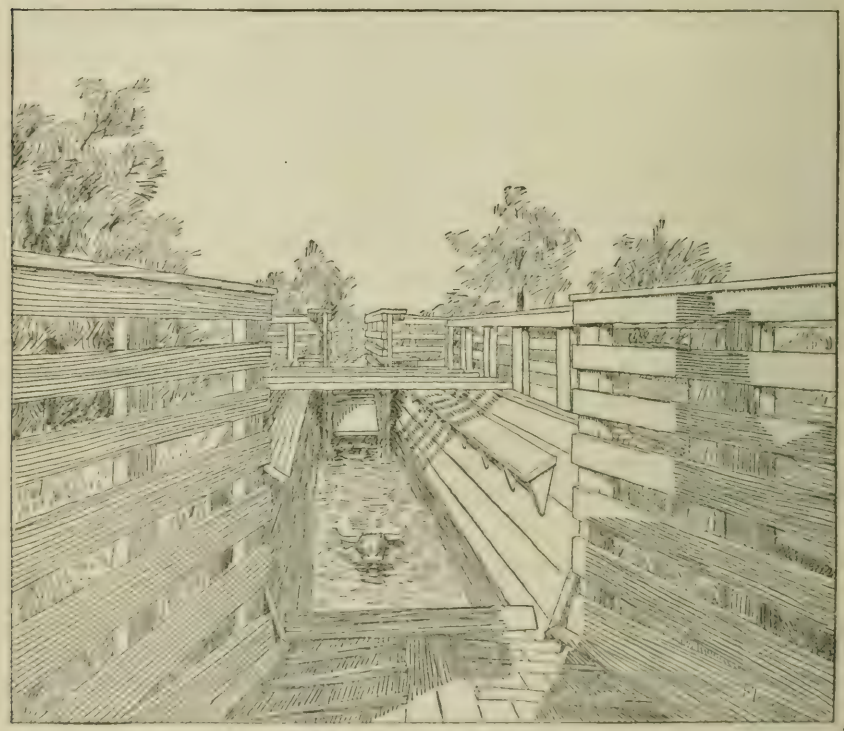


FIG. 121.—Steer in dipping vat.

in this solid-oil bath, and it soon became evident that it had a more severe effect on the animals than when used with water. A limited number of ticks (two or three on a dozen cattle) remained alive. The effect on the cattle was too severe to admit of double dipping. It therefore became necessary to discard this oil and to find some means whereby either the tick-destroying properties of the oil might be increased or the irritating effect on the animal sufficiently lessened to allow of a double dipping.

An old-time remedy for ticks and other skin parasites in the South is sulphur; and while this had been tested in various forms, both externally and internally, it had never been found to be reliable

where the result desired was to free cattle completely of ticks. However, it was thought that by the addition of sulphur the effectiveness of oil might be increased. In carrying out this suggestion it was soon discovered that part of the sulphur was dissolved in the oil, and if the oil and sulphur were heated to about 200° F. the oil would take up from 2 to 3 per cent of the sulphur, part of which, however, was precipitated when cooled off to ordinary temperature, leaving about 1½ per cent of sulphur in the solution. As no facilities could be obtained for heating a large quantity of oil at the ranch, the sulphur was simply added to the cold oil and stirred repeatedly for two days,

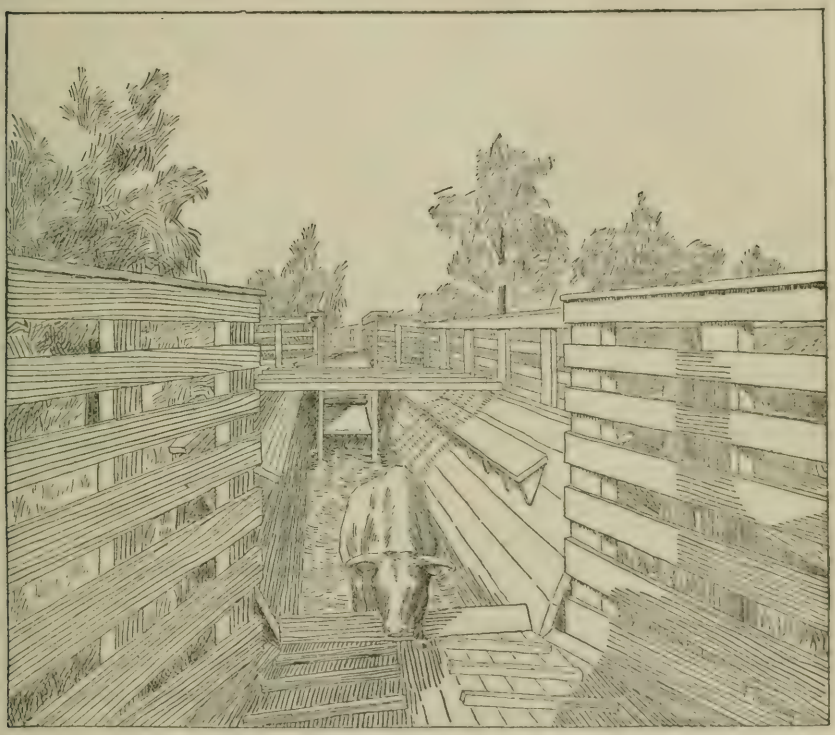


FIG. 122.—Steer emerging from dipping vat.

at the end of which time the oil had dissolved about 1 per cent of the sulphur. This preparation was poured into a small vat and a number of yearlings dipped in it. After three days not a single living tick could be found, but most of the animals had swollen eyelids and suffered considerably from heat. It is doubtful whether the addition of sulphur increased the irritating effect of the oil, but it was apparent that the animals dipped in it were not in a condition to be driven or transported. Those left in a good pasture, close to the dipping vat, soon recovered from the effects of the oil, but attempts to remove them to other parts of the ranch had to be abandoned, as they quickly became overheated.

EXPERIMENTS RENEWED AT FORT WORTH.

As no means could be found whereby the irritating effect on the cattle might be lessened, it having been shown in previous experiments that an addition of animal oil did not have the desired effect, it became necessary to suspend any further experiments with this oil; and as no other oil could be obtained in sufficient quantities within a reasonable length of time the field of operations was removed to Fort Worth. The experiments at Santa Gertrude's ranch had demonstrated that the tick-destroying properties of an oil might be increased through the addition of sulphur, and that a solid oil bath was more reliable, so far as the ticks on the lower part of the body were concerned, than a dip consisting of a layer of oil floating on water.

The problem remained to find an oil with a less irritating and heating effect than those heretofore employed, and, it having been observed that these effects decreased in direct proportion to the thickness of the oil, it was decided to obtain an oil as thin as possible. For this purpose a number of samples of various lubricating oils were examined and one of very light specific gravity, called extra dynamo oil, was selected. This oil was said to be perfectly free from acid, and to contain less paraffin than those hitherto used, while it contained a higher percentage of volatile substances than any of the others. A number of barrels of this oil was procured. In order to test the effect of the oil alone, two yearlings were dipped in a small vat completely filled with oil. The effect on the ticks was surprising. Two to three hours after the dipping all the large ticks were dead, most of them having turned into a black, brittle substance, resembling grains of scorched corn that might be ground into powder between the fingers. All the smaller ticks and molting ticks were also badly affected, while the medium-sized ones showed more resistance. In the course of forty-eight hours only two medium-sized live ticks could be found, those being on one animal, and as the oil had evaporated to a great extent there did not seem to be much probability of their dying. Neither of the animals showed any swelling of eyelids or any noticeable stiffening of the legs. One of them, however, an emaciated Jersey-cross "dogy," gradually lost its appetite and became weaker and weaker until after two weeks it died. A post-mortem examination showed thin, watery blood and a slightly enlarged spleen. At the time, however, this was not recognized as a case of Texas fever. As the other, a stronger animal, recuperated quickly, it was thought that the smaller one was sick at the time of dipping, and therefore did not possess sufficient strength to withstand the shock received during the process. As two ticks survived, the oil could not be considered reliable as a tick destroyer after a single dipping, wherefore it was decided to add sulphur to it. Six ticky yearlings were dipped in this preparation, and in the course of two days all the ticks, both large and small, had died with the

exception of half a dozen of the medium-sized ones, which did not die until the fourth or fifth day after the dipping. By that time all of the oil had practically disappeared from the skin and the protracted effect upon the remaining six medium-sized ticks was ascribed to the sulphur left after the evaporation of the oil. Not one of these animals appeared to suffer any inconvenience from the dipping, and after one week none of them showed unusual symptoms of any kind except the loosening up of the old epithelium on the sides of the neck and the shoulders, and on the inside of the hind legs. The skin remained soft and flexible, however, and no blisters or cracks were formed.

In view of these highly gratifying results the Bureau of Animal Industry issued instructions to repeat the experiment with a larger number of animals. Thirteen ticky yearlings were immediately dipped, and the result was equally gratifying, with the exception that one weak Jersey cross died in a manner similar to the one referred to previously. The middle of July arriving, the sanitary boards of the various States which were to cooperate with the Bureau in the tests of exposing dipped cattle with susceptible cattle in pastures north of the quarantine line became impatient, as pastures had been reserved since early in the season to receive the dipped cattle. In fact, all of the States except Illinois withdrew. Therefore no time was to be lost if a final conclusion was to be reached during the summer, and it was decided to use the extra dynamo oil with sulphur for the experiments. A tank car of this oil was immediately procured, the company selling the oil agreeing to heat it and dissolve the sulphur in it before shipping.

FIRST ILLINOIS EXPERIMENT.

On July 17 three members of the Illinois Live Stock Sanitary Board, including the secretary and State veterinarian, arrived at Fort Worth, accompanied by Dr. B. B. Page, of Rockford, Ill., who had arranged to buy a train load of cattle to be used in the experiment. He purchased at Jacksboro, Tex., a point about 65 miles northwest of Fort Worth, and more than 100 miles south of the quarantine line, 311 head of two and three year old steers, and had them shipped to Fort Worth. These 311 head of cattle were dipped in the large vat in the stock yards at Fort Worth on July 22. The weather, which had been remarkably cool up to this time, suddenly changed to intense heat, and, it being desirable not to expose the cattle to the sun immediately after the dipping, they were not passed through the vat until after sunset. By 11 o'clock at night all had gone through without a single accident, and the 311 head of cattle were at once loaded on 11 clean, disinfected cars, well bedded with hay. Hay was preferred to sand as a bedding, as the latter absorbed the oil too quickly when it came in contact with the skin when the cattle were lying down; but in the later experiments sand was used in the bottom of the cars

with a thick layer of hay on top, as with hay alone the floor became too slippery for the cattle to ride well. The train was placed in charge of Dr. Rice P. Steddom, an inspector in the Bureau of Animal Industry, and at 4.15 a. m. July 23 the train left Fort Worth for Rockford, Ill., arriving at the latter place on July 26 at 9 p. m. Dr. Steddom's report on the condition of the animals and their surroundings while en route is given, as follows:

Leaving Fort Worth at 4.50 a. m., July 23, the train arrived at Denison, Tex., at 8.30 a. m., at which time a small number of the dipped cattle began to show a slight irritation of the eyelids; in cars loosely loaded some were lying down ruminating. Many of the matured ticks had dropped off. As the day advanced the heat became intense, with no perceptible movement of the air, and the effect on the oil-covered cattle was very depressing, especially when the train stopped at stations.

Toward noon the inflamed condition of the eyelids became more general, and a 2-year-old steer fell down and was unable to remain standing when helped up. By 4 o'clock 4 more animals were down, and by 6 o'clock 3 cattle were dead and 6 were unable to stand. The car floors had become slippery from the oil, and the cattle stood with difficulty during the irregular jerking of the train. All ticks had turned dark, and none were alive so far as could be ascertained.

During the early part of the night the cattle cooled gradually and were fairly comfortable, although a number of them, exhausted from the heat of the day, could not be induced to remain standing, and were consequently severely bruised by being trampled upon.

At 3 a. m. the following morning (July 24) the cattle were unloaded at Parsons, Kans., for rest, feed, and water; 5 were dead and there were 6 "downers." Owing to the lack of shade at the Parsons stockyards, the cattle were loaded again at 10 a. m. the same morning after each car had been rebedded with 200 pounds of straw. The cattle were tired and sore, and all ticks were dark, hard, and shriveled. The temperature was a little more moderate than the day before and many cattle remained lying down during the entire day. The irritation of the eyes did not increase, but some of the more thin-skinned animals showed wrinkling and reddening of the skin on the neck and the inside of the thighs. At 6 p. m. the cattle were unloaded at Sedalia, Mo., when there were 3 more dead and 1 "downer."

At 7 a. m. the following morning the cattle were reloaded, and, the weather being cool, they rode fairly well to Galesburg, Ill., where they were unloaded at 10 p. m.

On the morning of the 26th the weather was decidedly cool, and the cattle were loaded at Galesburg at 11.30 a. m. in the best condition since they left Fort Worth; 3 "downers" were left at Galesburg. The trip from Galesburg to Rockford, Ill., was without unusual occurrence. The train arrived at its destination at 9 p. m., and the cattle finished unloading at the Northwestern stock yards at 12.30 a. m., July 27, there being 4 "downers" on the last run.

SUMMARY OF THE REPORT.

Of the 311 cattle loaded at Forth Worth, Tex., 295 arrived at Rockford, Ill., 4 of which were unable to stand and all rather tired and sore. Eight cattle died en route and 8 "downers" were left behind. The casualties were principally caused by the extreme heat during the first day's travel and the confinement and discomfort incident to shipment.

Dr. Steddom's notes, added to the facts given above, show that the first practical test with dipping and shipping Southern cattle was

made under very unfavorable circumstances. First, the heat became intense, registering more than 100° F. in the shade at several places through which the train passed during the first day on its way north; second, a number of the cars were overloaded, not leaving sufficient room for the animals to lie down and rest; third, the distance shipped was exceedingly long, consuming more than ninety-six hours. That loss during transit was not entirely due to the effect of the dipping is shown by the fact that a train load of undipped cattle, which were shipped at the same time over the same road, but for a shorter distance, suffered a proportionately greater loss from the heat alone.

CONDITION OF CATTLE AFTER ARRIVAL AT ROCKFORD.

Two hundred and eighty-seven head were placed in five different pastures in the vicinity of Rockford, Ill., where the animals soon began to fill out on the rich blue grass, and when seen again, in the middle of August, most of them had recovered and looked even better than before they were dipped.

A careful examination, made in company with the State veterinarian and the live-stock commissioners of Illinois, showed that not a single tick had survived, and only a small number of shriveled ticks were found, all of which were loosely attached to the skin and dropped off when merely touched. Some of the cattle were covered on neck and shoulders with peeled-off epithelium, but most of them showed absolutely no indications of having been dipped. The swelling of the eyelids had entirely disappeared, and the skin was soft and flexible in all cases, though the dry flakes and scales gave it a bad appearance.

A number of native cattle had been placed with each lot of dipped cattle (altogether about thirty-eight head) and, as the pastures were not very large, there was every probability that if any of the ticks should mature and produce young ones they would have a chance at all times to get on the native cattle. In order to demonstrate that the dipped cattle actually harbored the Texas fever microparasite in their systems, a number of ticks were obtained from the pastures in Jack County, Tex., where the cattle shipped to Rockford had been raised. These ticks were forwarded to Rockford, where their eggs were permitted to hatch. The young ticks were placed on two native cows in the stock yards at Rockford, and in the course of twelve to fifteen days both cows developed Texas fever and died.

Two months later, on September 24, Dr. Steddom again visited Rockford, and under date of September 30 he reported that his inspection of the dipped cattle revealed the fact that all, both dipped and native, were in good health. The Southern cattle appeared to be thriving, as shown by glossy coat and marked general improvement over their condition prior to dipping. There were no ticks on any of the cattle, and parties in charge of the several herds reported that no living ticks had been found, and that there was no ailment or disease among the cattle.

CONCLUSIONS FROM FIRST ILLINOIS EXPERIMENT.

The conclusions to be drawn from the Fort Worth experiment are (1) that dipping cattle in a saturated solution of sulphur in extra dynamo oil will destroy all ticks on them in a single dipping, no matter what stage of development the ticks may have reached; and, (2) that Southern infested cattle may, after all ticks on them have been destroyed, be brought into uninfected territory during the warmest season of the year and placed in close contact with susceptible cattle without danger of transmitting Texas fever to the latter.

While these results were highly gratifying, there were, nevertheless, several undesirable features which must necessarily be eliminated before the dipping process can be considered an unqualified success. The first and most important of these features is the extreme heat, which evidently must be avoided at time of dipping, and, so far as possible, while the cattle are in transit.

TEST OF SHORTER DISTANCE OF TRAVEL.

In order to test the effect of shipment to a shorter distance, the Fort Worth Stock Yards Company arranged to dip two car loads of ticky cattle and ship them from Fort Worth to Midland, Tex., a run of about twenty-seven hours. Unfortunately, the cattle secured for this experiment were a lot of ordinary range stock in very poor condition. It was a foregone conclusion that losses would occur, as at least half a dozen of the 110 head were cripples, and many others were so weak that they could walk only with difficulty. It was concluded, however, that if this class of cattle were able to stand dipping and shipping for a short distance, all classes of cattle would be able to undergo the test. On September 3 the 110 yearlings were driven through the vat without any accidents, and were immediately loaded into two cars well bedded with both sand and hay. Dr. Kiernan, an inspector of the Bureau of Animal Industry, was placed in charge, and about 11 o'clock in the forenoon the train started. The cattle had been dipped in the morning, and it was noticed that before the train left every tick which could be seen on the cattle after they were loaded in the cars had shriveled and turned black. The dipped yearlings arrived at Midland the next afternoon between 2 and 3 o'clock, and all of them were unloaded in fairly good condition. Dr. Kiernan's report of this trip follows:

After the dipping the cattle were loaded into two clean, disinfected cars, well bedded with sand and straw. The train left Fort Worth at 11 a. m. on September 13, and arrived at Midland at 2 p. m. on the following day. It was noticed during the entire trip that the ticks were dying fast and falling off the cattle. The animals shipped well, and when they were unloaded at Midland showed no ill effects from either the dipping or the trip. The cattle were taken to a pasture about 2 miles from town, where they were watered, and all drank freely. The temperature was then 100° F. in the shade, and there was no shelter of any kind to protect the animals from the burning rays of the sun. An examination

of the cattle on the following morning (September 15) showed that nearly 50 per cent of the animals were free from live ticks, but the cattle seemed to suffer considerably from the intense heat. On September 17 two yearlings were found dead in the pasture, the death of one being due to an accident. An examination of the remaining 108 head showed 90 per cent of them to be free from live ticks, while 17 head still had a few discolored and shriveled but live ticks on them. On September 20 four more yearlings had died, and no live ticks could be found on any of the remaining animals. A large number, however, were stiff and considerably lame, and some of them seemed to be very weak in the loins. A number of post-mortem examinations showed inflammation of both the large and small intestines, and a general anæmic condition, but in no case was there found evidence that death was due to the effect of the dipping. In the course of the following two weeks 14 more head died, but it was a noticeable fact that the skin of many of these was not by far so severely affected as was the case with some of those which survived, which fact makes it difficult to attribute the deaths directly to the dipping.

The cattle, however, continued to die after their arrival, and when cold weather set in a large number of them succumbed. According to a recent statement by the owner, which was published in a local stock paper, there were at the time he wrote only 32 head alive, and some of them were not expected to survive the winter. From later reports sent in by inspectors of the Bureau and of local cattle inspectors, there can be little doubt that the greater number of these animals died from Texas fever. The appearance of this disease among native Texas cattle will be discussed later.

The conclusions to be drawn, therefore, are that weak and emaciated yearlings should not be dipped and shipped even for a short distance, unless precautions are taken to protect them against extreme climatic conditions. The death rate in this Midland experiment by far exceeds that of the Illinois experiment, although the distance the cattle were shipped in the latter case was nearly five times greater than in the Midland experiment. This proves conclusively that strong, vigorous cattle, such as those in the Illinois experiment, are better able to stand the dipping and subsequent shipment than weak, emaciated cattle.

SECOND ILLINOIS EXPERIMENT.

Notwithstanding these rather unfortunate results, the Illinois Board of Live Stock Commissioners decided to attempt another shipment of dipped cattle from Texas, and Dr. Page, of Rockford, again volunteered to purchase the cattle for the experiment. The cattle which had been dipped in July and shipped to Illinois had improved so rapidly in the northern pastures that Dr. Page was of the opinion that, with cooler weather in his favor, a second shipment might reimburse him for the loss which he sustained in the first shipment. Consequently he purchased at Jacksboro, Tex., 184 head of strong, well-bred yearlings and 2-year olds, all more or less infested with ticks, which were taken to Fort Worth. On September 24 they were dipped and immediately loaded in cars, well bedded with both sand and hay,

and shipped to Rockford, Ill. Upon arrival at Rockford 9 head were down and soon died; others were not expected to live. In the course of the following week some of these died, and, according to a statement made by the State veterinarian of Illinois, who made post-mortem examinations of them, all showed symptoms of acute Texas fever.

On October 10 the writer visited Rockford, when 24 head, mostly yearlings, had died. A number of the remaining cattle were found to be considerably stiff, with the epithelium peeling off the neck and shoulders, and two or three were so severely affected that they were expected to die. Owing to his heavy loss, Dr. Page decided not to destroy any of the animals for post-mortem examination, but promised in case any more should die to forward specimens of the organs to the laboratory of the Bureau of Animal Industry in Washington for examination. This promise he complied with a short time afterwards, when two more yearlings had died, making a total loss of 26 head. A microscopic examination of the organs proved the diagnosis of Texas fever to be correct, as all of the tissues contained an abundance of the microparasite of that disease.

As these cattle were all raised and bred in Texas, hundreds of miles below the quarantine line, and all were infested with Texas-fever ticks at the time of the dipping, there can be little doubt that they were what is ordinarily considered cattle immune to Texas fever. Experience teaches, however, that such immune cattle may develop the disease within their systems when their vitality has been reduced by unusual exposure and hardships; and when to this is added the mechanical and chemical irritation of the skin which follows dipping, it is not surprising that a number of the dipped animals developed Texas fever.

TEXAS FEVER EASILY DEVELOPED IN TICKY CATTLE.

As an instance of this disease developing among Southern tick-infested cattle, may be mentioned a shipment of several thousand head of Texas cattle to Colorado in the winter of 1897–98. The cattle, all of which came from below the quarantine line, arrived near Denver in the beginning of January, 1898, and were immediately exposed to a severe blizzard, which was followed by intensely cold weather. As a result of this, 40 per cent of them (more than 1,000 head) developed typical Texas fever and died. A microscopical examination proved the microparasite of Texas fever to be present in nearly 50 per cent of the red blood corpuscles. In this case the cattle had not been dipped, but simply exposed to an extreme change of climate.

In the same manner Southern tick-infested cattle may develop Texas fever in warm weather when their vitality is reduced by driving either too fast or too long. A bunch of nearly 300 head of tick-infested cattle from a ranch in Hidalgo County, Tex., on the border

of Mexico, was driven to Nueces County, Tex., a distance of about 120 miles, during very hot weather. The pasture from which these cattle were driven and the one to which they were taken belonged to the same man, who every year took cattle from the one to the other without ill effect. In this case, however (the summer of 1896), the cattle developed Texas fever, probably due to the excessive heat during the drive. More than 60 per cent became affected, and nearly 70 head died. These cattle had not been dipped either, and were generally considered immune to Texas fever, as the records of the ranch where they were raised show that cattle have been shipped from there to all parts of Texas below the quarantine line without any ill effect resulting.

These circumstances tend to prove that the great loss of cattle in the three dipping experiments above mentioned are more due to other causes than to the direct effect of the dipping, although the slightly irritating effect of the oil no doubt tends to increase the mortality. It is a noticeable fact that in a bunch of dipped cattle which have been exposed alike in every respect there may be a number which do not show the slightest effect of the dipping, except the loosening up of the old epithelium. Though this may give a bad appearance to the animal, it certainly is not injurious, except perhaps in cold weather, as the skin remains soft and flexible. On the other hand, a number of animals of the same breed, age, and condition may show a staring coat, arched back, and the skin closely attached to the underlying tissues. The inexperienced mind naturally forms the opinion that the hides of the animals are scorched to a crisp by the oil and sulphur, when the fact is that the animals are simply hidebound, a very common symptom of Texas fever.

DEGREES OF IMMUNITY.

These great variations in power of resistance to the effects of dipping with cattle of exactly the same breed, age, and condition can not well be ascribed to a constitution more or less strong, or to individual peculiarities, except when viewed from one standpoint, namely, the degree of immunity to Texas fever which each individual has acquired. The manner in which the Southern cattle become immune to Texas fever, that is, by being exposed to the infection in pastures infested with ticks, warrants the inference that, according to the degree of infection, the cattle, even in the same pasture, are immunized to a greater or less extent. At times the cattle in the infected territory may grow to be several years old without ever being greatly infested with ticks; in fact, in one pasture there will often be numerous animals without a single tick on them, while others will be covered. Experiments show that a single exposure to ticks does not make an animal completely immune to Texas fever, even if a severe attack of the disease is produced thereby, and experience teaches that the infection proper, that

is, the microparasite of Texas fever, is of highly varying virulence in different parts of the country. Take, for instance, the various shipments of Louisiana and Mississippi cattle into Texas during the spring and summer of 1897 and 1898, which caused outbreaks of Texas fever among the supposedly immune tick-infested cattle in Texas.

An explanation of this fact is only possible from the point of view that the microparasites harbored in the blood of the Mississippi and Louisiana cattle were possessed of a higher degree of virulence than the microparasites to which the Texas cattle had been exposed and to which their systems had adapted themselves, and when transferred to the latter by means of ticks the result was outbreaks of Texas fever among the native cattle in the heart of Texas. For this reason Texas quarantined against cattle from Mississippi and Louisiana.

We are consequently justified in believing that not all cattle in the same region are equally immune or resistant to the effect of the Texas fever microparasite; and as the dipping of nearly 20,000 cattle during the past fall and winter has demonstrated that a number of these supposedly immune cattle succumb to Texas fever, it is obvious that those which died were the least resistant to the disease. This theory explains how a large number of the dipped cattle remained perfectly healthy while many animals in the same bunch became stiff and hidebound after receiving exactly the same treatment. Those which had acquired perfect immunity, and whose systems were in condition to suppress the ever-alert microparasite in their blood, remained well, while apparently equally healthy and thrifty cattle which, either for want of sufficient exposure or from a constitutional deficiency in antitoxin-producing properties, were unable to restrain the development of the germ, became affected with Texas fever.

Similar conclusions have been reached in other countries. Dr. J. Sidney Hunt, pathologist to the Department of Agriculture in Queensland, Australia, in discussing the preventive inoculation for tick fever (Texas fever), writes as follows:

This increased resistance is often, for convenience, spoken of as immunity. It should be at once indicated, however, that by "immunity," in this connection, is meant only such a degree of increased resistance as to amount to *practical immunity under ordinary conditions*. It is perhaps open to question if absolute immunity is ever acquired by cattle against tick fever, for it is a common observation in Queensland that herds through which the disease has passed may, though still tick infested, be perfectly healthy on their own runs. Yet, when such cattle are subjected to the hardships of droving, especially in bad seasons, a certain percentage will sometimes succumb to the disease. Unfortunately, we do not in fact know whether such mortality occurs in consequence of fresh tick infection picked up on the stock routes, and affects only such animals as have for some reason previously escaped the disease, or whether it is in reality due to a second attack of fever brought out by fresh tick infection in animals that have, indeed, already had the disease, but have not thereby acquired the necessary degree of resistance to withstand a fresh infection under the trying conditions frequently encountered on the stock routes. Or, again, for all we know to the

contrary, the mortality may be due, not to any fresh tick infection at all, but to the direct effect of such adverse influences as exertion, privation, and exposure in rekindling, as it were, the fires of the fever which have been lying dormant in their blood, or, as drovers say, "in bringing out the disease." And if it can be definitely shown that droving in connection with, or apart from, fresh tick infestment brings out the disease in animals that are immune on their own runs, then we shall have to recognize two grades or degrees of immunity—station immunity and road immunity.

That the dipping and shipping experiments of this summer have definitely proven that Dr. Hunt's supposition is correct can not be doubted, as all possibility of a fresh tick infection of the dipped animals which were shipped to Illinois is excluded.

ANIMALS TO BE DIPPED SHOULD BE IN GOOD CONDITION.

Experiments with thousands of cattle during the last five years have shown that animals may be dipped in highly irritating solutions which all but remove the hair and epithelium without fatally injuring the animals if they are properly cared for afterwards; and recent experiments have shown that hundreds of cattle may be dipped in oil and sulphur without a single loss when care is taken not to reduce their vitality by excessively long shipment or driving immediately after the dipping.

At Mammoth Spring, Ark., near the southern border of Missouri, a dipping vat was built during the latter part of September, and subsequently more than 600 head of cattle were dipped without a single loss. Only in the case of one lot of 24 calves which were greatly emaciated and badly infested with ticks, and where the owner insisted on having the animals dipped, although he was told that they were not in a condition to stand it, did some loss occur.

REMOVAL OF RESTRICTIONS FOR DIPPED CATTLE.

In order to make it possible to transport dipped cattle across the quarantine line, an order was issued by the Bureau of Animal Industry under date of October 12, 1898, as follows:

It is hereby ordered that cattle originating in the district described in the order of December 15, 1897, and amendments thereto, which district is known as the quarantine district, may, after having been properly dipped, under the supervision of an inspector of this Department, in a solution of 86 pounds of flowers of sulphur to each 1,000 gallons of extra dynamo oil, be shipped without further restriction: *Provided*, That application be first made to this Department and permission granted to establish the dipping stations, and that after being dipped the cattle are certified by an inspector of the United States Bureau of Animal Industry, and that the cattle, when dipped within the quarantined district, be shipped in clean cars, without unloading within that district.

During the following weeks a large number of applications were received for the establishment of official dipping vats in the various States and Territories interested in this matter.

About the middle of October the Interstate Association of Live

Stock Sanitary Boards held a meeting at Omaha, Nebr., at which fourteen States and Territories were represented. At this meeting the writer of this paper gave a detailed account of the various experiments with the dipping of cattle which had been under his direct supervision. The dipping question was discussed in full and the objectionable features of it were explained at length. Owing, however, to the very favorable reports received from the dipping station at Mammoth Spring, Ark., where by that time nearly 1,000 head of cattle had been dipped without any casualties resulting, the meeting passed a resolution as follows:

Whereas the experiments recently conducted have demonstrated that Southern cattle dipped in dynamo oil saturated with sulphur will effectually destroy the Southern cattle tick, and that such cattle may be mixed with Northern native cattle without danger of communication of Texas, or Southern, fever; therefore,

Resolved. That the quarantine regulations may be amended with safety so as to admit dipped Southern cattle, on the certificate of a designated inspector of the State or of the United States Department of Agriculture, to the Northern States during any portion of the year.

OPERATIONS FOR THE SEASON OF 1898.

Several dipping plants were built and put in operation without awaiting the sanction of the Government; but a number of casualties which occurred among several lots of dipped cattle, greatly exaggerated by press reports, very soon cooled the ardor of those who wished to establish dipping plants for speculative purposes. Since the middle of December very few cattle have been dipped.

In Oklahoma and Indian Territory several dipping vats were built, and during October, November, and December, 1898, about 10,000 head of cattle were dipped in oil and sulphur, the estimated loss being a little more than 1 per cent, confined entirely to cattle in a poor condition. At the dipping station of the Fort Worth Stock Yards Company there were dipped between October 29 and November 26 nearly 3,000 head of cattle, and only in instances where the dipped cattle were exposed to severe cold and blizzards immediately upon their arrival at their destination did the owners suffer losses of any consequence.

In all there have been dipped more than 20,000 head of cattle, and so far as the Bureau of Animal Industry has been informed the total losses are less than 250 head, or about 1¼ per cent. These losses were in every instance due to the poor condition of the cattle, unusual exposure to extreme climatic conditions, or unnecessarily long drives or shipments. The only place where the dipping of cattle has been carried on regularly as an enforced measure against the introduction of ticky cattle is in Oklahoma Territory. Mr. R. J. Edwards, secretary of the Live Stock Sanitary Board for Oklahoma, in the First Biennial Report of the Oklahoma Live Stock Commission, says:

Approximately, about 8,000 head were dipped under supervision and in compliance with the regulations of this commission within the last four months. The

results were entirely satisfactory, from an experimental as well as practical and commercial standpoint. In some few cases where cattle were young and weak the dipping was attended with disaster, but where cattle were in good condition the results have been most satisfactory. Considerable complaint came from the owners of herds that were dipped, who, wherever any loss occurred subsequent to dipping, attributed the cause of death invariably to the dipping, with no allowance whatever for the injury the cattle might have sustained while in transit on railway cars or from the effects of sudden climatic changes. Investigation of all these complaints by our Territorial veterinarian as well as the agents and veterinarians of the Bureau of Animal Industry proved beyond question that in most cases the death of the stock could be attributed more to other causes than to the dipping. The heaviest losses occurred in herds of cattle that were in very poor condition, that had suffered greatly in shipment before being dipped, and that had come from a climate which was much warmer than Oklahoma. The loss among the local herds of cattle in good condition at the time of dipping was proven by actual computation to be less than one-half of 1 per cent.

CONDITIONS FOR SUCCESS OF THE DIPPING PROCESS.

It is hardly to be expected that a remedy may be found which in a single dipping will destroy all the ticks on an animal without having any injurious effect whatever. The tenacity of life of the ticks and their power to resist the effect of chemical preparations which may be applied to cattle in the form of a dip have been too well demonstrated to give much encouragement along this line. The ultimate success of the dipping process is probably to be looked for in the exclusion of weak and emaciated cattle from the dipping vats and in protecting the animals against extreme climatic conditions and all circumstances which may tend to reduce their vitality during the first week after dipping. In the meantime experiments will be continued in order to determine if the dipping fluid can be modified so as to reduce the injury to the stock without vitiating its tick-destroying properties. Until this is accomplished all dipping under official supervision has been suspended.

SUMMARY OF THE PAST YEAR'S EXPERIENCE IN DIPPING CATTLE.

(1) Tick-infested Southern cattle, if they have been entirely freed from ticks, may be shipped into the uninfected district and pastured for an indefinite length of time with susceptible Northern cattle without communicating Texas fever to them.

(2) Dipping tick-infested cattle into a saturated solution of sulphur in extra dynamo oil will destroy all the ticks on the animals in a single dipping, no matter what state of development the ticks may have reached.

(3) The loss of cattle resulting from dipping is insignificant when proper precautions are taken not to reduce the vitality of the animals through exposure, extreme heat, or otherwise.

(4) Weak or emaciated cattle are unfit for either dipping or shipping, and young animals suffer more than older ones.

(5) Pregnant cows should never be dipped, as the shock itself is sufficient to produce abortion.

(6) The dipping of cattle in oil and sulphur has a tendency to produce a recrudescence of Texas fever in animals which are only partially immune to the disease.

(7) The effects of dipping and hardships incident thereto are more or less severe on Southern cattle in direct proportion to their susceptibility to Texas fever.

(8) Dipping in oil and sulphur has but a slight irritating effect on the skin of Southern animals which are perfectly immune to Texas fever, and only causes desquamation of the dead epithelium, which during cold weather may make the animals more susceptible to the surrounding temperature.

GRASS SEED AND ITS IMPURITIES.

By the late GILBERT H. HICKS,
Former First Assistant Botanist.

DIFFICULTIES IN SECURING GOOD GRASS SEED.

Wide differences in soil, season, and climate in the United States make the problem of securing suitable grass seed for sowing a difficult one. In the case of no other kind of seed does the buyer rely more implicitly upon the statement of the dealer. The uncertainty of obtaining a first-class quality of grass seed is increased by the fact that there are comparatively few American seedsmen who consider their trade in such seed important enough to warrant the employment of an expert. The majority of seedsmen deal principally in the seeds of vegetables, and handle grass seed only to accommodate their customers. Such dealers are not able to give a critical opinion of their stock and must themselves largely depend upon the representations of those from whom it is purchased.

Vegetable seeds are grown with special care, weeds and inferior plants being pulled out by hand to prevent deterioration of the stock. Such growing is personally superintended by the seedsman, or one of his agents, who keeps a complete record of the product of each field, so that its pedigree can be traced at any time. A careful dealer possesses similar data to a great extent with respect to imported vegetable seed.

Grass seed, on the other hand, is often harvested from meadows in which different species are growing. Frequently these are "natural" or self-sown fields, and seldom are they free from weeds; seldom also is a field occupied by a single species of grass. Furthermore, most grasses mature their seed very unevenly, often beginning at the top of the seed stalk. This seed begins to rattle out as soon as ripe; hence, to secure as much of the crop as possible it is cut before all of the seeds are mature. Some of the immature seeds ripen after the crop is cut, but a large proportion are of no account and are blown out if the seed is properly cleaned. At the same time the empty glumes, or "chaff," are also removed. Usually, however, heavy blowing entails a considerable waste of good seed, necessitating a higher charge for the remainder.

Many persons prefer to buy their grass seed "in the chaff" on account of the supposed saving in price, thinking that by sowing a

slightly increased amount a deficiency in quality will be made up. This is a doubtful economy, since in most cases such grades contain a much smaller proportion of good seed than the buyer imagines. Not only this, but the large amount of immature grains, if they germinate at all, are scarcely able to push up through the ground, and under the most favorable circumstances usually produce very inferior plants. It always pays in the long run to purchase the very best seed, provided the prices asked are not really exorbitant. This rule is especially applicable in the case of grass seeds. But seedsmen often complain that there is little demand for certain varieties of grass seed from which, at great expense, the chaff and impurities have been removed, so that it does not pay them to keep such seed in stock even if it is possible to obtain it at all.

With the exception of a few of the more common species, such as timothy, June grass, and orchard grass, farmers, and many seedsmen, too, for that matter, are not sufficiently familiar with the appearance of the grass seeds of trade to tell whether a given sample is true to name or not. Besides this, there is so much uncertainty, even under favorable conditions, of a good stand of grass when sown in the field or lawn that few people really know whether or not their grass seed is what it is represented to be.

The object of this paper, which deals only with the principal grass seeds sold in this country, will be to point out the distinguishing marks, where such exist, between the different species, in such a way that anyone can decide as to their identity; also to give warning against the more common impurities, and to state briefly the essential qualities of good seed, in the hope that this information may be of some value to seedsmen as well as to those who wish to secure good meadows and lawns.

POINTS OF DISTINCTION IN SPECIES.

Grass seed as understood in commerce includes the seed proper and the envelopes which adhere to it in the marketed state. The differences by which the seeds are distinguished belong, accordingly, to several parts.

CHAFF.

Beginning at the outside, there are several thin, scale-like organs of papery texture, which in technical language are called glumes, and in common parlance are known as "chaff" (fig. 123). These are no part of the seed, but form a closely fitting and generally persistent envelope for it.

The scale on the inside of the fruit is much thinner than the others and is called the "palet" or "palea." Before the fruits become separated from the plant the palea lies next to the stem. It fits closely to the grain like a sheath, and by German botanists is sometimes called "sheath-glume." The glumes are attached to the bottom of the fruit

and are more or less free above. In such grass seeds as timothy and redtop and in wheat the chaff is easily removed by thrashing, but in the majority of the species most or all of the glumes remain attached to the seed in the commercial sample, as, for example, in the bromes, orchard grass, etc. These glumes serve to protect the tender, seed-like fruit within from injury; hence, the glume-covered seeds retain their vitality better than the naked ones of the same species, although they may germinate a little more slowly. The glumes are usually marked by one or more ribs or nerves running lengthwise, and these are often useful characters to aid in distinguishing closely related kinds of grass seed.

FIG. 123.—Fruit of upright chess (*Bromus racemosus*): *a*, *a'*, spikelet; *b*, *b'*, single fruit, inner face, showing pedicel, palet, and concave face of glume with awn; *c*, outer face of glume; *d*, *d'*, caryopsis or grain; *e*, pedicel—the small figures all natural size.

AWNS.

Sometimes a stiff bristle-like appendage called the "awn" projects from one of the glumes (fig. 123, *b*, *b'*, *e*), either at the apex, as in quack grass, or from the back, as in the oat grasses, or from the bottom, as in Deschampsia. By simply noting the place of attachment of the awn one can distinguish yellow oat grass, for instance, from wood hair grass, the former being a very expensive seed, while the latter is correspondingly cheap and commonly used to adulterate the seed of yellow oat grass.

STEM.

At the base of the seed on the front side there is a little pedicel or stem, by which the next seed or flower was originally attached

(fig. 123, *b*, *b'*, *c*). When the upper seed falls a clean-cut scar is left on the top of this pedicel. Although both the pedicel and its scar are small and apparently insignificant, close attention paid to them by buyers of grass seed would frequently enable them to distinguish between closely similar kinds and prevent the great loss which results from sowing inferior species.

GRAIN.

The kernel or grain which remains after the chaff is removed is the real fruit. It is usually known as a "seed," but in reality it is an intimate union of the seed with the thin outer covering of the fruit, and is technically called the "caryopsis" (fig. 123, *d*, *d'*). In nearly all common literature, however, the term "seed" is applied to the fruits of wheat, oats, and other grasses, inclusive of their outer coverings, when these adhere to the grain in the market product, there being no good word in the English language by which the caryopsis can be separately designated. In this paper, therefore, whenever the word "seed" is used it refers to the entire grass fruit just as it is found in ordinary trade.

Other points to be carefully noted in grass seeds are their shape, color, size, and surface (whether smooth or rough). Awnless brome, for example, is very flat and quite broad, while seeds of the other bromes are usually more or less compressed or "keeled." (See fig. 123, *a*, *a'*). Since various cheap or worthless species of brome grass are often found in trade, this character becomes a matter of great importance.

WEIGHT AS RELATED TO QUALITY.

The weight of a pint or bushel of a given species of grass seed is, within certain limits, an excellent index of its quality. Seedsmen depend largely upon this criterion, and use an apparatus known as a "chondrometer" for weighing samples which they intend to purchase. This apparatus is made of brass, and consists of an upright standard, upon which is suspended a horizontal arm, as shown in fig. 124. One side of the right end of the arm is graduated in English measure to show the number of pounds to the bushel, the other side indicates the number of kilos per hectoliter.

The bucket, holding a pint, is filled with seed without being shaken down. The top is leveled off with a wooden block and the crosspiece of the arm slid along until it balances the seed, when by referring to the scale the weight per bushel or kilo is ascertained. The chondrometer is manufactured in England and costs about $20. With proper care it will last a lifetime. Experiment stations, seedsmen, and farmers purchasing seeds in large amounts would find a chondrometer very useful. Weighing a sample pint of grass seed on any good scales will answer all practical purposes, however, and the knowledge obtainable thereby will be well worth all the trouble taken.

The weight of different kinds of grass seed varies widely, and this holds good even of the same species, within certain limits. Various factors affect the weight of seeds. Large seeds, as a rule, are heavier than an equal number of small ones of the same species, but the reverse is often the case if equal volumes are weighed, a pint of small seeds then outweighing the larger ones. This, however, depends principally upon the shape of the seeds.

The season and soil have a marked effect upon the weight of grass seed. In some seasons, for example, 14 pounds to the bushel would be considered a good weight for orchard grass, while 18 pounds may be expected in more favorable years. Wollny has shown that in seeds of uniform size the volume weight increases with a decrease in

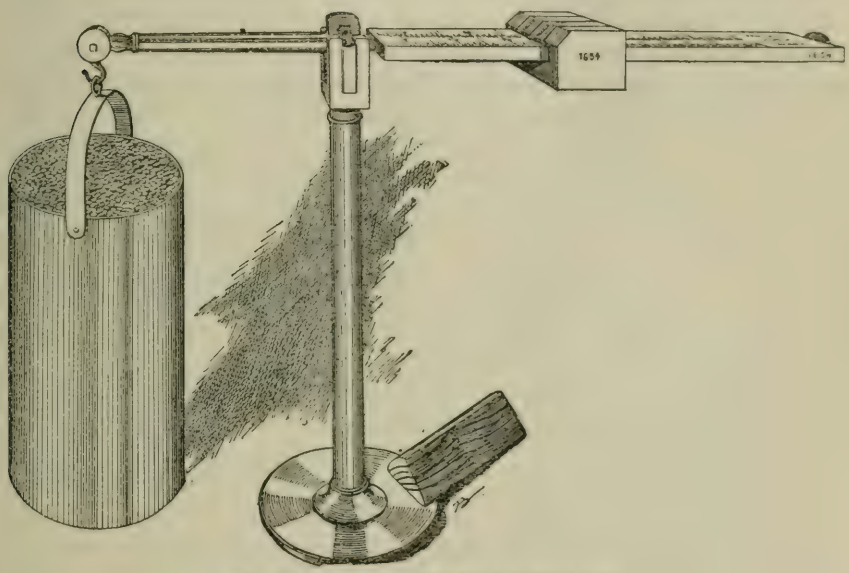


FIG. 124.—Chondrometer for weighing seed.

the water content. This varies greatly according to the manner of harvesting and storing, the weather, etc. Ordinary air-dry seeds are said to contain 8 to 12 per cent of water, but this amount is greatly increased if the seeds are stored in a damp place. According to the above, freshly gathered or immature seed would weigh less, volume for volume, than seed which had been thoroughly dried.

But the principal cause of light grass seed is the presence of a large amount of chaff. In cleaning grass seed the chaff should be blown out as much as possible, but this process necessarily wastes some good seed; hence, one who is cleaning the seed is apt to err on the side of safety, thereby retaining an undue amount of the chaff. There is no excuse, however, for chaffy seed except in those species, like redtop and the bent grasses, in which the glumes separate easily from the

seed after it has been cleaned. Ordinary redtop weighs from 12 to 14 pounds to the bushel, while "fancy," that is, chaff-cleaned seed of the same species, weighs 32 or even 40 pounds.

Seeds of the Poas, Kentucky blue grass, Canadian blue grass, etc., are characterized by woolly tufts of hair at the base (Pl. XXXIII, fig. 1), causing the seeds to cohere in irregular masses. These tufts are always rubbed off if the seed is properly cleaned. The seed in bulk is still very light. Unrubbed June-grass seed is often sold, the cheaper price being an inducement to the buyer. In reality, however, such seed is much dearer than that which is properly cleaned. Furthermore, the unrubbed seed, when sown, does not run so well out of the drill, and a poor stand results. The common trade standard of weight for Kentucky and Canadian blue-grass seed is 14 pounds to the bushel, but a good sample will sometimes weigh even as high as 24 pounds. By referring to the following table a purchaser can readily see whether his grass seed is of proper weight. He should bear in mind, however, that in unfavorable seasons such high-grade seed may not be on the market.

Standards of weight.

Name of grass.	Pounds per bushel.		Ounces per pint.	
	Good seed.	Extra fine seed.	Good seed.	Extra fine seed.
Awnless brome	13	14	3½	3¾
Bent, creeping	.....	20	5	.....
Bent, Rhode Island	.....	14	3½	.....
Bermuda grass	.....	35	8¾	.....
Blue grass, Canadian	14	24	3½	6
Blue grass, Kentucky	14	24	3½	6
Crested dog's-tail	20	28	5	7
Fescues (except meadow)	12	15	3	3¾
Fescue, meadow	22	24	5½	6
Meadow foxtail	6	8	1½	2
Meadow grass, rough-stalked	12	14	3	3½
Meadow grass, wood	12	14	3	3½
Orchard grass	14	18	3½	4½
Redtop, chaffy	12	14	3	3½
Redtop, fancy	32	40	8	10
Rye grass, English	24	28	6	7
Rye grass, Italian	18	24	4½	6
Tall meadow oat grass	10	13	2½	3¼
Timothy	45	48	11¼	12

VITALITY OF GRASS SEED.

No class of seeds on the market is likely to be of lower vitality than grass seed, especially the so-called "fancy" grasses, a term applied to those varieties which are not in common use. This lack of vitality may be due to any one or more of several causes, among which the

nature of the growing season and the method of harvesting are prominent. If a period of prolonged wet weather ensues when the grasses are in bloom, some of the ovules—the organs which develop into the seeds—will be imperfectly fertilized or not at all. As already explained, it is necessary to harvest the seed of many species of grass before it is all ripened, insuring a considerable proportion of imperfect and immature grains. Many of the rarer kinds of grass seed come from Germany, where they grow in woods and natural meadows. This seed is gathered mainly by women and children, who collect small quantities of each variety in sacks, the contents of which are afterwards brought together. Such seed is often allowed to "sweat," and, being finally stored in this half-dry condition, rapidly loses much of its vitality.

Bermuda grass is propagated largely by cuttings of its rootstocks. The seed ripens only sparingly in this country, and the imported seed often possesses a very low germinating power, due perhaps in part to improper storing during its ocean voyage. As at present marketed, Kentucky blue grass is considered of good quality if 50 per cent sprouts. Samples from Iowa were sent to the Department a few years ago which had been harvested and cured with considerable care. Of this seed, 90 per cent germinated without difficulty, showing clearly the possibility of securing a good vitality by proper management.

Most seeds are provided with a firm, closely fitting coat or skin, which sheds water to a large extent and helps to retain the vitality of the seed by protecting it against unfavorable external influences. The outer skin of the grass kernel, on the other hand, is usually very thin, and were it not for the chaff or glumes grass seed would lose its vitality much more quickly than it does. To illustrate this point, it may be stated that red-clover seed, if properly kept, will sprout very well when two or even three years old, while the germination of timothy seed can not be depended upon if it is more than one year old. Therefore timothy should be sown when perfectly fresh if the best results are desired.

Many kinds of grasses are naturally slow to sprout; hence, plenty of time should be allowed after sowing before they are condemned as nongerminable. In view of this fact, the planter should assure himself beyond a doubt of the vitality of every sample of grass seed he intends to sow; otherwise the loss of the time consumed in awaiting germination, added to the cost of the seed itself, will prove a great drawback to success.

There is probably no better way to judge a farmer than by his meadows and pastures. A consideration of the immense amount of capital invested in grass growing should serve to emphasize the importance to the farmer of knowing good grass seed from a poor article.

CLASSES OF IMPURITIES.

The impurities of grass seed may be divided into four classes, as follows:

(1) Inert matter, which usually consists mainly of chaff.
(2) Seeds of clover and useful grasses.
(3) Seeds of weeds.
(4) Seeds of inferior and harmful grasses.

The first class increases the cost of the seed, but is otherwise harmless; the second class is not objectionable if derived from useful forage plants adapted to the same soil and climate as the grass desired, except in case a pure meadow or lawn is wished or the grass is to be grown for seed purposes; the third class is very harmful, especially from the fact that weeds are much harder to eradicate from grass fields than from any other crop; the fourth class is the most dangerous, because hardest to detect and because the seed once sown may crowd out the good species. Impurities of this latter class are very common, and often, if not usually, the result of deliberate fraud. They are to be especially looked for in high-priced varieties or in any kind of grass seed which has yielded a small crop owing to an unfavorable season.

TYPICAL CASES OF POOR STOCK.

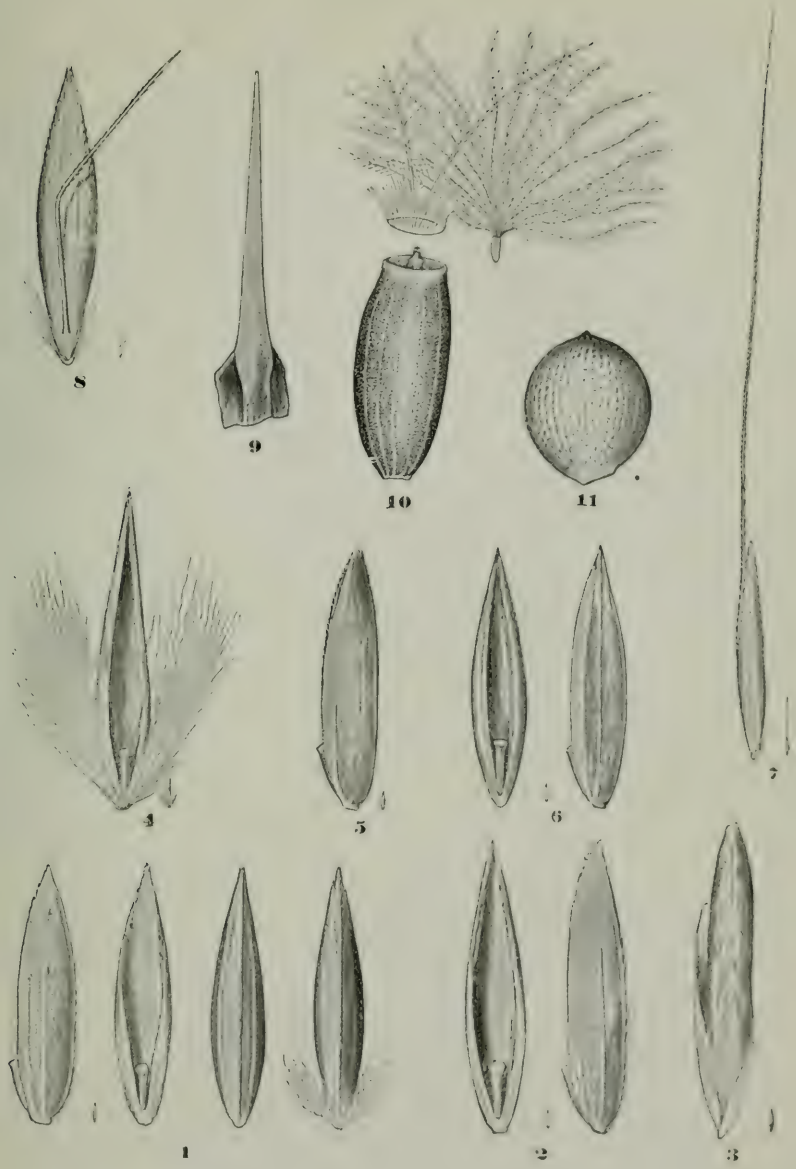
Every buyer of grass seed could give glaring examples of poor stock on the market. A few only will be cited, and those mostly from the experience of the writer. A sample of Canadian blue grass offered to the Department of Agriculture last year contained 11 kinds of foreign seed, principally weeds. Of 17 samples of this species examined for impurities, 15 contained seeds of Canada thistle or the spines, indicating the probable presence of this pest.

A sample of awnless brome was adulterated with meadow fescue, a much cheaper species, and entirely unsuited to the regions where the awnless brome is most desired. This sample also contained chess at the rate of over 5,000 seeds to the pound. Its poor quality was aggravated by the fact that only 19 per cent of the genuine seed sprouted.

A sample of crested dog's-tail grass from Germany was heavily adulterated with English rye grass. The latter seed may be bought at about $8 per 100 pounds, while the same amount of crested dog's-tail would cost from $35 to $60.

Another sample bought for Italian rye grass contained 20 per cent of other seeds, mainly perennial rye grass, one of the cheapest grass seeds on the European market, and a common adulterant of Italian rye-grass seed.

Meadow foxtail from Germany, offered to a dealer a few months ago for 30 cents a pound, contained only a little more than one-quarter



SEEDS OF POAS WITH IMPURITIES.

1, Kentucky Blue Grass (*Poa pratensis*), rubbed and unrubbed; 2, Wood Meadow Grass (*Poa nemoralis*); 3, Ergot; 4, Texas Blue Grass (*Poa arachnifera*); 5, Canadian Blue Grass (*Poa compressa*); 6, Rough-stalked Meadow Grass (*Poa trivialis*); 7, Silky Bent Grass (*Apera spica-venti*); 8, Wood Hair Grass (*Deschampsia flexuosa*); 9, Spine of Canada Thistle (much enlarged); 10, Canada Thistle (*Carduus arvensis*); 11, Stink Grass, caryopsis (*Eragrostis major*)—the small figures natural size.

(27.5 per cent) of the pure seed, the balance being about evenly divided between chaff and foreign seeds, principally English rye grass, worth about 10 cents per pound. Another sample of meadow foxtail from Germany contained 60 per cent of impurity.

A sample of awnless brome (*Bromus inermis*), offered to the Department of Agriculture for distribution last year, but rejected, contained 13 different kinds of grass and weed seeds, among others chess at the rate of 4,000 seeds to the pound. When tested for germination, this sample showed a vitality of but 16 per cent in place of the 75 to 80 per cent required by the standard for good seed.

Redtop seed offered as "fancy" at 18 cents per pound contained foreign seeds at the rate of over 283,000 to the pound! A sample labeled "Rhode Island bent" contained but 2 per cent of that species, 70 per cent being chaff, and 21 per cent seeds of another species of bent, while the balance (7 per cent) was dirt and weed seeds. Another sample bought for Rhode Island bent contained none of this species whatever, but consisted of 57 per cent of another species, 40 per cent chaff and dirt, and 3 per cent weed seeds, including 12 kinds. Similar examples could easily be multiplied if space permitted.

Some of the so-called "lawn mixtures" upon the market are the veriest frauds, consisting of a lot of inferior grass seed mixed with chaff and various impurities, practically the sweepings of the seed merchant, but invariably sold at the price of high-grade grass seed. A sample of lawn mixture purchased in a near-by market last year contained 45 per cent of impurity, principally chaff and dirt. Among the weed seeds present were sorrel, pigweed, three kinds of plantain, pepper grass, and stink grass. In general it is much better for the buyer to make his own lawn mixture, after consulting a reliable person as to the most suitable varieties for his case, and the proper proportions in which they should be used.

If a pure lawn or meadow is desired, no sample of grass seed should be sown which contains more than 1 per cent of other kinds of seed, and in no case should a sample contain as high as 1 per cent of weed seeds. Chaff, being merely inert matter, does no harm except to increase the cost of the seed.

The fact is, and this should be emphasized, that in none of the above cases, excepting perhaps that of the lawn grass, is it likely that the American dealer was aware of the inferior quality of the seed he had for sale. It had been offered to him by European seedsmen, in some instances at the highest market price, and seemed, on a superficial examination, to be good stock.

NECESSITY OF REGULATING IMPORTATION.

Considering the magnitude of the import trade in grass seed and the necessity of sending abroad for many of the higher-priced varieties, also in view of the multitude of dangerous weeds introduced in

foreign grass and clover seed, it would seem time that some method of seaboard inspection be adopted to prevent the introduction of the pests which frequently occur in foreign grass and clover seeds.

If American fruit be debarred from certain foreign markets until after it has been examined for the San Jose scale, and for various fungi, why should not American agriculturists be protected against the importation of dodder, ergot, Canada thistle, and many other equally troublesome plants? Leading American seedsmen recognize the necessity for some action of this kind, and have already urged the Department of Agriculture to aid in their protection.

In the absence at present of any compulsory system of Government inspection, the Secretary of Agriculture offers to test, free of charge, samples of grass and clover seed for intending purchasers, whether seedsmen or farmers, thereby warning them against undesirable impurities. It is to be hoped, however, as already intimated, that by the aid of the descriptions and illustrations which follow, the reader may be able to identify the different kinds of grass seed and their impurities for himself. The only apparatus needed in most cases will be a pocket lens, while the larger seeds can readily be determined by the unaided eye.

Description of Grass Seeds.

KENTUCKY BLUE GRASS.

Unless timothy be excepted, Kentucky blue grass, or June grass (*Poa pratensis*), is by far the most important grass seed in the American market. Fortunately for our farmers none of this seed is imported; hence, the only impurities to be expected are those which would naturally be found in the locality where it is grown. As the name indicates, the principal supply comes from Kentucky, Fayette and Bourbon counties being the centers of the seed-growing district. Within the last few years, however, it has been found that certain portions of Iowa, Illinois, and Missouri are also favorable to the production of this seed. There is a large export of Kentucky blue-grass seed from the United States to various parts of the world.

When harvested the seeds mat together in irregular masses, owing to the woolly tufts of hair at the base. (Pl. XXXIII, fig. 1.) By the process of rubbing, these hairs are removed, so that the seeds as usually found in trade are smooth. A brand is frequently offered known as "Extra cleaned," supposedly a superior article. On the contrary, seed of this brand has not been rubbed, hence can not be sown evenly. Furthermore, "Extra cleaned" June-grass seed usually contains a large amount of broken stems, chaff, etc., and is the poorest grade on the market.

Owing to its high price in Europe, the seed sold there is often adulterated with the seeds of cheaper grasses. Within the past year or

two attention has been called to a very serious fraud of a similar nature on this side of the water, which consists in the wholesale mixing of Canadian blue-grass (*Poa compressa*) with Kentucky blue-grass seed. These two kinds of seed are of about the same size and otherwise so much alike that it is very difficult even for an expert to distinguish between them. However, when Canadian blue grass is viewed from the side the back margin is seen to be straighter than in Kentucky blue grass; the nerves, also, of the latter are quite prominent, but are nearly or quite imperceptible in the former. (Pl. XXXIII, fig. 1.)

Seedsmen depend mostly on the color for identifying these species. When in bulk the seeds of Canadian blue grass are considerably lighter colored than those of Kentucky blue grass. The color, however, varies with age and is not a reliable means of distinguishing the two kinds of seed.

Nearly every sample of Canadian blue-grass seed thus far examined by the writer has contained either seeds or spines of Canada thistle, and, until closer study has been made, the presence of either of these impurities in a sample of Kentucky blue grass will probably serve as the most reliable indication of its adulteration with seeds of the Canadian species. These spines, however, are very small and easily overlooked. (Pl. XXXIII, fig. 9.)

While Canadian blue grass is valuable on dry and rather poor soils, especially in the New England and Middle States, it does not flourish on rich bottom lands, where Kentucky blue grass is generally sown for pasture. The genuine blue-grass seed costs, at wholesale, about twice as much as Canadian blue grass, which accounts for the frequent use of the latter by unscrupulous dealers to adulterate June-grass seed. It may be safely stated that not over 25,000 pounds of Canadian blue-grass seed is annually used in the United States for legitimate purposes, and that most of the seed which is imported in excess of this amount is used solely with fraudulent design. Canadian blue-grass seed is grown only in Canada, and prominent American seedsmen are agitating the necessity of strictly regulating its importation in such a way as to prevent fraud, which is now so common.

June-grass seed is generally harvested by means of a "stripper," which scrapes off the seed and part of the flower stem, leaving the remainder of the plant. Of the "fancy cleaned" seed, as it appears on the market, from 5 to 8 bushels per acre is considered a fair yield for Kentucky blue grass. After being stripped the seed is spread out in piles to dry and ripen, since much of it is immature at the time of harvest. In this ripening process the seed often becomes damp or heated, which largely accounts for the low vitality so common in the ordinary stock of trade. If June-grass seed is of a good quality, at least 50 per cent should germinate, but it is difficult to obtain this

vitality in the commercial seed. On the other hand, when extra care is taken in the harvesting and curing, June-grass seed will germinate as high as 90 per cent. If it were allowed to ripen thoroughly in the field a considerable amount would rattle out when harvested, entailing a loss which would necessarily greatly increase the cost of the seed. It is difficult properly to clean June-grass seed, and costly machinery is required for this purpose. In American-grown seed the principal impurities are seeds of sorrel, chickweed, plantain, and various sedges and other plants growing in low ground. Sometimes an ergot similar to that found in redtop (Pl. XXXIII, fig. 3) occurs in June grass. This is a very bad pest, and no seed should be sown which contains it. Timothy, redtop, white clover, and meadow fescue are often present, but these impurities are not objectionable unless June grass is to be grown for seed purposes. European seed frequently contains seeds of inferior wild grasses, such as the hair grasses (*Deschampsia flexuosa* and *D. cæspitosa*, Pl. XXXIII, fig. 8, and Pl. XXXVI, fig. 3), silky bent grass (*Apera spica-venti*, Pl. XXXIII, fig. 7), stink grasses (Eragrostis, Pl. XXXIII, fig. 11), etc. June-grass seed should show a purity of 90 to 95 per cent.

ROUGH-STALKED MEADOW GRASS.

The seed of rough-stalked meadow grass (*Poa trivialis*), which is adapted only to damp soils, is more expensive than that of Kentucky blue grass, and pure samples are much harder to obtain. It comes largely from Germany, near Hamburg, and the marshes of the Elbe. Denmark furnishes the best seed, but the foreign seed is apt to be heavily adulterated with Kentucky blue grass, which is not infrequently substituted entirely for rough-stalked meadow grass.

The seed (Pl. XXXIII, fig. 6) is very similar to that of Kentucky blue grass, the principal difference being the greater prominence of the lateral nerves in rough-stalked meadow grass. The seed also averages somewhat smaller and is more pointed, and the pedicel is usually longer and more slender. Rough-stalked meadow grass ripens very unevenly, which renders the collection of the seed extremely difficult, and seldom is the crop more than one-half as large as that of Kentucky blue grass. A purity of 90 per cent and vitality of 50 per cent should be required by purchasers of this seed. In addition to the seeds of cheaper Poas, blue pearl grass (*Molinia cærulea*, Pl. XXXV, fig. 2) is sometimes mixed with rough-stalked meadow grass.

WOOD MEADOW GRASS.

The seed of wood meadow grass (*Poa nemoralis*, Pl. XXXIII, fig. 2) is not sold in American markets, and, as in the case of rough-stalked meadow grass, pure stock is difficult to secure. It is quite easily distinguished from other commercial Poas by the hairy pedicel. The short hairs on the back margin of the outer glume at its base are also

TIMOTHY SEED AND ITS IMPURITIES.

1, Timothy (*Phleum pratense*) without and with the glumes; 2, Pepper Grass (*Lepidium virginicum*); 3, *Potentilla monspeliensis*, 4, Sorrel (*Rumex acetosella*); 5, Oxeye Daisy (*Chrysanthemum leucanthemum*); 6, Rib-grass Plantain (*Plantago lanceolata*); 7, Vervain (*Verbena hastata*); 8, Witch Grass (*Panicum capillare*); 9, Crab Grass (*Syntherisma sanguinale*); 10, Dodder (*Cuscuta trifolii*)—the small figures natural size.

useful in identification. Seed of wood meadow grass is often adulterated with that of cheaper Poas. A sample labeled *P. nemoralis*, sent to the Division of Botany for examination, contained none of this species whatever. Nearly 60 per cent proved to be seeds of Kentucky blue grass and 23 per cent of Canadian blue grass, while the remainder, 13.6 per cent, was made up of chaff, dirt, and various kinds of weed seeds, including Canada thistle.

This seed comes from Germany principally and is quite expensive. Wood hair grass (*Deschampsia flexuosa*, Pl. XXXIII, fig. 8) frequently grows along with it, hence should be looked for as an impurity, since it is almost impossible to separate the seeds of the two species by mechanical means. The standard of germination for wood meadow grass is 50 per cent, of purity 90 per cent.

The seed of Texas blue grass (*Poa arachnifera*) is sold to some extent in the Southern States on account of the excellent drought-resisting property of this plant. The seeds are easily recognized by the long tuft of wool at the base (Pl. XXXIII, fig. 4), which is much more pronounced than in any other commercial Poa, and does not rub off in cleaning. For this reason, however, it is very difficult to sow the seed properly, as it sticks together in irregular masses. The vitality of Texas blue-grass seed is very low; hence, the species is frequently propagated by root cuttings instead of by the seed. The latter sells for the enormous price of $3 per pound. So far as known, it is grown for commercial purposes only in the vicinity of Fort Worth and Durango, Tex.

TIMOTHY.

Timothy (*Phleum pratense*, Pl. XXXIV, fig. 1) is one of the best-known grass seeds in the market, and no dealer or farmer is likely to have any difficulty in detecting impurities therein. The color is silvery-white to gray, with a certain luster in fresh seed which is wanting in the old. Usually there is a considerable proportion of naked fruit in every sample, amounting in some cases to 50 per cent of the entire lot. These naked fruits are the best ripened and have a very high vitality when fresh. On the other hand, their vitality deteriorates more rapidly with age than that of the seeds which remain inclosed within the glumes. Timothy seed more than one year old usually possesses a very low vitality, while at least 90 per cent of the fresh seed should germinate.

The purity of American timothy seed is usually very satisfactory, 98 per cent being the present standard. In dry seasons, however, it often contains a good many seeds of pepper grasses (*Lepidium*, Pl. XXXIV, fig. 2), which are difficult to clean out, as they are very similar in size to timothy seeds. Cinquefoil seeds (*Potentilla monspeliensis*, Pl. XXXIV, fig. 3, and *P. canadensis*) are sometimes found in American timothy seed. Among other impurities present in

home-grown seed are sorrel (Pl. XXXIV, fig. 4), oxeye daisy (Pl. XXXIV, fig. 5), rib-grass plantain (Pl. XXXIV, fig. 6), vervain (Pl. XXXIV fig. 7), witch grass, and crab grass (Pl. XXXIV, figs. 8 and 9). European timothy seed is usually more impure than American, and sometimes contains ergot and dodder, two of the most dangerous pests ever found in a meadow. Clover seed often occurs in timothy, but does not appreciably lessen its value unless the timothy is to be grown for seed purposes. Owing to the difference in size, seeds of red clover are easily cleaned from timothy; but this is a much more difficult task in the case of white clover.

Timothy seed is exported in large quantities from the United States. In 1898 nearly 17,000,000 pounds were sent abroad. This was an exceptionally good year, however, and the average amount exported in the ten years ending June 30, 1897, was something over 9,000,000 pounds, with an average value of over $400,000. Five to 6 bushels per acre is considered a fair yield of this seed; 9 or 10 bushels is a large yield, although as high as 15 bushels per acre has been grown.

Timothy hay is of little value after the seeds have been removed by the present method of harvesting. Recent experiments by Mr. Henry Wallace, of Iowa, indicate that by making certain modifications in the process of thrashing, timothy seed may be harvested with a stripper, such as is used for June grass, so as to save a good portion of the stalks for hay and secure a good crop of seed at the same time. Timothy seed is grown in nearly all of the Western and Middle States of this country; eastern Germany and Austria also produce a considerable amount. Austrian timothy seed, however, frequently contains dodder.

ORCHARD GRASS.

Seeds of orchard grass (*Dactylis glomerata*, Pl. XXXV, fig. 1), resemble those of the Poas to some extent, but have no woolly hairs at the base; they are also much larger and taper to a sharp point. Fresh seed is of a light straw color. The lateral nerves show plainly, the surface is rough, and the margins of the glumes are provided with short bristle-like hairs. The pedicel expands quite abruptly at the top into a flat, oval disk, which readily distinguishes this seed from that of the rye grasses, with which it is often adulterated.

Frequently in commercial seed two or more fruits are found adhering to the stalk. This indicates immaturity, since well-ripened seeds come off separately when thrashed. Usually the glumes remain attached to the seed, but in some American samples deglumed seed occurs.

Owing to the excellence of this grass the seed is in great demand, and the United States exports a large amount to Great Britain and Germany. Kentucky, Kansas, and Ohio are the principal American States producing this seed. It is also grown to a considerable extent in New Zealand. The New Zealand seed is apt to contain velvet

SEED OF ORCHARD GRASS AND ITS IMPURITIES.

1, Orchard Grass (*Dactylis glomerata*), two seeds cohering, outer face, and single seed, inner face; 2, Blue [Pearl Grass (*Molinia cærulea*); 3, Tall Buttercup (*Ranunculus acris*); 4, English Rye Grass (*Lolium perenne*); 5, Italian Rye Grass (*Lolium italicum*); 6, Crested Dog's-tail (*Cynosurus cristatus*); 7, Velvet Grass (*Holcus lanatus*); 8, Bearded Darnel (*Lolium temulentum*); 9, Meadow Fescue (*Festuca pratensis*); 10, Soft Chess (*Bromus hordeaceus*)—the small figures natural size.

grass (*Holcus lanatus*, Pl. XXXV, fig. 7), a worthless species, which can not be cleaned out by ordinary methods, although a machine has been devised which is said to remove this seed perfectly. However, while seed of New Zealand orchard grass is considerably larger and finer looking than the American, the plants produced from it in this country are said to be much inferior.

German seed often contains large amounts of English rye grass, which is much cheaper, and in general not nearly so well adapted to the soils and climate of this country as orchard grass. In some years, owing to the scarcity and high price of orchard-grass seed, it is difficult to obtain a pure sample. In some cases the stock sold as orchard grass contains scarcely a good seed of that species, but, with the exception of some orchard-grass cleanings, is wholly composed of English rye grass. By comparing the illustrations of rye-grass seed (Pl. XXXV, figs. 4 and 5) with those of orchard-grass seed the differences in form and surface will be easily seen.

There is no worse adulteration of grass seed on the market than the one just cited, and it would be well for all intending purchasers of orchard-grass seed to inspect their samples carefully before buying. If there is any doubt as to its authenticity the botanist of the nearest experiment station or the Department of Agriculture should be consulted.

Foreign orchard grass is sometimes mixed with various fescues or blue pearl grass (Pl. XXXV, fig. 2). The latter is not only a worthless species, with a hard and woody stem, but is thought by some to be poisonous (Settegast). Foreign seed is also sometimes adulterated with crested dog's-tail (*Cynosurus cristatus*), which is not likely, however, to be found in imported seed, since it costs a great deal more in this country than the seed of orchard grass. Crested dog's-tail (Pl. XXXV, fig. 6) is quite similar to orchard-grass seed in shape and size, but being rougher and of a different color is easily distinguishable from the latter. Ergot is another serious impurity found in orchard-grass seed. Samples containing this pest should not be sown under any circumstances. Dock is a bad weed in fields of orchard grass in some places and should be carefully removed before the seed is harvested. Other impurities found in the seed sold in the markets are Kentucky blue grass, meadow fescue, pepper grass, and sorrel.

The seed of meadow fescue is somewhat similar in size and appearance to that of orchard grass, and in some years is extensively used in this country for adulterating the latter, since the seed of meadow fescue is usually very much cheaper in America than orchard grass. A careful study of the illustrations of the seeds of these two species (Pl. XXXV, figs. 1 and 9) will enable one to see the differences in shape without difficulty, the seeds of meadow fescue being quite blunt and flat while those of orchard grass are pointed and sharp-angled,

whence the former lie on the front or back while the latter lie on one side.

Orchard grass should be cut for seed when the glumes become straw-colored, and unless they are overripe the grains will not fall out very easily. Six to 9 bushels of seed per acre is considered a good yield in this country, although as high as 20 bushels per acre has been grown.

The poor quality of much of the orchard-grass seed in our markets is due largely to the fact that our best seed is exported on account of its high price, leaving to American farmers the scalpings, sievings, and blowings. A prominent seedsman states that no grass seed sold in America is willfully adulterated to a greater extent than orchard-grass seed. The English rye grass mentioned above as extensively used for this purpose is of very light quality, and costs but 1 cent per pound.

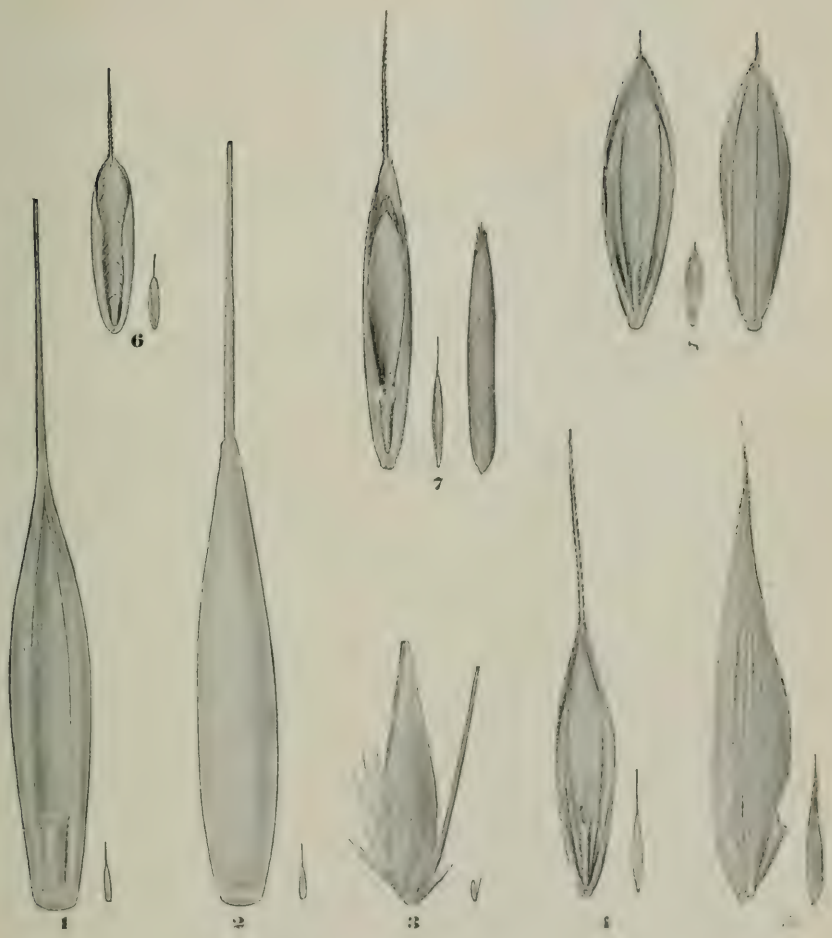
Owing to its importance and the difficulty of procuring pure seed, orchard grass should be purchased only from the most reliable dealers. The price quoted in 1898 by New York seedsmen was $2.50 per bushel of 14 pounds, or $17.50 per hundred. Good seed should show a purity of 90 per cent and a vitality of 75 to 80 per cent. Indeed, a prominent English firm guaranties to furnish orchard-grass seed germinating 90 per cent at a cost of 1 cent per pound higher than the ordinary seed of trade.

MEADOW FESCUE.

Meadow fescue (*Festuca pratensis*, Pl. XXXV, fig. 9) is one of the finest grass seeds on the American market. Eighty per cent of the samples tested in the laboratory of the Division of Botany have shown a purity of 99 per cent or more, and none have fallen below 97 per cent. Nevertheless, chess is not infrequently present in small amounts, and although such seeds are considerably larger than those of meadow fescue, it would be almost impossible to clean them out by machinery; hence, the only way to avoid them is to remove the chess from the fields before harvest. Other impurities to be found occasionally in small quantities are seeds of red and white clover, timothy, dock, smartweed, and foxtail grass.

Owing to the abundance and cheapness of American-grown meadow-fescue seed, it is never adulterated, but, on the other hand, it is sometimes used to mix with more expensive grass seeds, especially orchard grass. It is grown quite extensively in Kentucky, Missouri, and Kansas, less commonly in Ohio, and is exported everywhere. German writers are loud in their praise of the purity of American seed (which is infinitely superior to German in this respect), but they claim that meadow fescue from American-grown seed succumbs more easily to the cold and to fungous attacks in Germany than that raised from the German seed.

Two hundred pounds per acre is considered a fair yield of meadow-fescue seed, although 400 pounds has been reported. In unfavorable



SEEDS OF FESCUE AND BROME GRASSES.

1, Sheep's Fescue (*Festuca ovina*); 2, Red Fescue (*Festuca rubra*); 3, Tufted Hair Grass (*Deschampsia cæspitosa*); 4, Upright Brome (*Bromus erectus*); 5, Schrader's Brome (*Bromus unioloides*); 6, Chess (*Bromus secalinus*); 7, Hairy Brome (*Bromus asper*); 8, Awnless Brome (*Bromus inermis*)—the small figures natural size.

seasons, such as 1898, the yield may decrease to 60 or 70 pounds per acre. Owing to the tendency to rattle out when mature, the seed should be harvested with care. While the export trade in this seed has generally been excellent, there has been an overproduction in the United States in recent years, causing the price in Europe to drop considerably; hence, it would be undesirable for American farmers to increase their acreage in meadow fescue for seed purposes.

The European seed is frequently adulterated with English rye grass, which costs abroad only one-half as much, and is very similar to meadow fescue in form and size. It can generally be distinguished by the difference in shape of the pedicel, which in meadow fescue is slender and nearly cylindrical, the top being abruptly expanded into a disk (Pl. XXXV, fig. 9). In the rye grasses the pedicel is thick, rather flat, increasing slightly and gradually toward the top (Pl. XXXV, figs. 4 and 5). Blue pearl grass (Pl. XXXV, fig. 2) is also sometimes used to adulterate foreign seed of meadow fescue. Good seed should be at least 95 per cent pure and should germinate 90 per cent.

SHEEP'S FESCUE.

Sheep's fescue (*Festuca ovina*, Pl. XXXVI, fig. 1) is highly recommended for poor, sandy soils, hence is in considerable demand. The seed is much smaller than that of meadow fescue, is narrow, pointed, and tipped with a long awn, which is rough and bristly, as is also, usually, the upper part of the back glume. The pedicel is often hairy, but different individual seeds from the same lot vary greatly in respect to surface. The seed of hard fescue (*Festuca duriuscula*), various-leaved fescue (*Festuca heterophylla*), and red fescue (*F. rubra*, Pl. XXXVI, fig. 2) are so nearly alike that an expert can hardly tell the difference. Sheep's fescue is easily obtained and is rather cheaper than the other kinds enumerated, except meadow fescue. It comes from Germany, and is often mixed with wood hair grass, which is practically worthless for meadows or grazing. Wood hair grass is easily distinguished from all the fescues by the transparency of the upper part of the glumes, prominent tuft of hair at the base, and long, bent awn, which starts at the base of the seed (Pl. XXXIII, fig. 8) instead of being an extension of the apex, as in the fescues. Blue pearl grass and *Vulpia bromoides*, both worthless species, also occur in some samples of sheep's fescue. The seed of *Vulpia bromoides* is very similar in appearance to fescue, but is tipped with an awn which is twice as long as the body of the seed, none of the varieties of fescue in trade having awns longer than the body of the seed. Sheep's fescue should have a purity of 85 per cent.

RED FESCUE.

Professor Stebler, director of the Zurich Seed Control Station, states that less dependence is to be placed on the genuineness of samples of

seed sold under the name of red fescue (*Festuca rubra*, Pl. XXXVI, fig. 2) than of any other species. Red-fescue seed is quite expensive and all imported, mostly from Germany. The principal impurity is wood hair grass. Other impurities sometimes occurring are seeds of blue pearl grass, orchard grass, June grass, velvet grass, meadow fescue, English rye grass, and *Vulpia bromoides*. Red fescue seed should have a purity of 80 per cent. Various-leaved fescue is a variety of red fescue, and the seeds can not be distinguished with certainty.

ENGLISH RYE GRASS.

English rye grass (*Lolium perenne*, Pl. XXXV, fig. 4) is not a native of North America, but was introduced from England, where it has been cultivated for more than two hundred years. Lately it has come into use in the Western States to sow with alfalfa for mixed hay. It seeds freely, and the seed is easily harvested and cleaned. The heaviest crops of seed are from heavy loam and clay soils, but sandy soils, when moist, give good crops. The seed is usually taken after cutting for green fodder, but can be taken from the first crop. If the former method is adopted, the first cutting must take place early, when the grass is about hand high, or the seed crop will be delayed too far into the autumn. It is very important to watch for the proper stage of ripeness, because the completely ripe grain easily falls out, and a large loss will result. The harvesting takes place when the glumes are straw yellow and the stems are still green. The grain at this period is of a leathery consistency, but not hard, and can be readily indented with the finger nails. Most of this seed comes from Ireland and Scotland, where it is grown extensively. According to Sprengel, an average crop of seed is 530 pounds to the acre, but according to Werner 260 to 350 pounds of seed may be obtained, besides 2,000 to 2,800 pounds of hay.

The false fruit or commercial seed (Pl. XXXV, fig. 4) is long, elliptic, of a dirty straw color, and from half as long again to twice as long as the grain which it incloses. The back of the seed is rather faintly marked with five nerves, which become more distinct toward the blunt apex. The edges of the flowering glume are inrolled, covering the edges of the inner glume or palea. The seed is about 7 millimeters long by 1½ millimeters wide, the grain averaging about one-half this length. The pedicel is about one-third the length of the seed, gradually enlarging toward the top, and flat triangular in cross section.

The cheapness of this seed makes adulteration unprofitable, although it is much used to mix with more expensive seeds, as orchard grass. The principal impurities are Italian rye grass (Pl. XXXV, fig. 5), meadow fescue, and velvet grass.

English rye grass is readily distinguished from Italian rye grass by the awns on the latter. When these are absent or broken, the curved

back of Italian rye grass serves to distinguish it. The curvature of the back causes the seed to lie on its side, while the seed of English rye grass always lies flat. Italian rye grass is not used as much as English. Not being so permanent a grass, it is of less use for pastures. The best seed comes from France, and much is also imported from England and Scotland. This seed is not so pure as English rye grass, being frequently adulterated with the latter. It also contains tall buttercup (*Ranunculus acris*, Pl. XXXV, fig. 3), creeping buttercup (*R. repens*), rib-grass plantain (*Plantago lanceolata*, Pl. XXXIV, fig. 6), sorrel (*Rumex acetosella*, Pl. XXXIV, fig. 4), *Vulpia bromoides*, and soft brome (*Bromus hordeaceus*, Pl. XXXV, fig. 10). Both English and Italian rye grass should show a purity of 95 per cent.

AWNLESS BROME.

This comparatively recent introduction (*Bromus inermis*) gives promise of being valuable, especially west of the ninety-fourth meridian. The seed has up to recent years been exclusively imported from Europe and Asia, and several tons of foreign seed have been distributed by the Department of Agriculture during the past year. It is, however, being grown for seed in Texas and Colorado, and there seems to be no reason why it should not be much more extensively grown in the near future. The high price of the seed, which is at present quoted at from $9 to $10 per 100 pounds, will make awnless-brome seed a profitable crop for a few years at least. The seed sold so far has been pretty free from adulterations, but some cases have come to our notice in which the amounts of foreign seed present seemed to indicate intentional mixture. There is plenty of opportunity for such fraud, at any rate, and the purchaser will do well to carefully examine the samples offered. The principal danger at present lies in the introduction of weeds with the imported seed. The seeds of a number of plants whose possibilities as weeds are not fully understood have been observed in the imported seed, and the farmer who plants awnless brome should send to his experiment station or to the Department of Agriculture any strange plants found in his field.

Awnless-brome seed (Pl. XXXVI, fig. 8) is dark-colored, flat, and thin, 8 to 9 millimeters long by 2.5 to 2.25 millimeters broad. The back of the seed is of a lighter color than the front, and is marked with three large and four less prominent ridges. It is largest near the apex, and tapers down to the narrow base. The pedicel is slender, about one-fourth to one-third as long as the seed, and hairy. The impurities are meadow fescue, English and Italian rye grass, and chess. These are all easily distinguished from awnless-brome grass. The seeds of chess (*Bromus secalinus*, Pl. XXXVI, fig. 6), differ by usually being awned and by being not so flat, lighter colored, and provided with a row of bristles on each edge of the inrolled glume.

The seed of other brome grasses may be expected to appear in

samples of awnless brome if the high price of the latter continues. Chief among these is soft brome (Pl. XXXV, fig. 10). This worthless grass seeds freely and is cheap; consequently it is already used extensively to adulterate other grass seeds. The seed of soft brome is 7.5 to 8 millimeters long, with an awn nearly as long as the seed itself. The outer glume is much broader than the inclosed grain, and the edges of the glume are translucent. Awnless brome should yield at least 300 pounds of seed per acre. Twice as much has been obtained. The seed is harvested when the spikelets have a violet tint. The figures of the various species of brome will give a good idea of the differences between them. (See Pl. XXXVI, figs. 4 to 8.) Awnless brome should be 90 per cent pure.

MEADOW FOXTAIL.

Meadow foxtail (*Alopecurus pratensis*) is a native of Europe, and has been introduced to some extent into New England and the Middle States, where it is used to mix with other grasses for permanent pasture. Its use is probably hampered by the low vitality of the seed, which seldom germinates more than 50 per cent, and usually much lower. Of twenty-one samples tested by Nobbe, the highest germinated but 17 per cent. The principal cause of the low germination is the uneven ripening of the seed. This necessitates cutting many of the stalks before the seed is ripe. The best practice is to strip the ripe stalks one by one and to spread the seed in an airy place to dry, stirring it carefully every day for eight to ten days. If this is neglected, the vitality will be still further lowered.

Meadow foxtail is raised to some extent in southern Maine and northern Massachusetts, but is not grown on a commercial scale in the United States. The seed is imported from Europe, the best being raised in Finland. A great deal also comes from Denmark. Meadow-foxtail seed (Pl. XXXVII, fig. 1, 5) is 5 to 6 millimeters long by 2.5 to 3 millimeters broad. It is flat, ovate, loose in the glumes, and silvery gray or ash gray in color. The light, whitish color so esteemed by some is undesirable, because it indicates immaturity. The seed has a soft feeling, due to the covering of fine hairs. The edges are also provided with a fringe of long silky hairs. The outer glumes are united for the lower one-third of their length, and from between their upper parts a bent and twisted awn projects. This awn is attached to the base of the inner glume.

The purity of this seed is often low, samples containing much chaff and being frequently adulterated. A purity of 80 per cent should be required, however, as the presence of foreign seeds is usually the result of intentional mixture. Tests in the laboratory have shown the presence in some cases of more than 35 per cent of English rye grass. The seeds of velvet grass (Pl. XXXV, fig. 7) and creeping soft grass (*Holcus mollis*, Pl. XXXVII, fig. 1, 7) are also frequent impurities. These are readily distinguished when in the glumes by

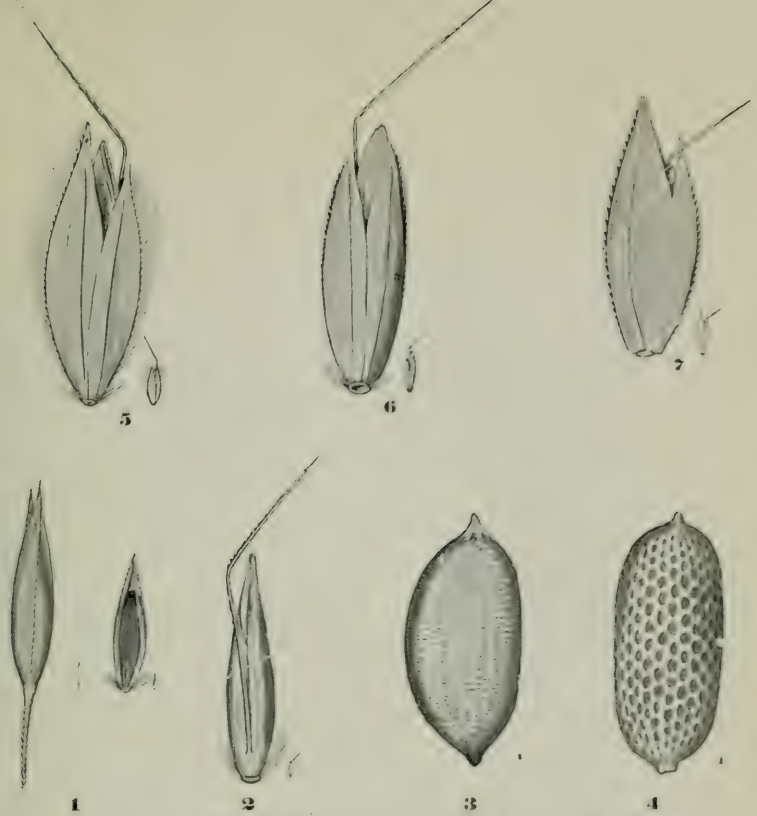


FIG. 1.—SEEDS OF AGROSTIS AND ALOPECURUS WITH IMPURITIES.

1, Redtop (*Agrostis alba*); 2, Rhode Island Bent (*Agrostis canina*); 3, Slender Rush (*Juncus tenuis*); 4, Canadian St. John's-wort (*Hypericum canadense*); 5, Meadow Foxtail (*Alopecurus pratensis*); 6, Slender Foxtail (*Alopecurus agrestis*); 7, Creeping Soft Grass (*Holcus mollis*)—the small figures natural size.

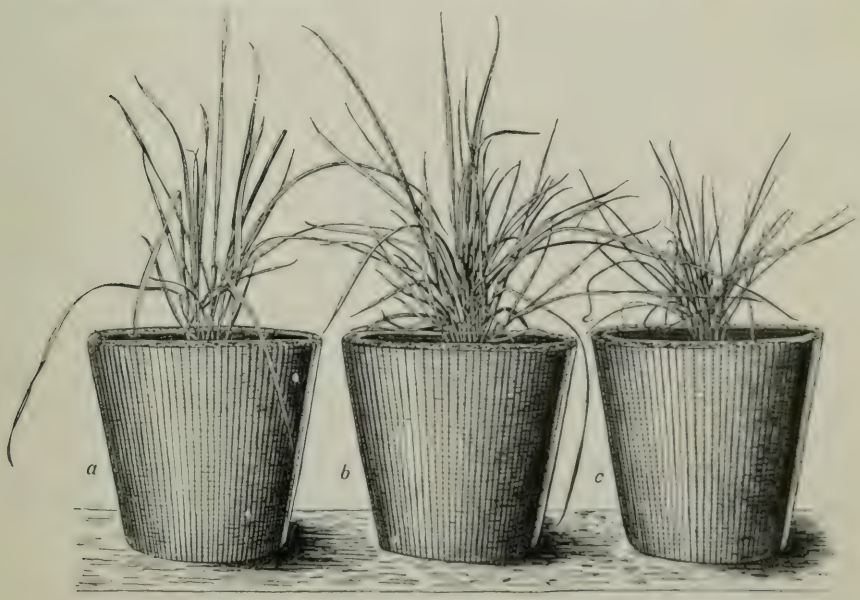


FIG. 2.—SEEDLINGS

a and *b*, Creeping Bent (*Agrostis stolonifera*); *c*, Rhode Island Bent (*Agrostis canina*).

the absence of long hairs on the edges and by the fact that the glumes are not united near the base, as is the case in meadow foxtail. Since the commercial seed is always in the glumes, this distinction is sufficient. But even when the glumes have been removed the difference is still clear. The grain of foxtail falls out of the glume naked and is brownish yellow in color, while that of both species of Holcus is inclosed in a delicate silvery white inner glume. The seed of slender foxtail (*Alopecurus agrestis*, Pl. XXXVII, fig. 1, *6*), a common weed abroad, is also used to adulterate meadow-foxtail seed. This, too, can be easily told by the absence of the long hairs on the edges of the seed.

According to Stebler, 6.21 pounds of pure and germinable seed should be sown per acre. The actual amount of commercial seed used will depend upon the purity and vitality of the sample. Much injury is wrought to this seed in Germany by a species of thrips (*Thrips cerealium*). This pest also occurs in the Eastern United States, but so far has not been considered dangerous. The attempt to grow foxtail for seed might, however, be seriously hampered by the ravages of this insect.

REDTOP OR HERD'S GRASS.

Redtop (*Agrostis alba*, Pl. XXXVII, fig. 1, *1*) has a nearly worldwide distribution, growing especially well in damp climates and on low, wet ground. Its chief value is as a pasture grass, although it is used for hay and also makes excellent lawns. Redtop seed is largely raised in Illinois and is exported to all countries. The fact that the seed is home grown enables the dealers to furnish purer seed than is usually the case with the imported article. Two principal grades are sold, "Fancy silver" and seed in the chaff. The "Fancy silver" should have a high percentage of purity. As high as 90 per cent may be expected. In the other grade there is always a great deal of chaff, and 60 per cent is a fair standard. The principal impurities besides chaff are timothy, horseweed (*Erigeron canadensis*), slender rush (*Juncus tenuis*, Pl. XXXVII, fig. 1, *3*), Saint John's-wort (*Hypericum canadense*, Pl. XXXVII, fig. 1, *4*), and yarrow (*Achillea millefolium*).

Redtop should yield from 10 to 20 bushels per acre of seed, and more has been obtained. The seed (Pl. XXXVII, fig. 1, *1*) is a small reddish grain inclosed in a silvery white, translucent glume. The glume is about one-fourth again as long as the grain and has a tuft of hair at the base, which is, however, often rubbed off in cleaning. The seed of this species is slightly larger than that either of creeping bent or of Rhode Island bent, but otherwise is indistinguishable except that the awns of Rhode Island bent, if not broken off, furnish a good characteristic for identification (Pl. XXXVII, fig. 1, *2*). The outer glumes of redtop come off easily, and in chaffy samples will make from 30 to 60 per cent of the weight. In the "Fancy silver" grade the chaff has been blown out.

BENT GRASSES.

Creeping bent (*Agrostis stolonifera*) and Rhode Island bent (*A. canina*) are much prized for lawns. The seed of creeping bent is largely imported, and is always very chaffy. A purity of more than 50 per cent can scarcely be expected. The most common impurities other than chaff are tufted hair grass (*Deschampsia cæspitosa*, Pl. XXXVI, fig. 3), which is often used as an adulteration, silky bent grass (Pl. XXXIII, fig. 7), slender rush (Pl. XXXVII, fig. 1, *3*), horseweed, and sorrel, although seeds of other weeds frequently occur. Creeping-bent seed is sometimes sold under the name of Rhode Island bent. The perfect seeds of the two species are quite different, that of the latter (Pl. XXXVII, fig. 1, *2*), having a bent awn attached near the base of the inner glume. This awn is about twice the length of the seed, twisted in its lower half and then abruptly bent nearly at right angles. These awns are frequently broken off, and in that case the seeds can not be easily distinguished from those of creeping bent or redtop. The presence of many awns in samples of creeping bent may be taken as an indication of the presence of Rhode Island bent. Creeping bent is never grown for seed, the seed being collected from plants growing wild in the forests of Germany.

Rhode Island bent grass is grown for seed to some extent in Rhode Island, but most of the seed is imported. Like that of creeping bent, the seed is usually chaffy, 50 per cent being a fair purity standard. It is frequently mixed with creeping bent, the entire sample being sometimes of this species. Besides this the principal impurities are slender rush, chickweed, Mayweed (*Anthemis cotula*), oxeye daisy (Pl. XXXIV, fig. 5), and yarrow. As stated above, the seed is easily distinguished from that of creeping bent when the awn is present, but is otherwise indistinguishable. A ready means of determining the relative purity of a sample is found in the seedlings. The seeds sprout a few days after planting, and soon the difference is apparent. The seedlings of Rhode Island bent have narrower and finer leaves than those of creeping bent or of redtop, and the habit of the plant is more slender and delicate than that of either of the other species. Seedlings of Rhode Island bent and creeping bent are shown in Pl. XXXVII, fig. 2.

THE SOLUBLE MINERAL MATTER OF SOILS.

By Thomas H. Means,
Assistant in Division of Soils.

If a piece of granite be exposed to the weather for a long time, changes will be noticed gradually taking place. The rock will whiten and finally fall to pieces, leaving a coarse powder without the slightest resemblance to the original rock. If the rock is weighed, it will be found that some of the material composing the rock has disappeared. This process of the breaking down of rocks has been going on for ages unnumbered, and to-day nearly all of the rocks are covered with a layer of rock powder or soil. While the rock is breaking down, or weathering, as it is termed, mosses and lichens begin to grow, and, as they die and give place to other plants, their remains decay and leave in the decomposing rock the black coloring matter which is called organic matter, and which in certain stages of decomposition is called humus. When the rock is all broken down and the organic matter, together with the humus, is mixed with the rock powder, there remains what is termed a soil.

WEATHERING OF ROCKS AND FORMATION OF SOLUBLE MATTER.

Many chemists have studied this weathering of rocks and the formation of soils, and all of them agree that in the process large quantities of the materials in the rocks are so changed by the weathering that they are rendered more or less soluble in water; then as the rainfall penetrates the rock and the rock powder, this soluble matter is gradually dissolved and washed out, accounting for the loss in weight of the decomposing granite.

Dr. George P. Merrill, of the United States National Museum, has examined a large number of rocks and soils, and has determined that rocks lose by solution from 10 per cent to as much as 98 per cent of their weight in passing from the solid rock to soil, that is to say, in the formation of an acre of soil 1 foot deep from 200 to 86,000 tons of the rock are removed by solution.

Rocks are composed of various materials, some of which in decomposing or weathering yield large quantities of soluble matter, while others yield little or no readily soluble matter; so that the rock is not dissolved as a whole, but the chemical action of weathering so changes some minerals that parts of them are made soluble. Thus feldspar, a common constituent of many of our rocks, is not soluble in water,

but as weathering goes on under the atmospheric conditions, the mineral whitens, breaks down, and the insoluble kaolin (clay) and silica (sand) are left, while potassium carbonate is washed out in solution. On the other hand, quartz, the most common of all minerals, does not change during the weathering, but simply breaks up into finer particles of sand, very little of which is removed by solution.

SOLUBLE MATTER IN SOILS.

With the formation of the soil this process of solution and removal does not cease, but as long as water is in contact with the soil grains there are chemical changes taking place and salts are being dissolved. Pure water will dissolve as much as 1 per cent of some of our soils, but the average amount dissolved will be much less than this, probably nearer one-tenth of 1 per cent.

The soils, like the rocks, are composed of various materials, and the water dissolves these just as it did the minerals of the granite. Some of the minerals contain plant food, some do not, and when all of the minerals containing plant food are dissolved and washed away, the soils become sterile and will not support plant growth. Plants need only a very small amount of mineral food at one time, but this small amount must be supplied throughout the growing season.

A number of chemists have made chemical analyses of the matter dissolved by water in various soils. They have shown that all of the minerals are more or less dissolved by the water, and that the solutions contain all of the mineral ingredients of a plant. The important plant foods, phosphorus, nitrogen, and potash, are present in small quantities in the solution, while lime is present in a much larger quantity in most soils. Should the plant foods be present in solution in large quantities, the first heavy rain would wash all out that were dissolved, and their value would be lost. The examination of large numbers of samples of drainage water has shown that phosphoric acid and potash are only washed out in small quantities, while nitrogen is removed nearly as fast as formed within the soil.

ABSORPTION OF SALTS.

It was noted many years ago that a soil possessed the property of decolorizing solutions and of rendering foul water pure. This is well illustrated in our common custom of digging wells; the deeper the well the purer the water and the less liable to contamination from surface impurities. This simple fact of the power of sand or soil to take the coloring matter out of manure extracts was noted by chemists, who found, on further examination, that the phenomenon was much more general and of a far larger interest than was first supposed. It has been found that all soils possess this property to a greater or less extent. They remove soluble matters from solution and gradually release them again, so that at no time is any large

quantity of matter present in solution. When a solution of potassium nitrate is poured through a soil the potassium is in a large measure absorbed and retained, while lime takes the place of potash in solution and is washed out as the nitrate of lime. Soils, in other words, decompose the salts and retain the alkaline portion (potash, soda) with the phosphoric acid, while the acid portions (nitric, muriatic, sulphuric, etc.) are removed with part of the alkalies and lime.

The great importance of this fact to the agriculturist can readily be seen. When a mineral fertilizer is applied to a soil, instead of being all dissolved and remaining in solution to be washed down into the subsoil by the first heavy rain, the plant foods are absorbed by the soil and gradually supplied for the use of the plant roots.

During a study of the soluble matter of soils in the Division of Soils several new methods and new apparatus have been used, and the results obtained have been of much interest to those engaged in agricultural research as well as to the practical agriculturist.

CLASSIFICATION OF SOLUBLE MATTER.

The soluble matter of soils may be classed under two general heads, (1) soluble mineral matter and (2) soluble organic matter. Under the first head are classified all salts and soluble compounds derived from the decomposition of rock or mineral parts of the soil. Under the second head are classified all soluble matter derived from plant and animal remains. The study has been confined almost entirely to soluble mineral matter, and only this class of soluble matter will be considered here.

There are three conditions in which a salt can exist within a soil, (1) insoluble; (2) soluble; (3) absorbed—physical and chemical absorption. Of these three conditions the first, in which the salts are insoluble, is of importance as a reserve, for there exists in this condition all of the undecomposed minerals with their stores of plant food. The term insoluble is used in a relative sense, for all the minerals are soluble in water to a slight degree. These minerals are constantly being decomposed, thus yielding their store of plant food in a more available condition for plant growth and furnishing supplies for continued fertility for a long or short time, accordingly as the soil contains much or little plant food locked up in insoluble form. In the second condition, in which the salts are actually in solution, they are, of course, in a condition in which the plant can most readily use them.

PHYSICAL ABSORPTION.

The absorption of salts has been briefly discussed in an earlier part of this paper. The condition of absorbed salts is one which has received much attention in recent years. There are two kinds of absorption, chemical and physical. The chemical absorption has already been treated in another paragraph, and the description which

follows refers to the physical absorption. Any solid body placed within a solution has the power of absorbing or condensing upon its surface matter which is in the solution. These salts when absorbed or condensed seem to have little effect upon the growth of the plant. They are very slowly given up by the solids to the solution again as the soil is leached. Such physical absorption or condensing action varies with the condition of the surface, that is to say, whether it is rough or smooth, compact or porous, and it also varies with the extent of the surface. Some salts seem to be more readily absorbed than others. In order to test the relative absorption of various salts which are found in soils, some experiments have been conducted upon the rapidity with which various salts could be washed out from a soil, in which there was no chemical action, but in which the salts were physically condensed, or absorbed bodily, much as a sponge absorbs water. The relative time of washing out the various salts was as follows:

Relative time of leaching salts.

	Minutes.
Calcium chloride	1
Sodium chloride	2
Magnesium chloride	2
Potassium chloride	4
Ammonium chloride	8

In this experiment there is the foundation of some of the most important principles regarding the removal of any accumulation of salts. It is seen that the calcium salt was most readily washed out, while the ammonium and potassium salts were the hardest to wash out.

CONDITIONS IN ARID REGIONS.

If in the piece of granite referred to in the beginning of this paper the rain water had not been allowed to wash out the soluble matter as it was formed, there would have been found a quantity of white salt in the rock powder and in the resultant soil. If the quantity of this white salt had been great, as much as 2 or 3 per cent of the weight of the rock, it would have been difficult or impossible to get a plant to grow in the soil. This has been the experience the world over, that plants will not grow in a soil that contains too much soluble matter.

In arid countries there is not sufficient rainfall to remove all of the soluble matter as it is formed in the decay of rocks and soils, and the result is an accumulation of salts within the soil. In still other parts of the country, where more rain falls, the salts may be washed out, but the solution runs down into inclosed basins having no connection with the ocean, and there evaporates, depositing the salts. In either of these cases plants suffer when the amount of salts reaches a certain per cent. It can safely be said that few crops can flourish when soluble matter amounting to one-half of 1 per cent of the weight of the soil is in solution around the soil grains when the soil is saturated with moisture. As the water of saturation weighs from 25 to 75 per

cent of the dry weight of the soil, it will be seen that crops will not thrive when the solution contains more than 1 per cent of the soluble matter. When the concentration of the soil solution reaches this per cent, the leaves of alfalfa turn yellow, wither, and die, just as the plant would do if drought prevailed.

AMOUNT OF SOLUBLE MATTER DEPENDS UPON CLIMATE AND TEXTURE OF SOIL.

In arid regions where the amount of rainfall is small, the amount of water which leaches through the soil is not sufficient to wash out all of the soluble matter. For this reason the amount of soluble matter in the western soils exceeds the amount of soluble matter in the eastern soils of the United States. The following table shows the relation between the amounts of soluble matter in the soils of different parts of the country:

Relative amounts of salts in soils.

No. of samples.	Kind of soil.	Locality.	Per cent soluble matter.	Pounds soluble matter per acre-foot.
15	Prairie	Kansas, Nebraska	0.033	1,155
22	Limestone	Virginia, Maryland, Pennsylvania, Kentucky.	.017	595
12	Gneiss	Virginia, North Carolina	.007	245
24	Truck	Maryland, Virginia, North Carolina	.006	210
17	Subtropical	Florida	.0012	42

The prairie soils throughout the West show large amounts of soluble matter, and they are exceedingly productive when enough rain falls to keep the soil in a moist condition. Of the soils of the humid regions, those formed from limestone show the greatest percentage of soluble matter. In general, it will be found that in the humid regions of the United States the percentage of soluble matter depends upon the size of the soil grains. The soils of the humid regions vary much in size of grain and extent of surface exposed on these grains upon which the water may act. The following table shows the relation in a general way between the texture of the soil and the percentage of soluble matter present:

Relation between texture of soils and percentage of salt.

Kind of soil.	Locality.	Relative extent of surface of grains.	Percentage of salt.
Florida soils		1	1
Truck soils		5	10
Limestone soils	Maryland	18	6
Do	Pennsylvania	33	27
Do	Kentucky	55	17
Do	Virginia	56	78

It will be seen from the table that the soil which had the greatest extent of surface for the water to act on (or, in other words, the soil which was made up of the finest grains) had also the greatest percentage of salt which was soluble. It is a well-known fact, also, that the general agricultural value of a soil varies in nearly this same ratio, that is to say, a heavy soil is better for general farming purposes than a light, sandy soil.

HUMID AND ARID REGIONS COMPARED.

There is another point of difference between the humid and arid soils which is of general interest as well as of general importance. The soils of the humid regions contain much more soluble matter than the subsoils, that is to say, the greater part of the soluble matter is concentrated within the surface foot of the soil. About 50 per cent of the rainfall of the humid regions either washes over the surface of the ground or else washes through the soil and sinks down below the subsoil to appear at a lower level and be carried off by streams into the ocean. This has been going on for ages, and the amount of soluble matter left is very small, only sufficient to supply the plant roots.

The absorbing action of the soil grains retains the greater part of the salt as it becomes soluble within the surface foot of the soil, and it is here used by the plants. Below this, in the subsoil, in the region where the action of weathering is reduced to a minimum, the amount of soluble matter found is very small.

In the arid regions, where the rainfall is not sufficient to keep the soil continuously moistened to any great depth and where the air is drier and evaporation much more rapid, the proportion of the rainfall drained from the land by the rivers is much less, in some cases less than 10 per cent, and in nearly all cases of Western rivers less than 25 per cent. Thus, with a small rainfall, very little water leaches through the soil, and therefore very little soluble matter is washed out.

In fact, in most of our arid prairies the soil is never wet from the surface to a depth of more than 5 or 6 feet. When the rainfall soaks down to the subsoil it carries with it some of the soluble matter which is in the soil. This soluble matter is absorbed by and condensed upon the grains of the subsoil, and when the water is again brought to the surface of the ground by the evaporation of the soil water, part of the soluble matter remains in the lower layers of the soil. Then, if an examination is made of the prairie soils as they normally occur, more soluble matter will be found in the subsoil than in the soil, while in the humid regions the conditions are just the reverse. Thus, in much of the Western country there are large accumulations of soluble salts below the surface of the ground. Such soils seem at first sight to be entirely free from "alkali." After a few years of irrigation these salts appear on the surface, and immediate damage to the crops results.

EFFECT OF IRRIGATION UPON LOCATION OF SOLUBLE SALTS.

When water is applied by irrigation great changes take place in the location of the soluble salts, frequently resulting in the ruin of the land temporarily. The word temporarily is used because methods of reclamation are possible, and the time will soon come when these lands will be reclaimed. Such lands are usually called "alkali" lands, though in the majority of cases the term is misleading, for often the salts are neutral in character.

When water is applied by irrigation under the present methods, a great deal more water is usually employed than is necessary for the growth of the crops. This excess of moisture slowly penetrates the subsoil until it is drained off into streams or strikes some bed of impenetrable material. If the soil is light and sandy, easily drained, the excess of water readily passes away and no permanent damage results to the farmer who applies the water. The water, however, too often only sinks to rise again to the surface at some lower level and to swamp the land.

When, however, the soil is heavy and impervious, the excess of water applied slowly penetrates the soil and remains in the subsoil without draining away, or at least drains away very slowly. Gradually the subsoil fills up with standing water until the level of the water reaches the roots of the plants growing on the surface of the ground. Since very few cultivated plants can live when their roots are under water, as soon as this condition of standing water is reached the plants die. All this time evaporation is going on upon the surface of the soil, and water is being drawn up by capillary force, bringing with it the salts it may have dissolved. These salts are left at the surface when the water evaporates, and slowly a crust forms. This accumulation of soluble matter finally becomes so great that no plant will grow on the land. The land is of necessity abandoned. In nearly every irrigated district of the arid West some of the lands first irrigated, the choicest of the lands, have in this way become so impregnated with the salts that crops can not grow. There are thousands of acres of land, formerly valuable property, which to-day are abandoned.

KINDS OF ALKALI.

There are essentially two kinds of alkali soils, black alkali, or sodium carbonate, which is the true alkali, and white alkali, or a mixture of several salts, as common salt, Glauber's salt, epsom salt, borax, Chile saltpeter, etc. When the black alkali occurs in the soil, gypsum is added in order to produce a chemical change in the salt. The black alkali is then changed to white alkali, which is much less harmful. In general terms, it may be said that plants can stand only one-tenth of 1 per cent of black alkali, while most plants are able to stand from one-fourth to one-half of 1 per cent of white alkali. If,

however, the salt is white and is present in sufficient quantity to hinder crops growing (that is, over one-half of 1 per cent), there is at present but one known method of reclaiming the land, that of removing the salts bodily.

METHODS OF REMOVING ALKALI.

There are several ways in which salts may be removed. The popular idea seems to be to wash the salts away by flooding the surface of the ground. Such a method is of little avail, for the amount of salt on the surface is but a small portion of the total amount within the soil. The soluble matter extends down all through the soil, and there may be as much at 10 feet below the surface as at the surface itself. Even should the small portion upon the surface be washed away, other salts would soon be drawn up from below and deposited. The general experience has been that there is but one effective method of getting rid of any accumulation of alkali. The land must be drained. Irrigation and drainage should begin at the same time, but since much of our land is already ruined by overirrigation and lack of drainage, the question of reclaiming these lands must be considered as well as the problem of preventing future occurrence of such disasters. There can be but one answer to all queries as to how to get rid of the alkali, and that answer is, drain the soil. As the water drains away, the excess of soluble salts will be carried off. The question of the manner of draining the soil will not be considered here, for the practical experience of the farmer and the conditions and methods at command will be a better guide to drainage than could be presented in the short space of this paper.

DRAINAGE OF ALKALI LANDS.

It might be well to consider the amount of salts removed by the waters of a ditch. During parts of May and June, 1898, the percentage of soluble matter was estimated in samples of water collected from an open ditch used for drainage near Billings, Mont. This ditch had been dug to drain away water from the town. A layer of gravel underlaid the valley and the ditch was dug down to this gravel. Several natural drains entered the ditch, and altogether the ditch represented the drainage from about 10 square miles. The table on the page following shows the quantity of salts removed by the water.

Salts removed by waters of a ditch.

Date.	Tons per hour.	Date.	Tons per hour.
June 4	13.6	June 13	21.6
June 6	19.1	June 16	10.2
June 7	19.0	Average	16.6
June 11	20.2		
June 12	12.7		

The examination of the water in this ditch on these seven days gives a fair idea of the average quantity of salts removed. The ditch was estimated to be discharging at the average rate of about 40 cubic feet per second. From this the number of tons of salts removed per hour by the ditch was calculated. At this rate of working, the ditch could drain 1 per cent of salt from the upper 5 feet of about 900 acres of land in one year.

The worst of the alkali lands is generally a heavy clay or adobe. The action of the soluble matter on the clay particles has rendered this soil very impervious to water. The drainage is very slow. It would require some time to remove the first excess of the salts and water, though were this once accomplished the soil would or could be brought back into its former condition of good tillage, and thus allow water to flow more rapidly. The lighter soils are usually washed free of all alkali by the first irrigation supply, and it is only when the level of standing water comes close to the surface of the ground that these soils are condemned as alkaline. The first and usually the worst effect is caused by water. If this water is immediately drained away, no lasting ill effect is produced in the soil; but if it remains in the soil the accumulation of the alkali at the surface begins at once and the soil is soon ruined.

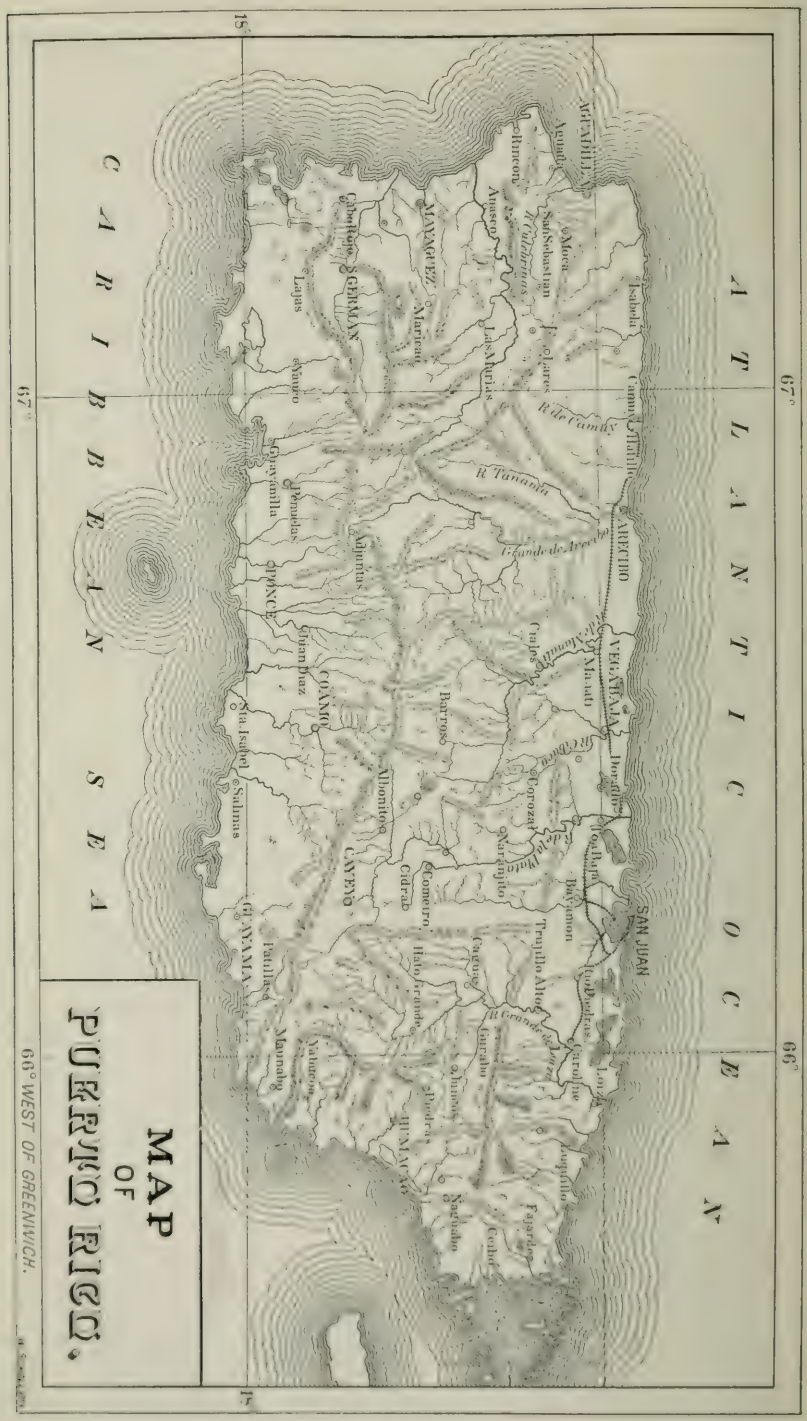
There are several important practical deductions to be made from the foregoing, especially by the irrigating farmer. It is very essential that he understand the physical properties and processes in the soil, especially in opening up a new country and on first applying irrigation waters. Much of the trouble which has come from alkali could have been prevented if these physical laws had been understood and care taken to make the practice conform in every way with the existing conditions.

CARE NECESSARY IN IRRIGATION.

With these soluble salts present in such abundance in the subsoil of the surrounding country, it is important that water be applied to the land as seldom as possible, and only so much at a single application as is necessary for the object to be attained. Any excess of water tends to accumulate in the soil to the detriment of the plant roots, or to seep down and injure the lands or farms in the lower

level by the accumulation of quantities of subsoil water and finally by the accumulation of alkali salts.

Where the evil of overirrigation has been wrought, too much can not be said in favor of a proper system of underdrainage. Even though a given farm may not be injured by alkali, seepage waters from this farm will rise upon farms lower down, bringing with them alkali salts, which, if allowed to accumulate, will ruin the land. Many of the western soils are hardly considered valuable enough to warrant extensive drainage; but drainage will have to be done sooner or later, and well-planned systems, even though small at the beginning, can be installed at a small cost per acre and the accumulation of the salts prevented. Systems judiciously planned at the beginning can be gradually extended as they are needed with a relatively small outlay of capital.



THE ISLAND OF PUERTO RICO.

AGRICULTURE IN PUERTO RICO.

By Roy Stone,
Brigadier-General, U. S. Volunteers.

GENERAL CONDITIONS.

The island of Puerto Rico (Pl. XXXVIII), with an area one-fourth less than that of the State of Connecticut, supports a population about one-third greater, and supports it almost entirely by agriculture, after paying a heavy tribute of taxation and another of remittances to absent landlords. The island does all this, too, with few of the modern implements, methods, or appliances. It has so few roads that large portions of its products are brought to market on pack animals or on the heads of men and women. It has few railroads, and these consist entirely of some short pieces along the coast. Its harbors are without improvements, and the cost of shipping its products amounts to an export tax. There is no place on the island where a large ship can come to a dock, and all goods have to be lightered out and in. While, as stated, the population derives its means of support almost entirely from the limited agriculture practiced, the island does not produce its own food staples, such as wheat, corn, rice, etc., and nearly half its imports are of cereals and other agricultural products. The island itself is so mountainous and so broken into steep declivities by the deep gorges of its numerous rivers that it seems to one from the United States, especially from the prairie regions, as if it were almost incapable of cultivation. The result obtained under all these difficulties makes the study of the conditions and methods of agriculture in the island peculiarly interesting.

TOPOGRAPHY.

The island, which is rectangular in shape, lies exactly east and west, and is situated between latitudes 17° 50′ and 18° 30′ N. and longitude 65° and 67° W. of Greenwich. It is about 100 miles long and 40 miles wide.

A high, steep ridge, accented with numerous higher peaks, known as the Cayey Range, extends unbroken from end to end of the island at a distance of 8 to 15 miles from the south coast. The Luquillo Range, lying in general nearly parallel to the Cayey, and nearer to the north coast than the Cayey is to the south, is broken by many

valleys, through which the streams rising on the north slope of the Cayey Mountains make their way to the sea. The general level of the Cayey Range is about 2,500 feet above the sea, and its peaks rise 1,000 feet higher, while the eastern peaks of the Luquillo reach a few hundred feet higher still. Between the two ranges lies what might be called a mountainous valley, full of sharp ridges, detached peaks, and deep ravines, with no level lands except a few narrow alluvial bottoms. Along either coast, however, extending from the foothills of the mountains to the sea, stretch beautiful plains, gently sloping to the shore and reaching in width at some points on the south side to 5 miles and on the north to 3 miles.

SOIL CONDITIONS.

To one of our own countrymen perhaps the most wonderful thing in the island is the depth of the soil on the faces of the steep mountains and its cultivation to their very peaks. Anything short of a vertical cliff is considered tillable, and is actually tilled and made productive. Why the mountains are not washed bare by the torrential rains, and why there are few or no landslips except where cuttings are made, are puzzling questions. The secret of it may be in the fact that there is no frost to dislodge the accumulation of the decaying rock on the mountain sides, and that the great depth of soil and porosity of the underlying rock absorb the rain as fast as it falls; but there is undoubtedly great art in the tillage and judgment in the planting of these lands so as to secure their preservation from erosion. Fortunately, the soil is so rich that very little tillage is required, and in the coffee districts, especially those of the highest lands, the only cultivator used is the machete, or short sword, which clears the fields of the wild growth but leaves the roots alive to help hold the ground.

The waste lands of the island are few, but those that do exist could be made useful by attention to the proper means for their improvement, and a scientific study of the adaptabilities of their various soils. There is not, properly, any one soil that is characteristic of the island. Even the coast lands will show different kinds. The coastal plains are generally rich alluvium. Many of the plains of the south coast, especially of the eastern section, have never been cultivated owing to the lack of rainfall, and one of the greatest benefits to be conferred upon the island will be the encouragement of irrigation.

DISTRIBUTION OF PRODUCTS.

Conditions of elevation and of soil naturally govern the distribution of the various agricultural products. The littoral plains are the home of the sugar cane wherever it has sufficient rainfall or can be irrigated, the cane requiring a large amount of water for its successful cultivation. Advancing into the interior, the growth of coffee begins at the foothills and continues to the tops of the highest mountains, but its best habitat is at an elevation of 500 to 1,000 feet.

OBSERVATIONS OF A NATIVE.

The following are some general observations on agriculture by a gentleman of Puerto Rico who is thoroughly acquainted with cultivation in the various sections of the island:

The island, on account of its warm climate and the richness of its various soils, of which it has all kinds suited to various cultivations, is in its general character adapted to agriculture in preference to any other purpose. All the tropical plants find suitable soil for their growth, though a few of the coast valleys do not yield to-day what they did a few years ago. Bad cultivation has in a measure exhausted their exuberance; nevertheless can they, under all systems of sound agriculture, that is to say, with irrigation, drainage, and scientific methods of fertilization of soils, compete with any other of the West Indian islands. The plains along the coast are adapted to sugar cultivation, except in those parts where drought will not allow anything but pasturage. They will also produce excellent tobacco, corn, bananas, and pineapples. Cocoanut trees line the seashores. In the interior, besides the growing of coffee, the soil and climate are adapted especially to such fruits as oranges, lemons, and limes. The banana also flourishes even to the mountain tops. The quality of the oranges is very high, equal to the best Florida orange, with the great advantage that they ripen much earlier. Excellent oranges are found ripening at Utuado early in August. The orange so far grows entirely wild, and there are many varieties. It needs the fostering care of American agricultural experiment stations to develop the best kinds of fruit for export. Naturally the early fruit will be most desirable, and a careful development of such varieties as would ripen in convenient localities in August and September would be of immense value to the agriculture of the island.

Crops in general on the island begin to ripen much earlier on the coast than in the mountains. The coffee crop begins ripening along the coast in August and September, and is all gathered by November, when the crop begins to ripen in the mountains, where its gathering continues until February. A small amount of cocoa is produced, but it is not likely to increase very largely, since it does not yield so well in elevated ground from the level of the sea.

THE LABORERS.

The laborers are mostly white natives in the interior, while those on the coast are colored, principally on the south and southeast coasts, because of the African slavery which existed on sugar plantations there.

When freedom came for the slaves in the year 1873 they entered on their new condition without any disturbance; and now that America releases a whole people from enthrallment, which she takes under her safeguard, why not expect still better conduct, if possible, from the former slaves? Apart from their ignorance and their unsocial way of living, they are, as laborers, to be considered very good. During nearly two years of the Cuban war all work was stopped in the island because the merchants feared to advance money to aid cultivation, and the ex-slaves patiently, and without troubling in the least the tranquillity of their neighbors, endured that difficult situation.

The average rate of wages is half a peso, or 50 cents, equal to 25 cents American money, per day. Laborers on the sugar plantations and in town generally board themselves. In the coffee plantations they are boarded, that is, houses and food are given to them.

All laborers in Puerto Rico easily apply themselves to any improvements in labor, and though they are not strong, they can sustain a long day's work even with poor and insufficient food. If collected in towns instead of living scattered, as they now do, no doubt all their habits, including their morals, would be modified

and improved and the education of their children facilitated. It would not take a long period to elevate them in the social scale and make them useful citizens; in other words, to change the man machine into a civilized true man. The laborers from the coast can be easily distinguished from those of the interior. They are stouter and healthier, owing to the difference in their feeding and dwellings.

Labor is commonly paid by the day's work in the coffee plantations and in almost all the agricultural employments. On the coast sugar-cane cultivation is done by the job, as cane cutting, harvesting, plowing, and all the different labor required to raise the rich gramineous plant. Only the mechanical part of this exploitation, which is done in the sugar factories, is paid by the day.

PRODUCTIONS FOR EXPORT.

The principal productions of the island for exportation are sugar, coffee, tobacco, and, can be in the near future, such fruits as bananas, pineapples, oranges, lemons, and limes. Besides these, though of less importance, all kinds of vegetables grow abundantly, are of excellent quality, and at any season, giving several crops a year.

The people raise corn, rice, beans, and various kinds of peas and vegetables, though not in sufficient quantity to provide for their subsistence, and are obliged to supply their additional requirements in these articles by importations from the United States. With quick transportation facilities, the people of the island would probably engage extensively in the cultivation of the more valuable products, as sugar, coffee, tobacco, cocoa, bananas, oranges, lemons, cocoanuts, pineapples, and early vegetables, and take from the States the flour, corn, rice, bacon, salt fish, etc., required as daily food.

BANANA CULTIVATION.

Banana cultivation will be one of the most productive agricultural exploitations. There are many different kinds of plantains, the banana, the one most usually brought to the American markets, being the kind which grows best on the island and yields the most fruit. It requires good soil and little water, for it brings humidity to the ground, perhaps because of the large leaves sucking the moisture of the air, which runs through the plant, or because it brings up the underground deep waters to the surface. Whatever be the cause, the ground is always moist in a banana plantation, however great the drought.

When planted in new soil the banana does not require any plowing, but it does when the lands have been much used and have, of course, lost their natural state of porosity. When once the soil is ready, holes are made 1 yard in diameter, 2 or 3 yards distant from one another, and about one-half a yard deep. In rich lands and new lands no fertilizer is required, but otherwise a basketful of some kind is useful; a sprout is then planted, which in three months' time will grow to 8 and 10 feet high, and nine months or a year after planting, according to the variety, will yield fruit in the form of a bunch, which will count as many sometimes as 200 bananas. In the first two years the weeds have to be removed, but afterwards the shade will prevent their growth.

In most places no water is required, but half a dozen irrigations a year will be enough in the driest lands. Once the plantation is in full growth and producing condition, it does not require more attention than the cleaning of the plants of their dry leaves and the keeping of all the detritus from the plants well gathered round the trunk to fertilize it, allowing plenty of space for the new sprouts to come out. Sometimes these come in such profusion, that the expert laborer has to extirpate them and only allow a certain number to grow up. When the plantation is in full growth and production the collecting of the fruit is constant, and every week the plantation can be gone through to collect the ripe bunches. As if nature had provided it, the largest bunches contain fruit of the most delicate

flavor, with sweetness and fine pulp, and they also are those that keep the best, lasting for many days, thus giving sufficient time for transportation. The dry leaves and trunks of the plants are useful for paper manufacture. When the bunch of bananas is ripe the tree or stalk, often 10 inches in diameter and 20 feet high, is cut down with a single stroke of the machete; the stump dies, but numerous sprouts are ready to take its place and the plantation constantly renews itself. Many are in good production for a half century or more, and wherever there is suitable transportation for so heavy a crop it is very profitable. The trunks are cut in pieces and piled round the tree for fertilizing.

CATTLE RAISING.

This industry is very profitable in the island, as various grasses and nourishing plants grow in profusion, and a good market for the surplus stock is found in Cuba and other islands. The cattle are of large size and of a uniform light-red color, and they seem to fatten easily. The cows are nearly as large as the oxen, but do not yield milk in proportion to their size. On account of the heat the milk can only be kept by boiling, and cream and butter are unknown. A very coarse cheese is made, but otherwise there is very little use of the milk. Whenever it becomes possible to establish refrigerating plants a very good local dairy business can be inaugurated. These cooling plants could be operated by electric power derived from the abundant waterfalls in the island as soon as capital can be found for their exploitation.

HOME MARKETS.

The peculiar facilities for manufacturing afforded by an abundant supply of labor and ample water power will lead to the establishment of many factories for working up the productions of the island, such as cotton, hemp, and other fibers. The husks of cocoanuts are now shipped to Germany for paper making. Water powers can be constructed at a very low cost as compared with those in the United States, and power can now be transmitted by electricity to a distance equal to the width or even the length of the island without serious loss. The establishment of domestic manufactures will, of course, greatly enlarge the home markets for agricultural products.

The attractions of the island for tourists and for health seekers will add a large population of nonproducers, and will also increase the home demand for many products. Moreover, as the people of the island improve in their condition and circumstances they will develop new and increased wants, as well as the means for satisfying them, and the home markets will be largely extended.

LAND OWNERSHIP.

The landowners are mainly white people, residents of the towns during most of the year, but a few owners in some parts of the island, as in the district of Ponce and on the north side, live in Europe. The landed property is well distributed, most of it being in small holdings. Only in the valleys and plains are there many estates of

great extent. The owners who live in towns spend a portion of the year on their plantations, where, during the season of gathering the principal crops, there are numerous entertainments and general festivity.

TRANSPORTATION FACILITIES AND IRRIGATION NEEDED.

Large tracts of land in the interior of the island are practically without cultivation on account of the lack of communication. Some owners have been obliged to give up raising vegetables in the interior because the prices obtained on the coast would not pay the cost of transporting them to the markets, which is greater than that of bringing them from Europe or some other distant country. It is safe to say that three times the present production of coffee can easily be counted on whenever proper means of communication are established. Transportation and irrigation are closely connected. As has been stated, many of the plains of the south coast, especially of the eastern section, have never been cultivated owing to lack of rainfall, and in order to irrigate these lands it will be necessary to bring the water through and under the Cayey Range, since nearly all the large streams of the island are on its northern slope. A project of this kind has for many years been in contemplation and several royal grants have been made for its encouragement. Those who are interested in promoting better communication have proposed while bringing the irrigation water through to bring also an electric railroad under the mountain in the same tunnel, and in addition to use the irrigation water after it passes through the tunnel to develop electric power, as this water will have a descent of a thousand feet to the sea. This combination of increased production through irrigation with improved transportation by means of this low-grade outlet for a system of electric roads in the interior of the island, together with the development of power to operate such roads, will cause increased prosperity everywhere. Many other water powers exist throughout the island, which can be made available not only for electric roads but for manufacturing purposes.

There are many considerations in favor of the adoption of electric roads for the island in preference to wagon roads. It is useless to build roads in the island unless they are thoroughly drained and macadamized. Ordinary wagon roads, especially in hilly districts, where the rain will follow the wagon tracks in the soft soil, are soon washed out of all semblance to roads, and enormous expense would be required to keep them barely passable for ox carts. Good macadam roads, on the other hand, will cost approximately as much as electric roads, while the latter, with properly paved gutters, will stand without washing for many years, there being no frost to loosen the soil. Another great advantage of a general system of electric transportation would be that central factories for the production of sugar and the preparation of coffee for the market would be established at convenient points, and the gathering of these products by rail for the

factories would be a great economy for the producers. It is estimated that the average percentage of juice extracted from the cane in Puerto Rico is not above 54 per cent of the weight of the cane, owing to the imperfect methods in vogue, while a modern central factory, with the best machinery, produces from 70 to 80 per cent. In the same way, such a system would greatly benefit the coffee country. The planter in the high lands, if he had electric trains running down to the coast, would send his crop to be treated entirely by machinery with less cost and better results than now.

FALSE IMPRESSIONS OF THE CLIMATE OF PUERTO RICO.

Many false impressions prevail regarding the climate of Puerto Rico. The best information indicates that the island is practically out of the track of the tropical hurricanes, and while such storms occur frequently in the West Indies, Puerto Rico is seldom touched by them. It is now nearly a quarter of a century since a hurricane has done any serious damage, and there is practically no more danger in the island from this cause than there is in the United States. The temperature is uniform, with no sudden changes, and the range from the highest to the lowest is very narrow. The heat is never so great as in the cities of the North American coast, ranging from 78° to 90° in the summer and from 60° to 80° in the winter. In the mountains, even in the hottest season, the nights are cool and the days comfortable except in the direct rays of the sun at noonday. Delicious breezes blow toward the land throughout the day and toward the sea at night. Even in what is called the rainy season there is scarcely a day without sunshine. In fact, what is called the rainy season is only a season of showery weather. The rain falls chiefly on the north side of the Cayey Range, leaving the south slope, especially along the sea, comparatively dry, sometimes extremely so. The trees are always green, as also the grass and vegetation, except in time of prolonged drought. Among other fallacies about Puerto Rico is one that the climate is so damp that iron can not be used for construction on account of rust, but the fact is that iron bridges exist throughout the island, and all sorts of tools of iron and steel are used, as are many small iron tramways. The air is probably no more damp than it is elsewhere in equally close proximity to the sea.

PUERTO RICO AS SEEN BY A UNITED STATES WRITER.

The following statements regarding Puerto Rico are from a new book on Cuba and Puerto Rico, by Mr. Robert T. Hill, of the United States Geological Survey:

No part of the Antilles is so susceptible of cultivation and diversified farming. Possessing every variety of tropical landscape, fertile from the mountain tops to the sea, rich in pasture lands, shaded with beautiful groves of magnificent palms, moistened by 1,300 streams, with here and there a hot spring, its agricultural possibilities are immense. * * * The island is almost entirely free from those

noxious reptiles and insects which infest the other West Indies. * * * The natives enumerate twenty-eight medicinal plants, twelve of which are used as condiments, as many used for dyeing and tanning, eight resinous trees and many large trees which have edible fruits. * * * The climate, though warm, is more agreeable and healthful than that of any of the other Antilles. The mortality does not exceed that of some of the more healthful countries of Europe. * * * The island has 66 tobacco farms, 240 large cattle farms, 361 large coffee estates, 4,184 small coffee farms, 4,333 sugar estates, 4,376 farms devoted to miscellaneous cultivation, and 16,988 small fruit farms.

NEED OF EXPERIMENT STATIONS.

No country or region is more in need of a system of official experimentation in agriculture like that of the United States than is Puerto Rico. There have been two institutions of the kind in the island under Spanish control, but, owing probably to inefficient management, nothing of practical value has been developed. Under an efficient experiment station system every one of the scores of products of the island could be experimented with and tested, selections and crosses made, diseases studied and cured, fertilizers tried, and methods of preservation and transportation devised, whereby, in time, intelligent cultivation and shipment would take the place of haphazard operations. Natural fertilizers are said to abound in the island, but so far very little use has been made of them.

As an instance of what Government can do to assist the development of agriculture in the Tropics, Mr. Hill, in writing of the island of Jamaica, which lies in the same latitude as Puerto Rico, a few hundred miles to the west, says:

> A department of gardens and plantations, under capable and experienced men, has carried on experiments which, while supporting the old, have encouraged the establishment of many new and promising agricultural industries; the Government has also promoted the construction of roads and the establishment of rapid steamship lines to the United States, and the people are now finding a source of livelihood and profit in products which were formerly disdained.

The Boston Fruit Company, which has the bulk of the traffic, runs some fifteen steamers from Jamaica to the United States, and a new line is to be started for European trade. A valuable trade is being created also in new potatoes, tomatoes, and other fresh vegetables for the markets of this country.

THE FUTURE OF PUERTO RICAN FARMING.

Under the new dispensation for Puerto Rico it is not difficult to forecast the probable rapidity of her progress in agriculture. Fast lines of steamers will be established to carry the tourist travel, seeking health and recreation. Capital from this country will develop the water powers of the island, provide irrigation, build electric railways, erect central sugar, coffee, and tobacco factories and warehouses, and make advances on growing crops.

The island will probably continue to draw the bulk of its food staples from abroad, especially no doubt from the United States,

importing flour, corn, salt fish, and meats, and devoting its whole area to tropical productions, thereby securing the best use of its matchless soil and climate. The dense population promises abundant labor for many years, and producers will thus feel secure against outside competition. It will, of course, be no place for laborers from the United States, but for families of moderate means who seek a mild climate for health or comfort in a country where frost will never come to ruin them, Puerto Rico will be the Mecca. A few acres in fruits or vegetables, well tended, will furnish an easy support, and whatever extra labor is needed can always be readily procured. The exports of the island will be varied and increased by the cultivation of medicinal plants and condiments, fibrous plants, and many kinds of tropical fruits not now shipped for the want of the necessary quick transportation.

The location of the island is peculiarly favorable for the marketing of its products. It lies midway between North and South America, equidistant from New York and Para, which latter is called the Chicago of South America, and it is directly on the route from Central America to all Europe; every vessel journeying to and from the isthmus canal will pass along the south side of the island and have the opportunity to replenish its stores and take more cargo. The effects of good government will be seen, too, in the relief from sundry vexatious restrictions heretofore imposed upon trade, and especially from arbitrary and unlawful port charges and fines imposed upon vessels for supposed offenses, which have in the past resulted in driving many lines of vessels from the island.

PRESENT DEPRESSION ACCOUNTED FOR.

The conditions of depression and even distress which now prevail throughout the greater part of the island (April, 1899) must be considered temporary and easily remediable by judicious legislation. Mr. Gardner W. Pearson, an American gentleman now residing in the island, gives the following facts, which account in some measure for the present conditions:

The following figures on exports from Puerto Rico are taken from the Estadistica General del Comercio Exterior for the year 1897, compiled by the Secretario del Despacio de Hacienda, and issued as an official document, printed at San Juan:

Exports of Puerto Rico for 1897.

[Value in pesos.]

Articles.	Total.	To Spain.	To Cuba.
Coffee	12,222,599.48	3,563,920.88	2,084,563.00
Tobacco	1,194,318.30	141,729.42	990,848.56
Sugar, centrifugal	1,316,584.08	501,992.08	2,792.60
Sugar, muscovados	2,608,415.22	770,058.85	2,868.71
Total	17,341,917.08	4,977,701.23	3,081,032.87

The articles given are far the largest products for export, but adding to these all other products, would make approximately $18,500,000 for total exports, of which, as shown in the table, about 8,100,000 pesos in value found a market in Spain and Cuba under tariffs which were made by Spain to favor her colonies.

Since October, 1898, when the last Spaniards left Puerto Rico, Spain has regarded the island as a foreign country and has applied her foreign duties to Puerto Rican products.

Before October, 1898, the Spanish duty on Puerto Rican coffee was 60 pesetas, equal to 12 Spanish dollars, or $8.57 gold per 100 kilos. Since October it has been raised to 130 pesetas, equal to 26 Spanish dollars, or $18.57 gold per 100 kilos, a difference of $10 gold per 100 kilos against Puerto Rico. On sugar before October, 1898, the duties were, to colonies, 33.50 pesetas, equal to 6.70 Spanish dollars, or $4.78 gold per 100 kilos. Since October they have been 82.50 pesetas, equal to 16.50 Spanish dollars, or $11.78 gold per 100 kilos, a difference of $7 gold against Puerto Rico. The above duties are substantially prohibitive, so far as Spain is concerned. The Cuban market has also been affected by recent tariff regulations.

As Spain and Cuba were Puerto Rico's principal markets, taking nearly one-half her product, she has lost markets to the value of 8,000,000 pesos, and can not get new markets without reducing the price of her goods greatly. Her coffee has fallen in price 40 per cent since the summer, and tobacco the same or a greater percentage.

An additional, and the most serious, cause of the extremely low price of coffee is the excess of more than 6,000,000 sacks in this year's production in Brazil. This, together with the comparatively short crop in Puerto Rico, has reduced the income of the island planters this year to less than one-third of the usual amount, leaving them in debt for previous advances and without means to make a new crop. There is so little capital in the island that planters are unable to borrow money on their lands, and numbers of them have been compelled to discharge the majority of their laborers or even to entirely abandon cultivation. These laborers have no other resource, no savings and no credit, and instant destitution has followed their discharge.

The Puerto Rican coffee has no market in this country, though in Europe it is considered among the best in the world. If it could be favorably introduced here, the increased demand would at once advance its price, which would give new credit to the Puerto Rican planters and enable them to resume work.

For the present, the military government, out of the funds in the island treasury, is providing food for those who are in danger of starvation and giving employment on roads to thousands. This is giving temporary relief, but can not continue indefinitely, and it is to be hoped, therefore, that some method will be found to speedily extend the markets for Puerto Rican products.

MAP OF ALASKA.

AGRICULTURAL EXPERIMENTS IN ALASKA.

By C. C. Georgeson, M. S.,
Special Agent, Office Experiment Stations, in charge of Alaska Investigations.

RESOURCES ENHANCED BY AGRICULTURE.

The reports on Alaska which have been given to the world from time to time by several of the Departments of the Government have made it clear that the Territory has vast and varied resources. Its fisheries, its mineral deposits, its forest areas, and its fur-bearing animals constitute sources of wealth, any one of which would be sufficient to attract attention and call out capital for exploitation and development. (For Alaska, see map, Pl. XXXIX.)

The greatest drawback to the development of all these resources has been the fact that the Territory has so far had no agriculture. Its situation, away from populous regions, and its inhospitable climate have had retarding effects, yet the chief obstacle is to be found in the lack of a food supply. The white population of the Territory is dependent upon the farmers of the States for maintenance, but what this means can scarcely be realized by those who are not familiar with the conditions. The fact that each of the many thousands of men who go there, to prospect, for instance, has to carry with him tons of provisions, not only increases the cost of the trip by the expense of transportation of these supplies, but also adds materially to the hardships and dangers. The cost of board in the camps on the Yukon is some indication of what the lack of agriculture means in the development of Alaska. In Dawson and other places $2 to $2.50 will pay for only a frugal meal. It stands to reason that if the means to support life can be produced within the boundaries of the Territory all the other resources will become more valuable, inasmuch as they can be worked at a greatly reduced expense for the cost of living of the workers. Agricultural pursuits would also attract a population from which the labor market in the mines and other enterprises could be largely recruited. Congress is aware of this state of affairs and, with a view to ascertain what the agricultural possibilities of the Territory are, appropriations have twice been made for the purpose of investigating the subject. In 1897, $5,000 was included in the appropriations of the Department to enable the Secretary of Agriculture to investigate and report to Congress on the agricultural possibilities of Alaska. The commissioners to whom this investigation was intrusted found

the situation on the whole more favorable than had been generally expected, and their report upon the subject was sufficiently encouraging for Congress to grant another appropriation for a more thorough investigation of the subject. The supervision of these investigations was assigned to the Director of the Office of Experiment Stations.

BEGINNING OF EXPERIMENTAL WORK.

The past season's work marks the beginning of experimental work in Alaska, and the present paper is prepared partly to note this fact, because of the historical interest it may hereafter have, and chiefly to give a brief account of the work that has actually been accomplished. The writer was directed to proceed to the Territory and inaugurate such preliminary experiments as might be carried out during a single season under the conditions prevailing there. To this end seeds of a somewhat extended variety of vegetables and field crops of the kinds that might be expected to thrive in that latitude were planted at Sitka and Skagway and the results of their growth noted. It is not claimed that these results are at all conclusive as to what the coast region will produce, and much less do they represent the capabilities of the interior. In other locations, and in less favorable seasons, failures may follow the efforts which were so successful at Sitka, but the results, nevertheless, indicate that Alaska has agricultural possibilities, and that they are much greater than has been generally supposed. It should be stated that hardy vegetables have been raised quite successfully for years past, not only at Sitka, but at nearly every settlement along the coast. The facts concerning their growth, however, lack the substantiation of a thorough test, and are more or less traditional.

EXPERIMENTS WITH VEGETABLES.

Sitka was reached by the middle of May and steps were at once taken to secure suitable ground for the experiments. The ground which was found available consisted of scattered patches, only one of which was really in proper condition for cultivation. This was the garden of the Hon. John G. Brady, governor of the Territory. Others were either new land, too raw for successful growth of cultivated crops, or old ground which had been in grass for several years, the sod on which had to be reduced in order to put the ground in condition for cultivation.

All of the seeds were planted between May 18 and 25. These dates seem late, especially for the grains, but as a matter of fact the season was backward and seed could not have been planted earlier. The list comprised the following vegetables: Asparagus, wax beans (3 varieties), beets (3 varieties), cabbage (6 varieties), cauliflower (2 varieties), carrots (2 varieties), cress, kale, kohl-rabi, lettuce (3 varieties), mustard, onions (4 varieties), parsley, parsnips, peas (13 varieties), radishes (4 varieties), ruta-bagas (3 varieties), rhubarb, salsify, spinach,

sage, thyme, turnips (3 varieties), and Windsor beans. All these varieties made excellent growth and produced vegetables that would compare favorably with the products of gardens almost anywhere in the States. The peas were especially prolific, the vines growing to large size and giving every indication of being well suited to the soil and climate. In like manner the turnips, radishes, parsnips, parsley, and salsify made excellent growth and produced roots as good as can be found anywhere. The wax beans did not do well; their growth was slow and rather sickly, and while they bloomed and produced pods, they can not be called a success. Windsor beans (*Vicia faba*) grew remarkably well and produced a good crop of pods, indicating that this class of beans can take the place of the wax beans if the latter prove a failure. The cabbage and cauliflower were seeded too late for the best results, but grew with sufficient vigor to prove there was nothing in the conditions to prevent the production of good heads. The early varieties produced solid though small heads by the end of September. The Scotch kale grew remarkably well, producing large, bushy plants with a wealth of crisp green leaves. Turnips and rutabagas seem to be particularly well adapted to the soil and climate of Alaska. Not only did those grown at both Sitka and Skagway in this test do well, but reports covering all of the coast region and several places in the interior indicate that turnips are a favorite vegetable with Alaska gardeners because of their rapid growth, the large size attained, and their excellent flavor. Turnips weighing over 5 pounds, and even as much as 10 pounds, are, according to reports, occasionally produced. Potatoes, in like manner, were a decided success, both at Sitka and at Skagway, and this is true, also, of all southeast Alaska. Tubers weighing a pound or more are frequently produced. In the southeastern region they are generally dry and mealy and of good flavor, but at the mouth of the Yukon and in the interior, reports state that they are generally soggy and frequently fail to mature properly. Onions did well, but were in no way extraordinary, and the same may be said of the beets. The spinach came nearer being a failure than anything else; the growth was poor and sickly and the plants showed a tendency to produce seed prematurely. Melons, cucumbers, tomatoes, and similar tender vegetables were not tried, but the writer saw cucumbers about 6 inches long in a garden in Skagway, September 19.

This test indicates that hardy vegetables can be grown with great success at Sitka and at places similarly situated as to climate and soil. As stated, the same vegetables were also grown at Skagway with similar results, except that the growth in some cases was not quite so vigorous. The conditions here were peculiarly adverse. The ground was new and raw, and had probably not been exposed to the rays of the sun for centuries. It was covered with moss, rotten wood, and similar vegetable débris which had never been removed, and it

was found that on being cleared in the latter part of May it was still frozen under the deep covering of moss. That the vegetables referred to were successfully grown under these conditions is certainly remarkable.

EXPERIMENTS WITH CEREALS, FORAGE PLANTS, AND FLAX.

The test in which interest chiefly centers, however, is that of the grains and forage plants, for no region can be called an agricultural country unless it can produce the grain and forage plants which are needed to support man and beast. Oats and barley comprising the following varieties were grown both at Sitka and at Skagway with most gratifying results. The varieties of oats were White Russian, Improved Ligowa, White Wonder, Duppaur (seed from Norway), and two unnamed Russian varieties from Province Perm. The White Russian and Improved Ligowa were sown broadcast and in rows 18 inches apart. In both situations the growth was most excellent and seed matured before the end of September. There was not seed enough of the foreign varieties to sow broadcast, and they were therefore sown in rows but with the same result. They grew to a height of nearly 5 feet and produced large panicles filled with plump, heavy grain, which matured perfectly.

Of the barley, were grown French Chevalier, Manshury, Champion of Vermont, Björneby (seed from Norway), and two unnamed Russian varieties from Province Perm. The results were the same as in the case of the oats. The growth was excellent. They matured seed by the middle of September. It should be stated, however, that both barley and oats seeded on new, poorly-drained land were a failure. This demonstrates that the soil must be put in proper condition by drainage and aeration before it can produce cultivated crops.

Of forage plants, were seeded the red, mammoth, Alsike, and white clovers. Norwegian seed was also used for the first and the last two varieties named. Timothy and hairy vetch were also seeded. All the forage plants made good growth, the clovers being especially vigorous. Some of the red clover measured over 2 feet in length by the beginning of September.

Besides these, some Riga flax for fiber was sown in several patches at Sitka, both on old and on new land. On the new land the flax was a failure, but on the old ground it grew with a vigor that is equaled only under especially favorable conditions. Much of the straw was more than a yard high, and though it was somewhat coarse and uneven, the fiber was, nevertheless, strong, and gave promise of better results on better prepared ground. The oats, barley, flax, potatoes, and forage plants are represented in Pl. XL.

While it is true these tests represent but a single season's growth at only two places on the coast, namely, Sitka and Skagway, and that there is, therefore, a possibility that other seasons and other places may prove unfavorable and cause failures, it should also be borne in

FIG. 1.—OATS, BARLEY, FLAX, POTATOES, AND CLOVER GROWN BY THE DEPARTMENT OF AGRICULTURE AT SITKA, ALASKA, 1898.

FIG. 2.—SILO BELONGING TO BAPTIST ORPHANAGE, WOOD ISLAND, ALASKA.

mind that there is apparently little difference in the climate of the entire coast region from Wrangell to Unalaska, and that, as far as the climatic conditions are concerned, what will grow in one place seems likely to grow also in other places along the coast. Although it would be unwise to build too great hopes on this showing, it is at least sufficient to warrant still further and more thoroughgoing experiments.

EXPERIENCE OF RESIDENT GROWERS.

Grain and forage plants have not been tested with sufficient care elsewhere in the Territory to warrant a positive statement that they will grow there, but vegetables and in some places berry plants have been tested more or less carefully at nearly every settlement in Alaska, and, to indicate what success growers have achieved, brief quotations from a few of the reports received on this subject are made.

From Wrangell, S. S. Crittenden writes:

This section is the natural home of the berry—strawberries, raspberries (black and red), currants, etc.—except the blackberry, which I have never grown successfully. Most of the wild berries are insipid, but the cultivated varieties are of splendid size and flavor. From a raspberry patch 75 feet square, of the red variety, I have sold $20 worth per week at 25 cents per quart. These bushes grew from 10 to 14 feet in height. The berries ripened about August 5 and lasted from five to six weeks. * * * Lettuce and radishes grown here would be a revelation to the Easterner for crisp tenderness. Rapid growth enables me to grow four crops each season on the same piece of ground.

J. H. Stevens writes from Juneau:

I have grown the following vegetables successfully this season, namely: Lettuce, radishes, beets, carrots, parsnips, ruta-bagas, turnips, cabbage, cauliflower, potatoes, onions, celery, parsley, and kale. * * * All varieties of radishes do splendidly. Some kinds are marketable in from twenty to thirty days. I have grown four successive crops on the same piece of ground this season. * * * Onions grown from seed were splendid and in great demand, but of value only as green onions. Sets do equally well and sell very readily, but are inclined to get strong with age. Celery, with a little care and protection, can be grown successfully. I grew some fine stalks, but did not bleach it properly, as I did not understand how to manage it. Kale grows to enormous size where the soil is rich, and it is of splendid flavor. My customers say that all kinds of vegetables grown here are superior in flavor and tenderness to any they have ever eaten in any country, and I believe this is true. Pieplant and horse-radish are thrifty and tender here with the same cultivation as in Oregon.

Eugene R. Bogart, of Kenai, writes as follows:

At Kenai, 10 miles north of Kussiloff, gardens can be seen, with peas, cabbage, tomatoes, turnips, ruta-bagas, radishes, lettuce, celery, beets, onions, and hills of potatoes, covering in all several acres. There never has been any trouble in raising garden truck at this place, the main difficulty being the poverty of the people and also the getting of seed to plant. * * * At Ninilchik, a village midway between Kussiloff and Anchor Point, are at least 20 acres under cultivation. The principal products are potatoes, turnips, cabbage, and lettuce, but all kinds of vegetables have been raised there.

Anderson Brothers write from Pearl Island, at the entrance to Cook Inlet, and incidentally mention the efforts at gardening by the natives:

The natives, seeing us raising potatoes and other vegetables, started in to raise some themselves, with surprising results. The implement they use in working the ground is generally a barrel stave or other stick of wood. This year most of them have a little garden, but our garden seed did not reach to all. The turnip is held the most easily raised of all garden products. They often grow to the size of a dinner plate in circumference. The native is a willing gardener. They have found that vegetables, along with salmon, save the flour sack a great deal. The commercial seeds found in this country are very unreliable, and if the Department would distribute some seed among the natives, I do not doubt that they would be thoroughly tested. We plant potatoes in May and harvest them the latter part of September or the beginning of October, according to the season. One box of seed potatoes will produce four boxes of as large potatoes as any raised in California and one box of small, immature potatoes.

Rev. V. V. Modestoff writes from Nushagak, a missionary station on Bristol Bay, an arm of Bering Sea:

In regard to gardening, here can be raised potatoes, cabbage, turnips, radishes, lettuce, peas, and carrots. We plant in the early part of June and gather the crops about the middle of September.

Rev. A. E. Carlson, of Unalaklik, a missionary station on Norton Sound, north of the mouth of the Yukon, writes:

We have for a number of years kept a garden at this place. Potatoes, turnips, carrots, cabbage, radishes, and green peas are doing very nicely on sandy soil. The last days of May or beginning of June is generally the time for seed sowing or planting, and the harvest time commences about September 20.

Father Crimont, superintendent of Holy Cross Mission, on the Yukon, some 300 miles from its mouth, writes as follows:

Our experience of eight or ten years has proven to us that agriculture in Alaska is not at all impossible. With very limited means our gardens have steadily improved, and this year our potato yield was 189 bushels to the acre, notwithstanding the unfavorable weather and the lateness of the planting—June 1. As a rule, however, our vegetables do not fully ripen, from the shortness of the season. We are confident, though, of gaining two weeks next spring by sowing wood ashes over the surface of the snow in the beginning of May. We tried it this last spring with satisfaction. Our crop this year was as follows: Potatoes, Early Rose, very plentiful, though small from want of time and being planted too thick; the largest weighed 18 ounces. Turnips, Yellow Globe, sown broadcast in new garden on half-broken ground; they did well; the largest weighed 5½ pounds. Ruta-bagas did better this year than last, having been planted 12 to 15 inches apart; the largest weighed 2 to 3 pounds. Cabbage, Large Drumhead and Early Wakefield, were satisfactory. Cauliflower was only fair this season; too wet. Beets, poor; all went to seed. Carrots, Danvers, did better than ever. Celery, parsley, rhubarb, and lettuce all did well. Onions were very small. We have never tried settings.

OBSERVATIONS ON CATTLE RAISING.

Cattle were introduced by the Russians in their various settlements, and according to reports they always did well. It is certainly

a fact that the cattle which are now found at the little towns along the coast look well during the summer while on pasture, and they appear to have become adapted to the climate. Family cows are kept by many of the white settlers, and one or more dairymen may also be found at nearly every town. The writer took occasion to examine these cattle wherever it was possible, and to look into the methods and cost of feeding. Grades of various breeds were represented. At Juneau the shorthorn type predominated; at Sitka, high-grade Jerseys; while at Kadiak and in the Cook Inlet region Holstein-Friesian grades were most common, with a sprinkling of some small dun-colored cattle with upright horns, said to be of Siberian origin and to be a remnant of the cattle kept by the Russians during their occupancy. The dairy cattle at Wrangell and Juneau, kept with a view to selling milk, were, during the summer, fed bran and other concentrated foods shipped up from Puget Sound ports, in addition to the natural pasture, and in winter the hay they ate was also shipped up from the States. But family cows, as well as beef cattle, were generally kept on native or wild-grass pasture exclusively in summer, and in winter on ensilage or hay made from native grasses.

CONDITIONS FOR CATTLE RAISING ALONG THE COAST.

The excellent condition of the cattle bore evidence to the nutritious quality of the indigenous grasses. On this point it is of interest to quote from reports made to the writer by men from various parts of the Territory who have had experience in cattle raising.

W. W. Warne, of Haines, says:

In stock raising I have had all the way from one to nine head at a time. There has always been an abundance of excellent feed along the beach and in the brush, so that for just about six months, say from May 1 to November 1, the cattle have been able to pick their own living and grow as fat as butter. In the fall, when the wild pea is ripe (of which the country is full), some of my cattle will not touch bran or other grain I offer them. My cows have always been good milkers, whether from breed or feed I can not say. They are mostly shorthorn. For butter they do not do so very well. We usually butcher every year, and the beef, if anything, is too fat, and without exception the finest I ever ate. I do not pretend to feed preparatory to butchering, as I consider the wild pea sufficient grain.

Rev. Albin Johnson, of Yakutat, says:

Cattle thrive, grow fast, and do wonderfully well here, and produce first-class beef. We keep six head of them. Feed is abundant. But there is one difficulty in connection with stock raising, and that is to cure hay for wintering them, because of the heavy rainfall. However, even this problemn can be solved. * * * We never buy anything in the line of hay or feed for our cattle. We make hay enough to last them through the long winter. We dry it by hanging it up on long poles, one above another, up to 12 tiers high, putting it from 1 to 2 feet thick. The last tier makes the roof for it.

Rev. Ivan Bortnovsky, from Kenai, says:

In regard to stock raising, I can say from experience that my cattle are in a splendid condition, healthy, and, from feed which is obtained in this neighborhood,

as plump as cattle which are stall fed in other localities. Alfalfa, timothy, and oat hay can be grown here with great success. Barley, wheat, and other grain hay, from the shortness of the season and the abundant rainfall, become coarse, so cattle will not eat it.

Mr. A. S. Tibbey, of Coal Harbor, makes the following statement:

We have made hay from the same land year after year for twelve years, and never planted any grain, as the native grass has grown on the ground from which we make the hay without our aid. In making hay we cut it, then spread it out to dry, and the next day take it into the barn perfectly cured, and it keeps all winter. * * * From an experience of twelve years I think the country adapted for stock raising. Grass and water is abundant, and in winter the dry grass seems to retain its nutriment, as all the stock we have had seem to enjoy it. The snow does not lie on the ground for any length of time, and cattle can pick up most of their feed all winter.

Mr. L. R. Woodward, United States commissioner at Unalaska, writes as follows:

I have cured and put up from 5 to 10 tons of the wild grass for hay here the last three years, as I had a cow to feed and care for. The hay was very good, and my cow did well on it. The difficulty I found was getting the hay cured, as it rained so much during the summer. I succeeded in making ensilage quite well. For eight months in the year this is a good grazing country, as cattle will live that time without feed, and some years they would live most all the year without feeding. Sheep and hogs do well here also. I am much interested in the agricultural development of the country.

The above quotations are sufficient to indicate what the conditions are at the points named along the coast.

Kadiak and neighboring islands, and, in fact, the entire region from Kadiak westward, would seem to be especially well adapted to stock raising. It is sparsely wooded and covered with a wealth of grass, and in some favorable positions cattle may run out the year around. While the writer was engaged in surveying land for a station at Kadiak the Alaska Commercial Company's schooner *St. Paul* brought in some carcasses of cattle which had been shot on a neighboring island, where, it was stated, they had been running without the care of man for eight years, and had increased 400 per cent. Capt. F. F. Feeney owns a ranch near Kadiak, on which he had at the time of the writer's visit a herd of 42 head of cattle. The barn on this ranch and a portion of the herd are shown in Pl. XLI. They were in splendid condition, and were fed nothing but native pasture.

A PROBLEM IN CATTLE RAISING.

The chief drawback to cattle raising in the coast region of Alaska is the difficulty of curing hay by reason of the frequent rains. The method of drying it on poles, referred to in the foregoing, requires much labor, and is scarcely practicable on a large scale. The silo promises, however, to afford a satisfactory solution of this problem. So far as fair trials have been made in ensilage making, the indications are that the native grasses can be preserved successfully for

FIG. 1.—CATTLE ON CAPTAIN FEENEY'S RANCH, KADIAK, ALASKA.

FIG. 2.—BARN ON CAPTAIN FEENEY'S RANCH, KADIAK, ALASKA.

winter use in the silo. The stock raisers on the coast region are so generally impressed with the feasibility of circumventing the rains and utilizing the native forage by this means that no less than four silos were building this summer at as many different places. How far it will be feasible to introduce cultivated forage plants is one of the problems that will receive early attention in the contemplated experiments.

LOCATION OF EXPERIMENT STATIONS.

Pursuant to instructions, the writer also surveyed land at Sitka, Kadiak, and Kenai, on the Kenai Peninsula, for experiment stations. Each of these regions has characteristics which in some respects differentiate it from the others. The conditions at Sitka practically represent all the heavily timbered region of southeastern Alaska, with its deep moss and peaty soil. At Kadiak the climate appears to be somewhat cooler and the soil less peaty, while in the Kenai Peninsula there is a large area of agricultural land inside the coast range which presents favorable conditions for cropping, although it lies north of the sixtieth parallel.

At Sitka the station comprises 110 acres and at Kadiak 166 acres. Both of these tracts have been reserved by Executive order. At Kenai a tract of 320 acres has been surveyed and recommended for reservation. Experiments at these places will be undertaken as soon as possible. It has been decided to locate headquarters at Sitka and for the present to make this the main station. At Kadiak and Kenai it is proposed to clear and prepare for cultivation only as much land as may be necessary to make a thorough test of the field and garden crops which can be grown at these places. The plan of experiments which has so far been outlined comprises the cost of clearing, draining, liming, and otherwise improving the land for cultivation; the test of hardy varieties of grain and forage crops, with a view to ascertain which can be recommended for the region. The possibilities of flax culture and the development of the flax industry is also to be looked into, as well as the testing of vegetables, the propagation and culture of small fruits, and the propagation and culture of hardy fruits, such as the apple, plum, and cherry. With live stock, a test will be made looking to the economic production of beef, pork, and dairy products, and an effort will be made to ascertain which of the hardier breeds of poultry are best adapted to the country, all of which it is hoped will be of practical benefit to settlers.

FARMING AN AID TO BOTH SETTLERS AND NATIVES.

The efforts which the Department of Agriculture is making to develop agriculture in Alaska will not only help incoming settlers, but will also be of great assistance to the native population. The condition of many native setlements is becoming more precarious year

by year. As the canneries increase in number and favorite fishing grounds are exploited by cannery boats, they can no longer catch their winter supply of fish with the ease they formerly could. The sea otter and seal, which have until recently been an important source of income to the native hunters, are reduced in number almost to the point of extinction, and with the advent of the prospectors and the professional hunter, even the large game and the fur-bearing land animals are rapidly diminishing in number. As these sources of livelihood become more and more depleted, the natives will be compelled either to appeal to the Government for aid or starve. The danger is a real one, and decisive steps should be taken to prevent this result. The only practicable remedy would seem to be to encourage the natives to cultivate the soil for at least a part of their living. The transition will not come easy to them, for they are not inclined in that direction by nature, but much can undoubtedly be done by gradual and persistent effort. As a beginning in this direction, seeds of hardy vegetables and grains will be distributed among the natives, and the cooperation of missionaries and other well-disposed white settlers will be secured to aid them in learning the successful practice of agriculture.

CYCLONES, HURRICANES, AND TORNADOES.

By F. H. Bigelow,
Professor of Meteorology, Weather Bureau.

ORIGIN AND CHARACTERISTICS OF THE THREE CLASSES OF STORMS.

Storms are divided into three classes, cyclones, hurricanes, and tornadoes, depending upon certain characteristics which will be discussed briefly in this paper. The ordinary storms that move over the United States are cyclones, and they come from the northwest or from the southwest, but in either case they usually pass off toward the Gulf of St. Lawrence. Cyclones occur at all seasons of the year, and they are much more vigorous in the winter than in the summer. The hurricanes never come from the northwest, rarely from the southwest, but they usually enter the United States from the south or southeast. They originate in the eastern parts of the Caribbean Sea, travel by a curved track northwestward at first, gradually changing more to the northward and northeastward in the Gulf and Atlantic States, till they, too, join the great path in New England by which storms leave this country. Hurricanes occur in the late summer or early autumn, from July to October in this part of the world, and they are very violent, the wind reaching 60 to 80 miles an hour in the central portions of them, so that they are usually destructive to the cities and towns visited by them. Tornadoes are much smaller in size, and even more dangerous than the hurricanes. Cyclones may be 1,000 miles in diameter, hurricanes somewhat less, say 600 or 800 miles, while a tornado is only a mile or so broad at the top and very much less at the bottom. The tornadoes of the United States occur most frequently in the Mississippi and the Ohio valleys, though there are few States east of the Rocky Mountains which do not receive occasional visits from them. They form in all parts of the temperate zones under different aspects, being known at sea as waterspouts, in deserts as sand storms. Small tornadoes are called fair-weather whirlwinds when they happen in fair weather on the lakes or on land under suitable conditions; white squalls in a dry atmosphere, only a small white cloud high up being visible. Bull's-eye squalls, which occur near the west coast of Africa, are quite similar in origin to the white squalls. A family of tornadoes may be produced at the same time, coming down from the same cloud, as many as fifteen tubes having been observed at once. Spouts are sometimes noted in clear and calm weather, when they are apt to be very small. Generally in this country tornadoes are formed in

the southeastern quadrant of a cyclone, and they move forward with about the same speed as the larger storm. It may be noted here that there are many minor whirls in the cloud region which have a gyratory motion, and that these are perhaps the first stages of the developments likely to grow into movements of large dimensions.

APPEARANCE OF THE DIFFERENT TYPES OF STORMS.

The appearances of the different types of storms are such as to clearly distinguish them from one another. The weather map issued daily by the United States Weather Bureau has sets of lines which inclose different kinds of areas of barometric pressure. The encircling lines are about parallel to one another, though many irregularities distort them and make them different in shape from circles. Some of these lines inclose areas of high pressure, as indicated by the barometer readings, and others low-pressure areas. The former are called anticyclones, because the wind blows out of them and circulates in the direction of the motion of the hands of a watch, thus making an outwardly directed spiral path. The latter are called cyclones, and the wind blows toward and around the center in the opposite direction to the motion of the hands of a watch, producing inward spirals. Evidently the air coming from the anticyclone must have a downward motion toward the ground to supply the place of that which flows away on all sides, while that entering the cyclone must have an upward movement to carry off the air entering the inclosing curves or isobars, as the lines of equal pressure are called.

MOVEMENT OF THE AIR AND APPEARANCE OF THE SKY.

The downward and upward movement of the air over the high and low areas, respectively, has very much to do with the appearance of the sky, for it is known from physical laws that air which moves downward grows warmer by compression, and that therefore any cloudy masses in the higher strata would disappear in the lower, because as air is heated it requires more aqueous vapor to saturate it. If the air rises, it cools by expansion, and can contain less vapor in the saturated state, so that the result is to form clouds and rain in the low-pressure areas. The reason cyclones are popularly spoken of as storms is because the precipitation usually occurs in them, while at the same time the wind is stronger than in the anticyclones.

A survey of the upper currents in the atmosphere, which can be made by studying carefully the movements of the clouds, shows that, while the structure of the circulation of the air is not very simple, yet it can properly be divided into two principal layers. The upper layer, embracing the strata from 3 miles above the ground to 6 or 7 miles high, includes several types of clouds peculiar to it, the alto stratus, alto cumulus, the cirro stratus, cirro cumulus, and the cirrus. The lower 3 miles contain the stratus, cumulus, and the strato-cumulus

cloud forms. All stratus clouds have a continuous, sheet-like appearance, and all the cumulus a rounded shape, like the backs of a flock of sheep huddled together; hence, it is easy to distinguish the currents of air in the upper and the lower region. It has been shown by the cloud observations that the strata of the upper and the lower layers of the air have very different kinds of motions over the United States. The upper levels move almost directly to the eastward at a great rate of speed, like a steady river flowing onward with but little to disturb its majestic current. The rate of motion increases upward with the height to 80 or 90 miles per hour in the cirrus level, that is, 6 miles high, each layer going faster than the one just beneath it. Hence, it can be readily inferred that there is a strong force acting to brush eastward any masses of air which are thrust upward into this region, and therefore all rising heated air, or the vapors which are driven up by whirling motions, are soon thrown toward the east like a column of smoke rising up into a strong current of wind. The consequence of this operation is to cause the clouds to overhang the eastern side of a cyclone rather than the western; thus, the observer many miles to the east of a storm sees the premonitory flying cirrus clouds before the storm proper arrives, and in this way the clouds may be utilized as harbingers to forecast the coming of a cyclone. A further study of these upper cloud masses shows that the forerunners succeed each other in quite a definite order. The cirrus and cirro stratus come first, the cirro cumulus next, and these are lower down by a mile, more or less; after these the alto cumulus and alto stratus, the clouds now becoming much more dense and continuous in their formation. They now form still lower, and the rain types set in—cumulus, cumulo nimbus, and nimbus—which are within a mile or two of the surface, and cover the central portions of the storm. Thus, it can be seen that the clouds, taken as a whole, form a shape much like a saucer looked at from beneath, the edges being higher than the central portions. In the rifts occurring within the thick masses of clouds near the center it is sometimes possible to make out two or three layers over each other at the proper elevations. On the western side of the cyclone the cloud banks end much more abruptly than on the eastern, the upper currents serving to sweep them toward the middle on the west side and away from it on the east side.

The upper currents are slightly deflected from the true eastward drift, flowing in gently sinuous lines, southward from a high area to a low area, and northward from a low area to a high area. These curvatures increase gradually in depth, from the cirrus to the alto cumulus, and in the strato cumulus, 2 miles high, they are very pronounced, the rotating tendency here beginning to control the circulation. From the cumulus to the ground the anticyclonic and the cyclonic gyrations are fully developed, and in the lower 2 miles the air moves about centers, producing the high and the low pressures at

the surface. It is interesting to note that from the ground upward to 2 miles the air moves in great circulating streams, having greater velocities as the height increases. The steady eastward movement in the upper levels is replaced by a confused set of currents squirming about among themselves, cold streams from the north, warm streams from the south, seeking to reduce their differing temperatures to the mean temperature of equilibrium. These streams are thousands of miles in length, say from the north Pacific coast to the Lakes, and from the Gulf of Mexico to the same region, where they produce a whirling or cyclonic action by their meeting together in a counterflow. At the same time this gyration takes on the laws of vortex motion and discharges the accumulating air upward into the great eastward drift. This addition of a circulating rotation to the straight eastward current causes the deflection alluded to, which is observed as a sinuous movement diminishing with the altitude till in the cirrus it is of but little importance. This counterflow of adjacent currents, alternately from the southwest and northwest, causes the formation of successive high and low areas of pressure by the operation of a deflecting force, due to the motion of the air over the surface of the rotating earth, so that a current moving north crowds eastward and a current moving south bends westward. It will be easily perceived that alternate currents from opposite directions thus heap up together on one side and pull apart on the other, forming in the first case a high area and in the second a low area. Around these the anticyclonic and the cyclonic movements take place, respectively, drawing down the upper air and thrusting it toward the ground, accompanied by a clear sky in the first case, but upward with cloudiness in the second case.

SOURCE OF ENERGY OF STORMS.

It has commonly been supposed by meteorologists, and the theory has been widely received, that the heated air of the Tropics rises near the equator, flows in the upper strata toward the poles, and then descends in the arctic regions to complete its circuit near the ground toward the equator. Now, while there is some truth in this view, yet the cloud observations give almost no evidence in support of this overflow poleward in the upper strata, a fact which is in striking contrast to the requirements of the theory. On the other hand the interchange of polar and tropic air, cold and heated masses, seems to be almost exclusively confined to the lower 3 miles of the atmosphere, and it certainly does not involve the upper layers to any important extent. The solar radiation expends most of its energy in these lower 3 miles, because there the air has greater density, and also the vapor contents are to a large percentage contained in this stratum. The consequence is that there exists a somewhat lawless interchange of warm and cold air in the lower stratum, with long currents of air having their bases in the Tropics and the polar zones,

respectively, which meet in the middle latitudes of the United States, and by their conflict and the laws of disturbed equilibrium generate the very confused and stormy circulation so characteristic of this country. It is not easy to distinguish clearly the dividing line between the general circulation of the air and these local cyclones, since both go on simultaneously and gradually merge into one another; but it is plain enough that the real source of the power expended in storms comes chiefly from this source, namely, the unequal heating of the lower atmosphere by the sun shining on the Tropics. Hence, a current of air from the Tropics may be impelled onward by its general gradients for days at a time, and another from the northwest may be sustained by its independent gradients. These must meet each other, form a cyclone with true vortex motion and an uplifting current in the center, which raises the moisture-bearing air to the point of cold suitable for saturation, when the rainfall occurs. This may continue for days, as long as the distant supply continues to flow onward. At the same time the upward thrust of this air into the eastward-drifting upper strata, entangles the storm with it, and this produces the onward motion of the storms across the United States.

FEATURES OF CYCLONES.

Cyclones do not have any local source of heat that will account for their vast ranges of operations; they are often very cold on one side and warm on the other side; they do not derive much of their energy from condensation of vapor into rain, because many dry cyclones, fully formed and deep, are seen to pass from the Pacific to the Atlantic coasts with almost no precipitation; there is much rain with a cyclone in the Gulf States, because the tropical streams of air are there highly charged with moisture, the rain being very largely a product and not a cause; also, heavy and widely extended rains occur under other conditions without any important cyclonic action. The proper study for the meteorologist is therefore the behavior of these extensive independent streams of warm and cold air in their counterflow. Also, it should be remembered that the closed isobars, circular or roughly elliptical at the surface, lose their closed character within 2 miles of the ground, pass into sinuous curves, and finally straighten out into lines quite nearly coinciding with the parallels of latitude. There is no special source of energy above a storm, within these 2 miles, to be discovered by special observations, and the movements of the air in this lower layer are the same in direction above as below, though somewhat more rapid and rounded in their curvatures above than at the ground. A complete knowledge of conditions observed at the surface, or visible from it, comprises all the information that will be available in the practical discussion and forecasts of storms, except for the more strictly scientific problems involved in the subject.

FEATURES OF HURRICANES.

As already mentioned, hurricanes occur in the southeastern parts of the United States and adjacent waters during the season of the year when the cooling of the northern hemisphere takes place, as the sun retreats toward the southern hemisphere. At this season the calm belt of the tropics and the heated, moist condition of the air in the region known as the doldrums are at their farthest northern limit. The South Atlantic permanent anticyclone, which lies over the subtropical ocean, is in its fullest vigor. Now, superposed upon these states of the lower atmosphere, the colder temperatures of the upper atmosphere, caused by the approaching autumn, on account of the more rapid circulation higher up, overspread the tropic strata near the surface. As the polar air cools first, it flows gradually above the warmer air at the south of it near the ground and covers it with a circulating sheet of temperature cool or low for the time of year. The effect of all this is to make the atmosphere unstable, that is to say, too warm at the bottom compared with that above it to be able to maintain the usual equilibrium. The tendency is therefore for the lower air to rise vigorously, and burst its way upward by convection, in order that the normal equilibrium may be restored. Of couse, this action is favorable to the formation of cyclonic gyrations and the development of severe storms. Hurricanes seem to generate in some such way as this, though our observations are as yet inconclusive on that point, since there is always observed to be a stagnant, warm condition over the ocean at the time the incipient cyclonic action begins. It is to be especially considered that the isotherms in hurricanes do not show any very decided differences in temperature on opposite sides of the center, such as always prevails in the cyclones of the north. There are no counter-flowing currents here, and no source is known from which these can arise in the equatorial region to produce the marked temperature gradients found in cyclones. Furthermore, hurricanes are much more circular in shape, and conform more exactly to the pure theory of cyclones, as derived from mathematical analysis.

There is another feature of great interest to be considered. It was stated that in the case of common cyclones, even those having very great strength, the deflection or distortion of the eastward drift at the 3-mile level is only moderate. In the case of hurricanes, which are centered in the East Gulf States so that the wind directions can be observed on all sides, it is proven that the circulation is not only more rounded, but also that it penetrates the upper strata very much farther, and twists even the cirrus level entirely out of its ordinary shape. The circular components are therefore very strong up to 6 miles in hurricanes, while they are equally pronounced in cyclones only to a height of 3 miles. This is a very marked characteristic, and indicates that hurricanes depend largely upon vertical convection for their power, while cyclones depend almost exclusively upon horizontal convection, that is, upon the counterflow of very long branches of horizontally moving atmosphere, having their bases several thousand

miles apart. As hurricanes move northward, out of the Tropics, they gradually assume the nature of true cyclones, since vertical convection is finally superseded by horizontal convection in the North Atlantic districts.

The physical features of hurricanes are well understood. The approach of a hurricane is usually indicated by a long swell on the ocean, propagated to great distances and forewarning the observer by two or three days. A faint rise in the barometer occurs before the gradual fall, which becomes very pronounced at the center; fine wisps of cirrus clouds are first seen, which surround the center to a distance of 200 miles; the air is calm and sultry, but this is gradually supplanted by a gentle breeze, and later the wind increases to a gale, the clouds become matted, the sea rough, rain falls, and the winds are gusty and dangerous as the vortex core comes on. Here is the indescribable tempest, dealing destruction, impressing the imagination with its wild exhibition of the forces of nature, the flashes of lightning, the torrents of rain, the cooler air, all the elements in an uproar, which indicate the close approach of the center. In the midst of this turmoil there is a sudden pause, the winds almost cease, the sky clears, the waves, however, rage in great turbulence. This is the eye of the storm, the core of the vortex, and it is, perhaps, 20 miles in diameter, or one-thirtieth of the whole hurricane. The respite is brief and is soon followed by the abrupt renewal of the violent wind and rain, but now coming from the opposite direction, and the storm passes off with the several features following each other in the reverse order.

By the laws of vortex motion the winds approach the center in spirals, the circular and the centrifugal movements increasing every moment. At the core within the walls of the columnar vortex the air circulates about the calm central part, gradually rising to the cloud stratum, just above the inflowing disk. Here the air flows out suddenly on all sides, the circular motion decreasing, the air cooling by expansion, causing a great, thin sheet of rain 200 to 300 miles from the center. At this distance the vortex sheet turns up suddenly (not down, as usually stated) and discharges the expended matter into the high upper currents of the atmosphere. The feeding wind lines are more nearly parallel to the ground than the upper discharge lines, but they all form a columnar vortex of unusual configuration. There is probably no feature of nature more interesting to study than a hurricane, though the feelings of the observer may sometimes be diverted by thoughts of personal safety.

FEATURES OF TORNADOES.

The formation of tornadoes is attended by the two features which have been described, namely, the counterflow of two horizontal currents of air, and the vertical convection, which is of local origin. They are of small dimensions, but particularly vicious and destructive. They occur during the summer, when the warm weather is at its maximum. The interior of the country is heated; the ocean districts

are comparatively cool. The great Atlantic high area, produced by the general circulation, protrudes upon the southeastern districts; in the same way the Pacific "high" overlays the northwestern districts of the plateau. Hence, between these, in the Mississippi and Missouri valleys, there is a region of encounter for the southern winds produced by the Atlantic "high" and for the northern winds maintained by the Pacific "high." The southern winds are warm and charged with aqueous vapor; the northern winds are cool and comparatively dry. The meeting of these two types of winds in the central valleys, the same conditions extending along the Ohio Valley to the Lower Lakes, is attended by two or three typical local effects. In the first place, there are calms at intervals, local pools of stagnant atmosphere, into which these opposing currents have not penetrated; in the second place, the intense radiation of the sun superheats the strata of air near the ground and causes relatively unstable equilibrium, with its tendency to overturn the strata in a vertical direction; in the third place, the cool currents from the north, borne aloft in the general eastward drift, tend at times to overlay this stagnant atmosphere in the ground stratum and to increase the unstable equilibrium.

CONDITIONS PRODUCING STORMS.

The above are the conditions that always favor the formation of local storms, tornadoes, thunderstorms, and showers, in which precipitation generally occurs during the summer. Masses of air of different temperatures in the great north and south currents may thus approach a stagnant and calm region, such as the later hours of the afternoon develop, the increase of cloudiness being merely a symptom of the existence of rising and cooling currents, which portend a storm, and finally set the entire mass into a mixed congested state. The cool air comes down and the warm air rises, but they both resist mixing intimately. Rather they tend to be drawn out into long bands or ribbons before such mixing is accomplished, and these are the conditions for local showers. When the condensation is rapid in the strata a mile high, the formation of thunderstorms and electric discharges is caused. In certain peculiar formations of the circulation a tornado tube is projected downward. This is a simple vortex and obeys the laws of the movements of fluids in gyratory circulation. If a mass of air 6,000 feet in diameter is rotating at the half-mile level and it runs into a vortex so that the tube is 100 feet in diameter, and supposing the outer edge of the upper part of the vortex makes 7 miles per hour, then at the rim near the bottom of the vortex we should have a velocity of 200 miles per hour. This causes an enormous centrifugal force in the lower tube, a partial vacuum of low temperature. It is accompanied by a forward movement of the entire vortex system. The vacuum tube causes the explosive and disastrous effects upon the objects in its path, as noticed in the tornado accidents; the wind at great velocities prostrates every obstacle; the cold generates the sheath of vapor

that makes the tube visible; the same sudden condensation causes electric discharges, just as in thunderstorms on a large scale. There is no real mystery about the formation of tornadoes or respecting their terribly destructive power. It all goes back to the same principle that discharges a gun, in which case there is a sudden formation and expansion of gas; but in the tornado it is the reverse process, namely, the sudden production of a vacuum into which outside air discharges itself, that is, into the hollow vortex tube, and with the further result of quickly cooling the heated air drawn into the vortex.

NO PRACTICAL PREVENTIVE OF TORNADOES.

There is no practical way of warding off tornadoes when conditions are favorable for their development. The tubes resist an explosive discharge in the air outside, these having often been fired upon by cannon at sea. They sweep readily through a forest or a city. There seems to be no annual increase in the number of them. Some have sought to connect their recurrence with the frequency of sun spots, and it is possible that there is some indirect connection, just as in all the other elements of the weather, but only through the general circulation.

WHERE AND WHEN TORNADOES OCCUR.

There are some portions of the United States which are free from tornadoes, such as the Rocky Mountain plateau and slope. In the central valleys they are of annual occurrence, and they are likely to visit almost any of the States east of the Mississippi River. In the winter months tornadoes occur only in the Gulf States, but as the weather grows warmer they extend northward, and in the summer they are of the greatest frequency in Nebraska, South Dakota, Iowa, and Minnesota. This variation is evidently to be referred to the average probability of cool currents of air from the north encountering warm, moist currents from the south, in the intermixture which is always going on throughout the lower strata, farther north in summer than in winter. More tornadoes occur in the months of May and June than in the other parts of the year, and this is due to the same principle of contrast in temperatures, which is greater locally in the spring than in the summer, when heat prevails generally, or in the winter, when cold is widely distributed.

The annual average number of tornadoes which are well defined and destructive is about twenty-five, and their frequency is quite uniform from year to year. Of this number the destructive tornadoes of great violence have been twenty-four in eight years, that is, three each year. The record shows that from 1889 to 1896 property to the value of $31,000,000 was wrecked. As much as $23,000,000 of this must be attributed to three tornadoes, or tornadic hurricanes, which passed through the regions of dense population, namely, that which visited Louisville, March 27, 1890, destroying property to the value of

$3,000,000; that which visited St. Louis, May 27, 1896, from which the loss was $13,000,000, and that which traveled from Cedar Keys to Washington, D. C., September 29, 1896, from which the damage was $7,000,000. The latter was more strictly a hurricane, but many of its features were very close to a large tornado in type. Previous to 1889 the records show that there were three destructive local storms annually for each of the preceding eighteen years.

WIND VELOCITIES OF TORNADOES.

It has not been easy to secure exact data for the computation of the wind velocities which accompany tornado vortices, but the great waterspout of August 19, 1896, which developed in Vineyard Sound, about 7.5 miles northeast of Cottage City, and of which very good photographs were taken, to some extent supplies this defect. The bearings of the spout were noted from several places, so that its place can be plotted accurately on the map and its dimensions computed. It was found that the tube extended from the cloud to the surface of the sea, 4,200 feet, was 3,400 feet in diameter at the top, 170 feet at the narrowest part, which was 1,500 feet above the sea, and about 250 feet at the sea. This expansion near the surface was due to the retardation caused by contact with the water and the suction of air into the tube from below. The radial velocity was outward from the top to the narrowest part, ranging from 7.0 to 0.3 miles per hour, and very feebly inward in the lower third; the rotation velocity at the cloud was 14.0, and near the sea 350 miles per hour, this being the velocity of a body falling freely from the height of the cloud to the sea; the vertical velocity was 0.1 at the cloud and 35 miles per hour at the sea.

The effect of these motions is to strike a very severe blow laterally upon any object upon which the tube impinges, and to lift vertically at the same time. The air just outside the tube is undisturbed, and the sudden contact with the tube is like a stroke from a heavy hammer. The formula shows that this is equivalent to a sudden pressure of 330 pounds to the square foot at the maximum. The destructive effects at St. Louis upon the bridge and upon heavy buildings indicates a pressure of 60 to 90 pounds per square foot as that which must have been exerted to produce the observed effects. This would imply a rotatory velocity of about 175 miles in the St. Louis tornado. It is evident that the Vineyard waterspout was one of the largest of its class. Contrary to common experience, it occurred on a day when the humidity of the air was low, instead of high, as usually supposed. This shows that the origin was chiefly dynamic, rather than due to heat processes wherein aqueous vapor is turned into water. The inference regarding the structural strength of buildings is that they ought to be able to resist at least 40 pounds per square foot applied laterally, for extraordinary storms, such as hurricanes, but that nothing which can be built is likely to withstand the vortex of a tornado when it operates in full power.

FORAGE PLANTS FOR CULTIVATION ON ALKALI SOILS.

By Jared G. Smith,
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INTRODUCTION.

When the excess of alkali in a soil rises to such a sum total that the cereals can not be grown, the best use to which the land can be put is the growth of forage.

There is no crop, so far as known, which can be profitably grown on land that contains over 2 per cent of the combined alkalies within the first 2 inches of surface soil. Soils containing as much as 1 per cent of alkalies within the first 2 inches will not grow cereals, and the maximum for trees, vines, and root crops is much lower. There are extensive areas in the West which are thus excluded from the category of farming lands because of the excess of alkalies. Such lands are not necessarily barren, although they can not be profitably cultivated. They are often covered by a rank growth of vegetation, indicating that there is an abundance of plant food in the soil, if only the plants are so tolerant of alkali as to be able to secure it. Many of the alkali plants have considerable value as forage, and of these some few show special adaptation to the changed conditions which cultivation brings.

The crops which originated in humid regions will not grow on soils which are strongly impregnated with the alkalies, and so to meet the conditions one must either take the useful plants of the alkali regions of his own country or depend upon those which have been introduced from similar regions elsewhere. If it is not possible to grow a vineyard or an orchard, a field of alfalfa or one of grain, there are a number of forage crops that can be successfully cultivated, because they originated in alkali regions and are tolerant of considerable amounts of alkali in the soil.

As the amount of alkali in the soil increases the number of species of plants which will thrive decreases. Hilgard, Loughridge, and Davy have published many interesting observations as to the occurrence of different plants on alkali soils, and as to the maximum quantities of alkali of which different native plants and cultivated crops are tolerant. Davy states that there are in the State of California 197 species that grow only on alkali soils. Some of these occur in similar situations in many other parts of the West, while others are found only in California. The greasewood of the Pacific coast (*Allenrolfea occidentalis*) will grow in a soil containing a maximum of 194,760

pounds of alkali salts per acre to the depth of 1 foot. The scrub saltbush (*Atriplex polycarpa*) will grow where there are 78,240 pounds, while samphire (*Salicornia*) was found growing on land which contained 306,000 pounds, or more than fourteen times as much as the greatest amount of which wheat is tolerant. Wheat will grow on land which contains a total of 20,520 pounds or less of the sulphates, carbonates, chlorides, and nitrates of soda and potash per acre to the depth of 1 foot. This amount of alkalies is less than one-half of 1 per cent by weight of the soil. In contrast, Kentucky blue grass will only withstand a total of 2,680 pounds, while Australian saltbush will endure 30,920 pounds.

EFFECT OF ALKALIES ON PLANT GROWTH.

When wheat is sown on land containing as much as 1 per cent of the alkalies, the seeds are unable to germinate, or if germination takes place the young plants die of thirst, although the soil may contain water enough for the needs of the plants if the alkalies were eliminated. Alkalies in solution increase the density of the soil waters, and the young plants die of thirst, because the soil absorbs the water from their roots instead of the roots absorbing water from the soil. There is usually more alkali at the surface than at the depths where the roots feed, and it is often the case that a crop will live on land containing an amount of alkali which would prevent the germination of its seeds. Thus alfalfa is an excellent crop for moderately alkaline soils, because the thick growth and abundant leafage shade the soil and prevent evaporation of water and accumulation of alkalies at the surface. The long taproots penetrate to the deeper levels, where there is comparatively little of the alkali present.

When there is an excess of the injurious salts at the surface, the seeds are unable to absorb water and there is marked retardation of germination. Buffum[1] has shown that while 82 per cent of alfalfa seeds germinated in five days on soil from which the alkali had been extracted and in four days on wet pads containing no alkali, it required fourteen days to germinate 80 per cent when 1 per cent of combined alkalies was present. A similar retardation took place with turnips, barley, rye, oats, and wheat. The seeds appear to lie dormant for a short time, ready to start growth when the alkaline solution becomes sufficiently diluted to enable them to take up the necessary water. Similar germination experiments were undertaken by Dr. Leather[2] during his investigations of "usar" land in northwest India in 1895 and 1896 to determine the effect of the soda salts on seeds of corn, wheat, barley, peas, gram, and cotton. The germination of the cereals was seriously affected by seven-tenths per cent of either sal soda or Glauber's salt in the soil. The germination of corn and barley was

[1] Bul. 29, Wyo. Agr. Exp. Sta., 1896.
[2] Agr. Ledg. No. 13, 1897 (Calcutta).

retarded by from two-tenths to four-tenths per cent of common salt, and cotton was similarly affected. Peas and chick-peas were affected by a much smaller per cent. Two-tenths per cent of the black alkali prevents the growth of most cultivated crops from the seed, corroding and destroying the plumule after it has emerged from the seed coats. But where the deeply rooted leguminous crops, such as alfalfa, once become established, or where rooted cuttings of other plants are set out so that the roots feed below the surface, they will withstand more alkali than the cereals or other annuals. The salts are concentrated at the surface, and thus prevent the germination of the seeds, while the alfalfa and the rooted cuttings feed at depths where a very much smaller amount is present.

NATIVE PLANTS OF ALKALI SOILS.

Among the plants which only grow on alkali soils, there are many which are valuable for forage. The late Baron Von Mueller, the eminent Australian botanist, first drew attention to the importance of the cultivation of such plants. In the first edition of his work, "Select extratropical cultivated plants," published in 1872, he showed the possibility of utilizing the orache, a saltbush of the gardens, which is a native of southern Europe and Africa. In the 1876 edition he added two species of Australian saltbushes to his list. Later explorations, conducted largely by Von Mueller and associated botanists, developed the fact that the vegetation of extensive areas in the central portion of Australia, notably in western New South Wales, Queensland, and South Australia, consisted almost entirely of Atriplex. The fact was known that these Atriplex, or saltbush, areas would carry and maintain in better condition a larger number of sheep and cattle than would be supposed, judging from the limited grass vegetation. Stock grazed on saltbush was also remarkably free from parasitic diseases, and it was assumed that the plants had tonic properties owing to some bitter principle, together with the large amount of salt, found in the leaves. Through Von Mueller's efforts, the cultivation of a number of saltbushes was undertaken in South Africa and Australia, northwest India, and later in California, and everywhere the plants showed remarkable adaptation to saline or alkali-impregnated soils. The success of these experiments led to similar ones with saltbushes native to the various alkali regions of the world, and a larger number of species have been shown to be adaptable to the various climatic zones.

To show the small beginnings of one of these experiments, Mr. E. G. Alston, the well-known experimental agriculturist of Cape Colony, planted in April, 1886, six seeds of *Atriplex halimoides*, which had been obtained by Professor MacOwan from Baron Von Mueller. Two of the seeds germinated, but one plant died before reaching maturity. The seeds from the single remaining plant were saved and tried the

following years on a larger scale. This one plant has been the mother of nearly all of the South African stock of a species now widely cultivated by sheep men in all of the colonies.

The seed production of all of the saltbushes is enormous. Plants of *Atriplex semibaccata*, grown on the grounds of the Department of Agriculture, commenced to blossom and ripen seed when only 6 inches high, and continued until their growth was checked by severe frosts, about the first of November. It is probable that many of the plants ripen thousands of seeds in a season's growth. A plat of *Atriplex holocarpa*, 5 feet square, ripened half a bushel of seed, gathered by frequent pickings during the season of 1898. On the first of November, when growth had entirely ceased, the ground was covered to the depth of 2 inches with the globular, spongy seeds. The saltbush that has been most extensively cultivated in this country is *A. semibaccata*, which was introduced by the California experiment station about 1880. Importations of seeds of this and others have since been made by the Department of Agriculture and by a number of Western experiment stations.

Numerous analyses of the different saltbushes and alkali plants have been made with the view of determining their feeding value. The percentage of ash is very high, ranging from as much as 19.4 per cent of the total weight of dry matter of the plant in *A. semibaccata* to 31.3 in *A. nummularia*, and even 37.2 in *Kochia pyramidata*. The alkali grass (*Sporobolus airoides*), which, as its name implies, thrives on alkali lands, contains but 9 per cent of ash, while the amount in alfalfa averages only 2.7 per cent. The difference in the composition of the ash in a number of these plants is shown by the following table:

Composition of the ash of saltbushes and greasewood, compared with that of Eastern-grown alfalfa and timothy hay.

Name of plant.	Silica.	Potash.	Soda.	Lime.	Magnesia.	Iron.	Alumina.	Phosphoric acid.	Phosphoric oxide.	Sulphuric acid.	Sulphuric oxide.	Chlorine.	Sodium chloride.	Carbonic acid.
	P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
Saltbush, *Atriplex semibaccata*[1]	16.21	11.42	35.39	5.79	3.23	1.38	1.95	2.80	.....	2.64	.....	24.33	....	.....
Saltbush, *Atriplex nummularia*[2]	1.12	15.69	29.57	8.65	6.77	.64	.....	.....	4.11	.....	3.17	.....	30.28	.....
Gray bush, *Kochia pyramidata*[2]	1.52	12.39	34.43	8.75	7.32	1.28	.....	.....	3.98	.....	1.11	.....	26.67	.....
Greasewood, *Allenrolfea occidentalis*[1]	11.81	18.53	39.45	1.36	1.09	.....	.....	3.51	.....	4.93	.....	.....	.....	.....
Greasewood, *Sarcobatus vermiculatus*[3]	3.00	22.06	23.89	6.52	1.35	(4)	[4]4.73	4.12	.....	4.33	.....	8.01	.....	23.80
Eastern timothy hay[1]	35.60	28.80	2.70	9.30	3.60	.....	.....	10.80	.....	3.90	.....	5.00	.....	.....
Eastern alfalfa hay[1]	9.3[illegible]	23.45	1.56	44.30	4.68	.....	.....	8.34	.....	5.73	.....	3.12	.....	.....

[1] Bul. 105, Cal. Agr. Exp. Sta., 1894.
[2] Bul. 22, N. Mex. Agr. Exp. Sta., 1897.
[3] Journ. Proc. Roy. Soc. N. S. W., Vol. XIV, 137, 1880.
[4] Iron and alumina estimated together.

The most striking variation is in the amount of soda present in the ash of the greasewood and saltbushes as compared with Eastern alfalfa and Eastern timothy hay. In the latter the amount is inconsiderable, while nearly two-fifths of the ash of greasewood (Allenrolfea) is composed of soda. The draft on potash and phosphoric acid is very much greater in the alfalfa and timothy than in the saltbushes. Alfalfa takes up five times as much lime as any one of them. Hilgard has estimated that a crop of 20 tons of green saltbush, equal to 5 tons of saltbush hay, will remove 1 ton of soluble mineral matter from the soil.

Where the excess of alkali is only very slightly above the maximum borne by the cereals, the land can be put in condition for the growth of other crops by planting saltbush and removing the successive crops from the field. If a soil containing 30,000 pounds of the soda salts to the acre foot is cropped with saltbush, which is each year removed from the field and fed elsewhere, the time when wheat and barley may be grown will be hastened. Saltbush would not produce this effect if it were allowed to remain on the field or if it were grazed. Neither can this method be profitably used where there is any very large amount of alkali in the surface soil, on account of the time requisite for noticeable improvement. At a 20-ton yield of the green herbage per acre the soda salts removed each year would amount to 1,200 pounds.[1] Saltbush withstands black alkali better than any other cultivated crop, probably because the dense mat of vegetation completely shades the soil and prevents evaporation and the subsequent rise of the salt to the surface, where it becomes poisonous to plant life.

SALTBUSHES NATIVE TO AUSTRALIA.

There are a large number of Australian saltbushes which would be valuable if introduced into this country. There are undoubtedly many which may be profitably experimented with to supply the needs of sections too cold for the successful growth of those already introduced. Some of the more valuable will be mentioned here.

AUSTRALIAN SALTBUSH.

Australian saltbush (*Atriplex semibaccata*, fig. 125) is a much-branched perennial, which forms a thick mat over the ground to the depth of a foot. The branches extend from 6 to 8 or 10 feet, so that one plant will often cover an area of 20 feet in diameter. The leaves are about an inch long, broadest at the apex, and coarsely toothed along the margin. They are fleshy and somewhat mealy on the outside. The pulpy, flattened fruits are tinged with red at maturity, but dry out as soon as they fall from the plant. They are produced in enormous numbers and ripen continuously for three or four months, or in situations where growth is perennial throughout the year. At the California experiment station it was determined that

[1] Bul. 105, Cal. Agr. Exp. Sta., p. 16, 1894.

the seeds germinate better when sown directly on the surface without any covering. When they were harrowed in to the depth of 2 or 3 inches most of them either rotted before germination or the young seedlings were unable to reach the surface. Some practical stockmen have had good results in establishing this saltbush on an alkali range by sowing the seed on the ground when it was wet with heavy rains and at once driving a flock of sheep over the land, thus treading them into the soil.

Sheep are especially fond of this saltbush, and cattle relish it if combined with other feed. Von Mueller states that in his opinion many of the valuable qualities of the Australian wools are due to the abundance of this and other saltbushes in the regions in which the

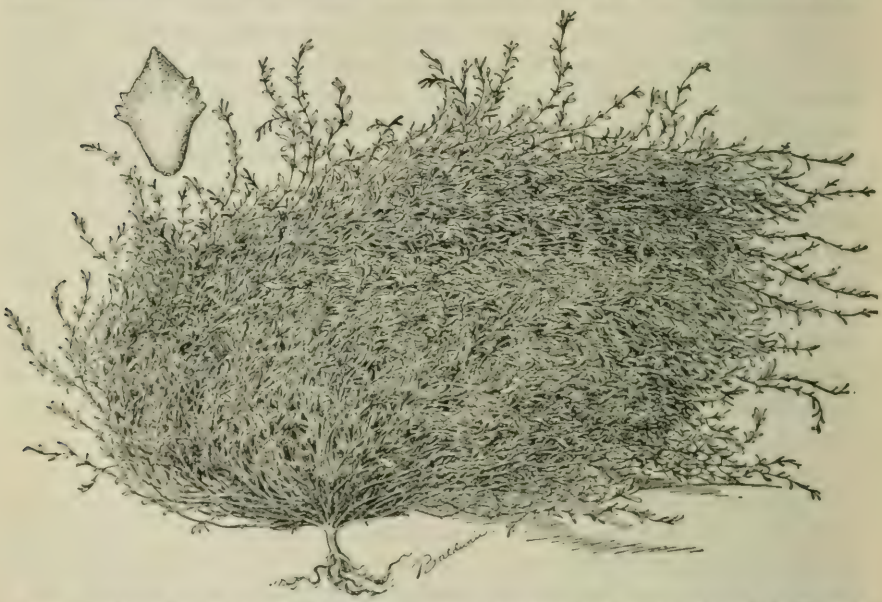

FIG. 125.—Australian saltbush (*Atriplex semibaccata*) grown in the grass garden of the Department of Agriculture.

sheep are grazed, and Turner states that if the saltbushes were entirely exterminated it would tend to decrease the value of the wool. The plant may be propagated by cuttings, as well as from seed, and this method is to be preferred wherever the land contains much alkali. The seeds will germinate in the presence of an amount of soda salts which would entirely prevent the growth of cereals. This is especially true in the case of Glauber's salt, though there is of course a limit to the amount of alkali the plant will tolerate, as in the case of wheat or alfalfa. This saltbush is perennial in California, Arizona, and New Mexico, but must be treated as an annual wherever the winters are at all severe. In South Dakota plants from seed sown in May had just commenced to blossom at the time of the first hard frost in autumn.

Atriplex semibaccata is the most promising of the Australian saltbushes for cultivation in this country, both because of its hardiness and the bulk of fodder produced. The forage contains 11.6 per cent of crude protein in the air-dry substance as compared with 14.3 per cent for alfalfa. Thus, 100 pounds of the dry substance will contain 8.7 pounds of digestible crude protein as compared with 10.6 pounds in alfalfa. The nutritive ratio is 1 to 4.5 for saltbush and 1 to 4.1 for alfalfa, so that it would seem to have nearly as high a feeding value as the latter, assuming that the extraordinarily large ash content does not prove detrimental to the animal.

SLENDER SALTBUSH.

Slender saltbush (*Atriplex leptocarpa*) is a perennial, with procumbent stems from 1½ to 2 feet or more in length. It resembles the previous species in many particulars, though the plants are smaller and it produces a smaller amount of forage. It is more widely distributed in Australia than *A. semibaccata*, occurring in western Queensland and New South Wales and in South Australia along the Murray River, sometimes carpeting the ground over considerable areas. Von Mueller says that its drought-enduring qualities are remarkable. It is particularly relished by sheep, which browse it down so closely that large tracts of it are often entirely destroyed. The seeds are smaller than those of *A. semibaccata*, somewhat cylindrical in shape, two-pointed at the apex, and slightly swollen at the middle. They are produced in great abundance and germinate readily under ordinary conditions. This species has been tried in California and in the grass garden on the grounds of the Department of Agriculture, and a fair quantity of seed has been distributed to a number of farmers in the West. It is about equally hardy, as regards cold, as *A. semibaccata*, but will perhaps withstand a greater degree of heat.

GRAY SALTBUSH.

Gray saltbush (*Atriplex halimoides*) is a shrubby perennial with something of the habit of *A. semibaccata*. The leaves are larger and broader and the whole plant has a whitish appearance. The stems are rather more woody than in the case of either of the two preceding species and the plant is more drought resistant. On this account it has proved adapted to conditions in South Africa and probably also would be of value in South America. When not too closely grazed it ripens seed in great abundance. It would be valuable for trial in Arizona and southern California.

ROUND-LEAFED SALTBUSH.

Round-leafed saltbush (*Atriplex nummularia*) is a perennial shrub which grows to the height of from 6 to 10 feet. The leaves and stems are covered with whitish down, and the broad, fleshy leaves are

produced in great abundance. The plant is diœcious, producing male flowers on one plant and female flowers on another. It will grow on soils more heavily impregnated with alkali than *A. semibaccata*, and will also withstand droughts better, but is less hardy to cold. It is extensively planted and highly valued in central Australia and South Africa. In habit of growth and appearance it resembles the native shad scale of the Rocky Mountain region. It is only adapted to cultivation in the warmest portions of the Southwest and it might well be grown more extensively in southern California and Arizona. If rooted cuttings are planted over the range immediately following heavy rains, when the soil is wet enough to fairly start the plant, it

FIG. 126.—Annual saltbush (*Atriplex holocarpa*) grown in the grass garden of the Department of Agriculture.

will undoubtedly be a very valuable addition to the range forage plants. This saltbush produces the greatest amount of seed in the driest seasons, resembling in this characteristic most native desert plants. The seeds germinate readily when sown on moist soils. According to analyses the round-leafed saltbush will take up more soda salts than will *A. semibaccata*, and on this account will probably succeed on soils too heavily impregnated with alkali to permit the growth of other species.

ANNUAL SALTBUSH.

Annual saltbush (*Atriplex holocarpa*, fig. 126) is a low, densely branching annual, less leafy than either of the preceding species, but

valuable because of the immense number of round, spongy seeds or fruits which it produces. The fruits are from one-fourth to one-half inch in diameter and are readily blown about by the wind, so that if the plant is once established on the range and is not eaten down too closely by stock it will soon become widely distributed. It is one of the saltbushes which is fairly hardy, but is perhaps less drought resistant than many of the perennials. The seeds are not only carried by the wind, but float on the water, and are widely scattered in this way by floods or by the torrential rains to which the arid regions which it inhabits are subjected. Its successful growth in the grass garden on the grounds of the Department of Agriculture indicates that it would be a valuable species to introduce not only on alkaline soils, but also in the grazing regions of the West and Southwest, probably as far north as Colorado and Utah.

OLD-MAN SALTBUSH.

Old-man saltbush (*Rhagodia parabolica*) is an erect, perennial shrub, formerly very abundant in western Queensland and New South Wales, but which has now almost disappeared because of overgrazing by cattle. It grows 5 to 10 feet high, frequenting low, moist places. The whole plant is whitish, with a mealy covering like that on the leaves of the common garden pig's foot or lamb's-quarters (*Chenopodium album*). Cattle and sheep browse the leaves and tender branches, seldom permitting it to ripen seed in any quantity, but it grows well from cuttings and may be rapidly disseminated in that manner.

ARROW-LEAFED SALTBUSH.

Arrow-leafed saltbush (*Rhagodia hastata*) is a low, spreading, perennial shrub, seldom growing more than 3 to 5 feet high. Like the preceding, its leaves and branches are whitish. Cattle and sheep graze this plant wherever found. It grows wild in Queensland, New South Wales, and Victoria, and is said to be one of the most drought resistant of all the saltbushes. It will stand some frost, and would be a good plant to introduce on the cattle ranges of Texas and New Mexico. Like all others of this group, it not only produces an abundance of seed, but may readily be reproduced from cuttings.

BLUE SALTBUSH.

Blue saltbush (*Chenopodium auricomum*) is another shrub that was formerly abundant in the hottest portions of the interior of Australia, but has now almost entirely disappeared. The writer collected some of it in 1891 in western New South Wales. It was in a thicket of "wait-a-bit" and other thorny acacias, protected by them from all browsing animals, much as clumps of succulent grasses are often found in cactus thickets in Texas and the Southwest. Blue saltbush is so called from its color, which varies from blue-gray to yellow. It

is an excellent forage plant, and its introduction into the arid ranges of the Southwest is recommended. It seeds abundantly, and may also be propagated from cuttings.

GRAY BUSH.

Of the gray bush (Kochia) there are a dozen or more species in the arid portions of Australia. All are shrubby perennials, more or less sought after by cattle and sheep, and are correspondingly valued by owners of stock. One characteristic feature of all of them is that their leaves and branches are covered with short white woolly hairs, that prevent the evaporation of water from the leaves. They are adapted to the driest and hottest climates, and are without exception alkali plants. Some of the Kochias flourish in central Australia, where the day temperatures approach those of the Death Valley in southern California. They would be valuable for introduction into southern Arizona and the deserts of southern California as range plants, to supplement the forage supplied by Franseria, Allenrolfea, and other shrubs. An objection to the Kochias is that the matted tomentum with which they are covered often forms hair balls or phyto-bezoars in the stomachs of cattle, sometimes causing considerable losses during droughts. But as similar losses occur from the feeding of overripe crimson clover and a variety of other plants, this objection need not be considered a fatal one. The Kochia saltbushes resemble the winter fat (*Eurotia lanata*) and cottonweed (Froelichia) of Texas and the West in appearance, and to some extent also in feeding value, although the latter do not approach them in the matter of seed production.

AMERICAN SALTBUSHES.

A great number of saltbushes may be introduced from Australia for the benefit of the Western stockmen, but while foreign species are being sought, the native saltbushes, which thrive on alkaline and saline soils, should not be overlooked. There are about 40 species of native Atriplex saltbushes in the Western States. Many of these are superior to those of Australia, in that they are hardy as regards cold as well as resistant to alkali and drought. They are grazed to some extent in summer, but are, as a rule, most highly valued for winter forage, because there is an abundance of nutritious and succulent grasses and annual plants in summer, so that the saltbushes are not then required.

SHAD SCALE.

Shad scale (*Atriplex canescens*, fig. 127), is a perennial shrub, often 6 to 10 feet high, rather common on the high plains from Wyoming and Nevada to Arizona and western Texas. The narrow gray-green leaves and young branches are browsed by cattle. The seeds are

produced in great abundance, often a peck or more on one plant. These are much sought after by sheep and are considered very fattening. On ranges used as summer pastures for sheep the shad scale can now only be found on rocky cliffs or other spots inaccessible to grazing animals; but in regions which can only be pastured in winter through lack of water, except that supplied by snowdrifts, the shad scale is found to be increasing from year to year. This is because the stock are necessarily kept off in summer, so that the plant has opportunity to fully recover from the winter grazing and mature its normal crops of seed. Shad scale grows on lands heavily impregnated with white alkali, and also withstands small amounts of the black alkali. It is worthy of cultivation on soils that will not grow grain, alfalfa, or tame grasses. This plant is superior to the shrubby Australian saltbushes, in that it thrives where the winters are quite severe.

FIG. 127.—Shad scale (*Atriplex canescens*): *a*, fruit; *b*, flower.

NUTTALL'S SALT SAGE.

Nuttall's salt sage (*Atriplex nuttallii*, fig. 128) is the most common salt sage of the plains of northern Colorado, Wyoming, Montana, and northern Nevada, and is considered by stockmen the most valuable of that region. It is a low, leafy shrub, seldom more than 2 or 3 feet high, and, like the shad scale, is perennial. It grows where the soil is dry and so strongly impregnated with alkali that little else will thrive except rabbit brush and bitter sages. It is one of the best of the wild forage plants for winter pasturage. Nelson states that the leaves and young twigs, and especially the seeds, are very fattening, and that sheep eat the forage both green and when it has cured upon the ground. The plant endures much severe trampling and hard usage. In the Red Desert of Wyoming it supplies fully one-half of the winter grazing. Nuttall's salt sage is worthy of introduction into

cultivation along with the Australian saltbushes, and wherever it now occurs on the ranges care should be taken not to exterminate it.

SPINY SALT SAGE.

Spiny salt sage (*Atriplex confertifolia*) is a perennial, spreading shrub, with numerous, short, thick leaves and spiny branches. It grows 2 or 3 feet high in clumps 4 to 6 or 8 feet in diameter. The leaves and fruits drop off in autumn and are collected in the depressions of the surface or form little wind drifts behind the bushes. These piles of leaves and seeds are the first to be eaten by the sheep and cattle when they enter the winter pastures. The spiny branches are also browsed to the ground. This salt sage is apparently more resistant to strong alkali than almost any of the others, as it often occurs on "greasewood lands" containing a large amount of sal soda. It grows from the Dakotas, Montana, and Idaho southward to Mexico. Spiny salt sage will probably not improve much in cultivation on account of its woody stems, but on moderately strong black alkali lands it is worthy of cultivation for winter forage.

FIG. 128.—Nuttall's salt sage (*Atriplex nuttallii*).

SCRUB SALTBUSH.

Scrub saltbush (*Atriplex polycarpa*) is one of the shrubby saltbushes of California investigated by Davy. It was found growing on gravelly soil containing a maximum of 78,000 pounds of salts per acre-foot, considerably more than the Australian saltbush will stand.

There are fourteen or fifteen other species of Atriplex in California, mostly confined to the arid alkaline valley lands and the seashores. Many of these contribute to the forage of the region and add value to both winter and summer ranges. Besides these and other closely related shrubby saltbushes there are a number of annuals which are fully as valuable as any of the introduced ones, either in feeding value, amount of seed production, or resistance to and tolerance of injurious soda salts.

UTAH SALTBUSH.

Utah saltbush (*Atriplex truncata*) is one of the best of these annual species. It has much the habit of *A. semibaccata*, covering the ground with a thick mat of leaves, and thereby preventing evaporation and the rise of alkali to the surface. It is common in northern Utah and Nevada and eastern Oregon on clayey soils impregnated with common salt and white alkali. A few seeds were distributed in 1896 by the Division of Agrostology, and a number of those who grew it have reported it as being of much promise for the reclamation of alkali soils. It is closely grazed by cattle wherever they have access to it, so that it is hard to find in sufficient amount to supply any quantity of seed. It is never abundant except where undergrazed or protected by fences.

TUMBLING SALT SAGE.

Tumbling salt sage (*Atriplex volutans*) is a rank, leafy annual, which forms an upright compact mass 2 or 3 feet high. Nelson says that it may prove more valuable for certain alkali soils than any of the foreign species. It produces a great abundance of seed. Tumbling salt sage gets its name from the fact that, like a great many other plants native to the Western plains and prairies, the stem breaks off close above the ground in autumn and the plant goes rolling across the country, scattering its seeds at every bound. It might prove a bad weed in grain fields because of this tumbling habit. It has very little forage value after the seeds have fallen.

NELSON'S SALTBUSH.

Nelson's saltbush (*Atriplex pabularis*), although a perennial, grows rapidly and puts out a great many stems from the roots each year, so that it would have the value of an annual in cultivation. It has only been collected in the Red Desert of Wyoming, on saline flats along the creeks and in the dry beds of alkali basins. Cattle and sheep relish the herbage, grazing it down to the ground each year. It is one of the most promising of the wild saltbushes for cultivation on strongly alkaline soils for winter and summer pasturage.

WINTER FAT AND GREASEWOOD.

WINTER FAT.

Winter fat (*Eurotia lanata*) is a white-hairy perennial, 1 to 2 feet high, closely related to the saltbushes, and growing with them on strongly alkaline soils. The cottony seeds are produced in great abundance, and both seeds and stems are eaten greedily by all grazing animals, so that this plant is now almost exterminated wherever cattle have free range. It is widely distributed from Manitoba to Texas and westward to the Sierra Nevadas, and wherever it occurs is highly spoken of as a winter forage plant. Experimental cultures of

it in the grass garden at Washington, D. C., show that while it would not rank with the clovers, yet it makes a fine growth on cultivated land. The seed was sown on the surface and raked in. Seed might be gathered by ranchmen and sowed in spring on land which had been disked or harrowed, and while it could not be cut for hay it would make excellent winter grazing for either sheep or cattle. It thrives on alkaline soils and will tolerate moderate amounts of the white alkali. Stock grazed on lands where winter fat grows make a rapid growth, and are said to be remarkably free from disease because of the tonic properties of this plant. It is worthy of cultivation, and should be given a trial wherever seed is obtainable from the wild plant.

GREASEWOOD.

The name greasewood is commonly applied to a number of thorny shrubs characteristic of strongly alkaline soils. The common greasewood, or Chico plant, of the Rocky Mountains, is *Sarcobatus vermiculatus*. Its range extends from the Upper Missouri and Platte rivers to the Gila and the eastern slope of the Sierra Nevadas. It grows to the height of 4 to 8 feet. The narrow leaves are usually 1 to 1½ inches long, and are very numerous on the young shoots and branches. Many of the latter are thorn-pointed. One would never imagine that this greasewood could have any value as forage, yet cattle and sheep eat the leaves and browse the smaller stems. The seeds are also eaten. An analysis of the ash of this plant at the New Mexico experiment station showed 22 per cent of potash and 23.9 per cent of soda present. A sample of soil taken from under one of the plants contained two-tenths per cent of black alkali, while a similar sample taken 20 feet away from the plant showed no black alkali. Greasewood develops a thick taproot that goes down 15 or 20 feet or more, and it also sends out lateral surface roots through a radius of from 8 to 12 feet. Large amounts of the soda salts, especially the carbonate, are absorbed. Much of it finds its way into the leaves during the natural processes of growth. Then, as these fall during the winter, there is an accumulation or concentration of soda in the surface soil as a result of decomposition and the leaching out of the soluble substance of the leaves. Greasewood is tolerant of an amount of sal soda that would not only prevent germination of the seeds of cultivated plants, but would destroy the living plants themselves. It is an almost sure indicator of black alkali. Western ranchers recognize the general rule that lands covered with greasewood can not be profitably reclaimed.

The Californian greasewood (*Allenrolfea occidentalis*) is an erect, diffusely-branching shrub, 2 to 5 feet high. It occurs from northern Nevada and Utah to western Texas and southern California. Like the preceding, it is one of the characteristic black alkali plants. Davy found it growing in the San Joaquin Valley on a heavy, yellowish clay

soil containing from 27,320 to 194,760 pounds of total salts per acre-foot. The minimum of alkalies where this plant was growing is more than the greatest amount borne by any of the cereals. Coville found it on the immediate border of an alkaline marsh in the Death Valley, where such alkali-resistant plants as shad scale, saleratus weed, and mesquite bean were located fully 300 yards back from the barren depression at the center of the marsh. This greasewood is grazed to some extent in winter and adds to the value of the pasturage at that season of the year.

CONCLUSIONS.

Wheat and beardless barley can be grown for hay on land so strongly alkaline that alfalfa would neither germinate nor grow. The saltbushes hold relatively as much advantage over the cereals in the matter of tolerance of alkalies as the cereals do over alfalfa. The native salt sages and greasewood will supply considerable forage where neither wheat, alfalfa, nor the saltbushes will thrive.

The early solution of the alkali problem in the West is of great importance because of the extensive areas affected. There are thousands of square miles of alkali lands which, if they can be permanently freed from the excessive accumulations of soda salts, are potentially as rich in plant foods and as capable of producing large crops of the cereals, fruits, and vegetables as any lands in the United States. The possibilities for increase in value by the transformation of such extensive alkali areas from a low rate of productiveness to a high one are almost unlimited. In many localities it is simply a matter of the more intelligent use of water on irrigable lands; in others a beneficial change may be accomplished by the substitution of improved methods of soil cultivation and drainage. On lands not subject to irrigation a fourfold benefit may be secured by growing alkali-tolerant forage crops: (1) The surface will be shaded by the dense growth and the rise of alkali checked; (2) the total amount of forage may be increased, often tenfold, enabling the rancher to carry an additional number of stock on the same acreage; (3) there will be an improvement in the physical condition of the soil through increase of the amount of organic matter; (4) a gradual diminution of the amount of deleterious salts by removal in the plants themselves.

RECOMMENDATIONS.

Complaints are sometimes made that saltbushes, salt sages, and greasewood are unsafe feed for cattle and sheep. These plants are all quite rich in muscle-forming crude protein, especially in the spring. Losses from feeding on them are due to "hoven," or bloat, a disease which is common wherever stock are permitted to gorge on rich or succulent vegetation, and not to any inherent poisonous properties in the plants. Care should therefore be taken not to allow stock to overeat when first turned out on the saltbush pastures.

The saltbushes and salt sages, both introduced and native, although experimented with in cultivation only twenty years, have proved to be of value in all alkali-impregnated soils. A more extended cultivation of saltbushes is recommended throughout the West, and while trials are being made with the Australian species, the native forms that have been produced by natural processes, many of them being fully as leafy and having as succulent herbage, should not be overlooked. It is probable that quite a number of the thirty or more salt sages and saltbushes that grow wild on the high plains, mesas, and deserts of the West would, if only given an equally favorable opportunity, prove to be as well adapted to cultivation as any of the foreign species. Such plants as saltbushes, or even sagebrush and greasewood, will prove of great value where the cereals and garden crops will not grow because of the alkali in the soil. The plants native to any region are the most promising for cultivation in similar regions. Following this law the plants native to alkali soils are the ones for those soils. As the West is developed the amount of grazing land is each year decreasing in extent, and as the better-grassed, natural pastures are devoted to the cultivated crops, the extensive areas of alkali-impregnated soils will become more valuable. The increase of these soils in value in the estimation of the Western cattle growers will come through their utilization in the production of saltbushes and other alkali-tolerant forage plants.

THE PRESENT CONDITION OF GRAPE CULTURE IN CALIFORNIA.

By George Husmann,
Of Napa, Cal.

THE BEGINNING OF GRAPE CULTURE.

Grape culture in California is a comparatively new industry, and many lessons had to be learned before its present status could be attained. The vicissitudes attending the progress of grape culture in California have resulted mostly from not fully understanding in the first place, when the industry was in its infancy, the varied soil and the climatic conditions peculiar to the State. In order to see and fully appreciate the nature of the mistakes made, the history of the industry must be understood. The missionary fathers planted the first vineyards on irrigated soil. They instructed and employed the Indians attached to and dependent upon the missions in the cultivation of these vineyards, in which but one variety of the European grape was used, still known as the "Mission," though often erroneously called "California." While the exact origin of this grape is yet in doubt, it is unquestionably of the European species *Vitis vinifera*, but whether grown from seed or from cuttings brought from Spain has not been determined. The "Mission," altogether different from the native wild vine *Vitis californica*, is evidently a sherry grape, and as such it is now used.

THE BEGINNING OF SYSTEMATIC GRAPE CULTURE AND WINE MAKING.

It was not until in the fifties, after the gold excitement had somewhat subsided, that some German and French pioneers began to give attention to grape culture and to make and handle wine systematically. Up to this time wine was mostly kept and transported in skins of rawhide, as in olden times. It may be said, therefore, that the industry as such is hardly fifty years old.

Up to 1850 the "Mission" continued to be almost the only grape cultivated, and most of the vineyards and wine cellars were clustered around Los Angeles. The fact was made clear, however, that the European grape, which could not be cultivated with success in the Eastern States, had found a congenial home on the Pacific coast. The important points lost sight of, on the other hand, were that rainless summers produced a fruit very high in sugar, and that the wines made from it

were "heavy" and "heady." The French and German vintners fell into the error of letting the grapes hang until they were very ripe, as was the custom in their native countries, where they could hardly obtain a thoroughly ripened product except in the best of seasons. In California the fruit, which came to full maturity every year, contained so much sugar that it could hardly be converted into sound, palatable wine by fermentation, and the result very often was a milk-sour, imperfectly fermented wine, which was, as already stated, heavy and heady in quality. Naturally such wines did not find favor with connoisseurs. Claret especially, made from the Mission grape, was deficient in color and acid—a sorry beverage indeed. This venture into the markets gave the wines of California their first setback. Another injurious practice was that of selling the entire product of cellars or wineries, good, bad, and indifferent, at an average price. The dealer, having invested his money, had to devise means to get it back; and thus many poor wines, which injured the reputation of the young industry, were sold. The method was an easy and lucrative way for the producer to dispose of his whole crop; but it has worked an injury to the industry, which continues even now.

THE FIRST ERA OF THE INDUSTRY.

The success with the "Mission" encouraged the planting of vineyards, however, and as the men who had embarked in the industry soon saw the deficiencies of that grape, exertions were made to introduce better varieties from Europe. Among the foremost to embark in this laudable enterprise was Col. Agoston Haraszthy, who made an extended investigation of the vineyards of Europe and introduced the best varieties he could find. Messrs. Gundlach & Dresel, of Sonoma, also imported choice varieties from the Rhine at great cost, even for that period of difficult and expensive transportation. All of these importations succeeded in so favorable a climate, though many of the choice varieties proved shy bearers under the system of short pruning, "stool fashion," which had been followed with the "Mission," and for that reason they were neglected. When a longer system of pruning was adopted, these same choice varieties yielded good returns and formed the basis for better wines. This may be called the first or trial era of the young industry, extending from 1855 to 1875, at which time wines and grapes fell to a price so low that they would not pay for the picking, and in many cases hogs were turned into the vineyards to utilize the crop.

But still some of the wines, especially the finer grades, found favor and created a demand which exceeded the supply. Then, however, began the sale by the producers of their entire products, as already stated, and the injurious practices growing out of such a system. The dealers who bought the wines disposed of the low-grade goods as California wines, while the better qualities, sufficiently

aged, to be found in nearly every cellar, were generally sold at high prices as French and German wines. The State thus suffered all the discredit for the poor wines, but obtained no credit for the really fine wines which were produced. This practice prevails to a certain extent to-day, fostered by a false idea which leads many people to pay high prices for foreign goods, while scorning the home product, even though this may be better in quality.

THE SECOND ERA OF THE INDUSTRY.

Under the impetus of increased demand grape culture again revived, and prices for grapes and wines from first hands increased at such a rate that viticulture once more promised to be the best paying industry in the State. This general feeling initiated a second era of prosperity. It had been demonstrated that all varieties of *Vitis vinifera* flourished well in California; that vines could be cultivated successfully without irrigation; that the dry summer only seemed to stimulate the vines into a production of perfect fruit, and that not only wines but raisins also could be produced equal to the best brands of Spain. Under this impression and in the belief that California was to be the foremost grape-growing country on earth, a fuller knowledge of European methods was desired. A number of prominent wine merchants subscribed to a fund and sent Charles A. Wetmore—then a young man, and a graduate of the State university, well versed in the French language—to France to acquaint himself with French practices. Mr. Wetmore was well received, treated with the utmost courtesy, and came back enthused with the idea that France was the greatest wine-producing country, and that California needed but follow in her footsteps as a wine producer to become the France of the New World. Imbued with this idea, he presented a bill to the legislature creating a State board of viticulture, with a liberal appropriation, the main object being to further viticulture in all its branches. The bill also provided for the districting of the State, with a representative from each district on the State board, and for a chief executive viticultural officer with office at San Francisco. Upon the passage of this bill Mr. Wetmore was appointed the chief executive viticultural officer.

The new régime was initiated in 1880 with great energy and zeal, and as the members of the board were all prominent grape growers, it was accorded the general confidence of the public. Mr. Wetmore especially was enthusiastic in advancing the theory that this State contained a much larger acreage adapted to viticulture than France or any other European country; that it could not be excelled in the production of "vin ordinaire," and that enough of such wine could not be produced to satisfy the demand. This, with a lively demand for grapes at high prices by the wine makers, created a furore in vineyard planting in the early eighties. Many persons thought they saw

in the industry the best means to become wealthy in a short time, and invested in vineyard property at high prices.

Expensive cellars and wineries, equipped with the best machinery which the genius of Heald could invent, crushers, stemmers, and presses capable of working up 300 tons of grapes per day, were introduced. As an illustration of the sudden rise of the industry it may be noted that the small county of Napa had over two hundred cellars and wineries, ranging in capacity from 10,000 gallons up to 3,500,000 gallons, that of the largest cellar, the Greystone, above St. Helena.

DEPRESSION OF THE INDUSTRY.

The facts that success in grape culture could be attained only through years of toil, during which the vines would have to be cultivated, staked, and pruned, and that rapid increase in production would also necessarily reduce the prices, were overlooked, or at least not sufficiently considered. The legitimate result came only too soon; a crisis followed in the year 1886, when grapes dropped from $25 and $35 per ton to $8 and $10, and ordinary wines to 6 and 8 cents per gallon from first hands. The Phylloxera had also been doing its silent but effective work on the roots of the Vinifera vines; numbers of the vineyards of Sonoma and Napa counties had succumbed to its ravages, but many of the vintners, not believing that their vineyards would be devastated by it, failed to adopt the only remedy, the planting of resistant vines as grafting stocks. Many of the grape growers were bordering on despair. They had invested their all, some of them more than their all, in their vineyards, and, expecting returns from them, had borrowed money from the banks to keep them up. They now found that the vineyards would hardly pay the cost of cultivation. At 5 to 6 cents per gallon for wine, the price paid by the dealers, the hundreds of cellars and wineries, with their costly equipment, had to close, and half of these are still empty or working up to barely half their capacity. Cooperage, which had been paid for at the rate of 10 cents per gallon, fell to 2 and 3 cents, and can now be secured for one-fifth its original cost. Not only was the wine business affected, but the raisin business also suffered from overproduction, notwithstanding the fact that the growers had been duly warned against it by Mr. George West. The conditions described, which continued until the nineties, formed the darkest days of the grape growers of California, and they are referred to only with the view of leading to an avoidance of similar mistakes in the future. While these difficulties and misfortunes, characteristic of the transition stage of every industry, have passed, it is thought never to return, it may be of benefit to repeat some of the causes which worked the great change in the industry. Phylloxera, although it destroyed thousands of acres of once flourishing vineyards, was only partly to blame for the disastrous conditions. The Anaheim disease caused great ravages

in the southern part of the State, working destruction faster and even more completely than the Phylloxera. The prices received for grapes and wine, the latter selling as low as 5 cents per gallon wholesale, after six months of care, offered no inducement to the wine maker to buy grapes from his neighbor, nor for the grower to plant and cultivate them. As the vineyards would not pay for staking and diligent cultivation, many were left to take care of themselves. Owners were at the end of their resources, and the banks which had loaned money on the vineyards were obliged to take charge. In 1889, or perhaps even earlier, some enterprising men, seeing the ravages of the Phylloxera, and appreciating the danger that threatened grape growing, at that time a lucrative industry, commenced the planting of resistant vines, but most of the growers regarded the repeated warnings they received only as a scheme to sell these resistant vines and cuttings. The only remedy was the planting of new vineyards on resistant stocks, and this course, owing to the low prices which soon after prevailed, from causes already explained, was not adopted to an extent sufficient to make up for the decrease due to neglect and the ravages of insects.

TRADE CONDITIONS.

Unfavorable trade conditions were in large measure responsible for the reduction of prices to a point at which producers could no longer exist. Both dealers and producers were by the summer of 1892 fully aroused to the danger threatening the future of the industry. Frequent conferences were held, but no tangible remedial measures were adopted until the winter following, when the producers established a system of cooperation; the Wine Makers' Corporation was formed, and it soon controlled 80 per cent of the output. The corporation was thus enabled to practically control prices, and it established a uniform system under which wines were rated as standard or common and extra or finer, according to quality, all wines classed as inferior to the first-mentioned grade being condemned as unfit for sale as wine and ordered distilled. A contract was entered into by which an association of the principal dealers agreed to purchase from the Wine Makers' Corporation 5,000,000 gallons of wine yearly at prices to be fixed by a joint committee, or, if the committee could not agree, by a board of arbitration. Under this arrangement matters for a time improved. Later, some of the producers having entered the field as dealers, underselling the dealers' association, the amicable agreement fell through; so complete indeed was the rupture that some lawsuits ensued between the two associations.

At the annual meeting of the Wine Makers' Corporation, in December, 1897, a resolution was passed empowering the board of directors to enter the markets of the world, and the board has done so with marked success.

The outcome so far seems to be that the lawsuits referred to have

been compromised, and a sale has been made of 5,000,000 gallons of red wine to the principal dealers of San Francisco at prices varying from 12½ to 15 cents per gallon. This, in view of the phenomenal production of 1897 (27,000,000 gallons of dry and about 7,000,000 gallons of sweet wines) seems a fair price, although the production of 1898 may not exceed 8,000,000 gallons.

THE FUTURE OF THE INDUSTRY.

And now, after this retrospect of the vicissitudes through which the industry has passed during the last fifty years, which seems to have been necessary in order to show its present condition, what is to be said of its future? Many mistakes and blunders have been committed; indeed, there should be no hesitation in admitting that mistakes alone are to blame for any lack of success—mistakes largely due to overconfidence in the great resources of soil and climate of California. But in spite of all these vicissitudes the fact remains that there has been laid the foundation of a great industry. While many who entered the lists with high hopes of success failed to achieve it, either for want of means or experience, yet we can not close our eyes to the fact that "survival of the fittest" has again been the result, and that there is still an army of those who are confident of winning the fight, fully alive to the task before them, and determined to profit from the mistakes of the past by avoiding them in the future. Nor must the many obstacles that confront the industry be forgotten. The consumption of wine among Americans is not, as in many countries, almost universal; moreover, among those Americans who use wine there are many who, as the result of mere fashion or fancy, continue to drink wines bearing French and German labels, preferring them at treble the price to good, wholesome California wine. It is also a well-understood fact that in catering to this very prejudice many of the best California wines are offered for sale under foreign labels, thus depriving the wine industry of the State of all the reputation to which their superior quality justly entitles it, while it is left to bear all the discredit of the poor wine offered for sale under the domestic label. It is, moreover, strikingly illustrative of this American prejudice in favor of things labeled "imported" that even the best American wines are rarely, if ever, offered at great banquets, even when these are State celebrations, at least under their own names. These are some of the disadvantages attendant upon the effort to build up a native wine industry. Besides all these, there are the difficulties presented by the Phylloxera and the necessity of replanting with resistant stocks. Still, many are bound to keep on, some, perhaps, because, having invested their last dollar in the industry, they can not go back, but the majority still have faith that, with the experience gained in the past and in view of the measure of success attained and of the recognition awarded California wine in foreign

countries, success will eventually reward the persevering and intelligent grape grower. At the Paris Exposition of 1889 not less than thirty-five medals (gold, silver, and bronze) were awarded to wines made on the Pacific coast, and since then many foreign experts have visited our vineyards to judge for themselves of the product. While it may be said that little more has been done so far than to make experiments, these experiments have shown that California has a climate and soil not surpassed elsewhere on the globe for the production of fine wines and raisins. The producers have learned to know their shortcomings and their gains, and this of itself is a step to ultimate success. California grape growers think they see the way clear before them, and, undismayed, they will "fight it out on that line," even if it takes several summers.

VARIETIES TESTED AND EXTENSION OF TRADE.

Since the pioneers in the business introduced the best European and Asiatic varieties, these have been tested on their merits in different parts of the State. From the crude beginnings with the "Mission" grape in the making of white wine and clarets the growers have progressed to the best varieties of grape, testing over twenty varieties. Wherever California fine wines, white or red, have been introduced under their true labels they have been bought and consumed with satisfaction, establishing their name and fame. Experience has taught what and where to plant. Certain counties in the State have been found to be adapted to grapes for the finest dry wines, and others best adapted to fruit for sweet wines and raisins; it has also been found that different varieties of grapes need different pruning and training to produce the best results. It is known that it is folly to plant Vinifera varieties direct, and the best resistant stocks have been found. The Riparia, once the favorite stock because it grows easily from cuttings and takes the graft readily, it has been discovered, will only do on deep soils and in locations which are under the influence of the moist air in the neighborhood of the bay or the ocean, and that it will not flourish in the interior valleys or on dry, gravelly soil, where the Lenoir and the Herbemont withstand the longest drought. The Rupestris seems also adapted to the driest soils and locations of the State, especially the Rupestris St. George, lately introduced from France, where it is now one of the favorite stocks. The growers are satisfied now that many of the best varieties when grafted on resistant roots in their proper localities will produce better crops than they ever did on their own roots. Such are a few of the many lessons which have been learned; and as the trade in California wines is extending in all directions—to England, Belgium, Germany, the Hawaiian Islands, Central America, Japan, and China, with the prospect that the newly acquired possessions may also afford a market for our wines, brandies, and raisins—it is thought that the better era, which has been hoped for so long, is dawning at last.

STATISTICS OF THE INDUSTRY.

A few statistics may help to explain the present condition of the industry and the confidence in better times and prices in the future.

According to the latest returns, gathered by the California Wine Makers' Corporation, there are 157,000 acres planted to grapes, of which about 90,000, in round numbers, are wine grapes, the balance being table and raisin grapes. The area in table grapes may be estimated at 17,000 acres, which would leave 50,000 acres in raisins. The trade in wines shows about 6,000,000 gallons consumed in California, while the exports are about 14,000,000 gallons per annum, a total demand of, say, 20,000,000 gallons, in round numbers. The vintage of 1896 fell somewhat short of this amount, and prices had advanced to from 15 to 18 cents in the fall of 1896. Then came the unprecedented crop of 1897, about 27,000,000 gallons of dry wines and about 7,000,000 gallons of port, sherry, angelica, and sweet muscat, and also the unfortunate wine war between the two associations, who underbid each other in the principal markets for so-called standard wines, that is, wines of low grade, for which a large market had developed among the French and Italians in New Orleans and New York. With the cellars full of wine everywhere, this created a temporary glut, and these wines came down in price below paying rates. But the season of 1898 followed, with a crop variously estimated at from 8,000,000 to 10,000,000 gallons, enough below the average consumption to absorb the surplus of 1897. New customers from abroad also entered the market, so that the larger wine makers, who at first offered only $6 to $8 per ton for grapes, bid up to $10 and $12 per ton before the season ended, and they are now buying all the young and older vintages they can obtain at from 12½ to 15 cents per gallon for clarets and 14 to 17 cents for white wines. These, of course, are figures for round lots or whole cellars. There is really no surplus, and all the wines of both crops will be needed before the crop of 1899 will be fit for market. It would not be surprising to see good, sound wines go up to a wholesale price of 20 and even 25 cents per gallon. True, a number of young vineyards were planted during 1896–97, when prices advanced; but as it will take four years from the time of planting for the vines to come into bearing, the product can not yet be counted, while there is a direct loss of old vineyards, by Phylloxera and neglect, of at least 2,000 to 3,000 acres annually. The continued drought has also injured the vines in many sections, so that it will be surprising, indeed, if the crop of 1899 exceeds 8,000,000 gallons, even under the most favorable conditions.

THE MACHINERY.

During the palmy days of the industry human skill and inventive genius did its utmost to construct crushers, stemmers, and presses, which the experts of the Old World call the best they have yet seen. With crushers and stemmers capable of working up 300 tons of grapes

per day, a step further has been taken in the invention of the must pump, whereby the grapes are emptied from above into the crusher, falling thence into a cylinder below, whence they are carried through a 6-inch hose into a fermenting tank. Such machinery is, of course, only used in large establishments, where many thousand tons of grapes are worked up in a season. There are a number of tanks in large wineries which have a capacity of 25,000 to 30,000, even up to 100,000, gallons, and the Italian Swiss Colony has capped the climax with a wine cistern holding 500,000 gallons. When this was empty in the summer a great fête was given and a dance performed inside.

While referring to the subject of machinery and to the magnitude of the plant devoted to the manufacture of wine in many establishments, a warning, which may also serve as some encouragement to the smaller producers, may be timely. It is this: The very best results as regards quality must not be expected from these immense establishments. The care in every detail essential to the very best quality of wine is difficult to attain in the conduct of a big establishment, where, moreover, the selection of the grapes can hardly be as discriminating as when conducted on a smaller scale. Wine making is not only an industry; it is an art. It is from the smaller cellars, under the constant, watchful supervision of the proprietor, who must himself be an expert connoisseur in wines and must know just how to handle the product at every stage during, as well as after, its manufacture, that we may expect wines of such flavor and delicacy as to command the highest price and add to the fame of the California wine product.

THE BEST VARIETIES OF GRAPES FOR FINE WINES.

A sketch like this would not be complete without naming some of the best varieties of grapes for fine wines. The two great requirements are fine quality and at least moderate productiveness, for an unproductive variety will not pay at the low prices at which grape growers must sell.

DRY-WINE GRAPES.—*For white wine:* Semillon, White Burgundy or Chablis, Red Veltleiner, Franken Riesling or Sylvaner, Lady de Coverly or Thompson Seedless, Sauvignon Verte, Traminer, and Johannisberg Riesling. *For red wine:* Petite Sirah or Serine, Butan, Val de Penas, Carignane, Petit Bouschet, Alicante Bouschet, Spanna, and Tannat.

SWEET-WINE GRAPES.—*For sherry wine:* Palomino or Listan and Yellow Mosler. *For port wine:* Trousseau and Zinfandel. The last variety has been the leading claret grape, but has many faults. Its good qualities are productiveness and easy cultivation and pruning. Grown on hillsides and in red soil, it makes an excellent wine, but in moist locations it lacks color and flavor. Its great drawbacks are uneven ripening, liability to ripe rot, and the difficulty in fermentation, all of which make its production very difficult and uncertain.

THE RAISIN INDUSTRY.

This is second only to the wine industry in importance. It centers principally around Fresno, where barely fifteen years ago the beginnings were made. Encouraged by the large returns, vineyards of hundreds of acres were planted on every ranch, until the product of 1897 amounted to over 4,000 car loads of 10 tons each, at a price of 1¾ cents per pound. This was a losing price for the producer, and even at this low figure 1,000 car loads were left unsold. The raisin growers saw that something must be done, and an association was formed, with Mr. Theodore Kearney as its president. The necessary steps being taken, about 90 per cent of the growers were secured, who obligated themselves to sell only through the association and at the price fixed by it. The price was fixed at 3 cents per pound, with the prospect of raising it as the market justified, but with a guaranty to each buyer that the price would not be lowered. The price was afterwards raised to 3½ cents, and the result was that not only the 1,000 car loads from the crop of 1897 were disposed of, but that the entire crop of 1898, amounting to about 3,000 car loads, was sold, excepting perhaps 700 car loads, which would not last over a month. All of these sales were made for cash, and the result was that over $3,000,000 was distributed among the members of the association, with a pro-rata share still due them at the final settlement. It is now the aim of the association to draw all the raisin-producing counties into league with it, and thus to make a pool of the whole industry. In a paper, read before the State board of horticulture at its annual session, Mr. Kearney proclaimed the belief that there was no overproduction possible if the markets were managed in the right way, and the last season's experience encourages his conclusion. He advises strongly that the prune growers of the State organize on the same plan. The best varieties of grapes for raisins are Muscatel Gordo Blanco, Muscat of Alexandria, Sultana, and Lady de Coverly, better known as Thompson Seedless. The Sultana will also make excellent white wine.

TABLE AND MARKET GRAPES.

This branch of grape growing seems not to promise very large returns, either at home or abroad. The best returns seem to be from late varieties, such as Flame Tokay, Emperor, and Cornichon. There are districts where these grapes will remain fresh on the vines even in January, and as they can be shipped to the San Francisco market at that time, there seems an opening for them at lucrative prices. Verdel, Thompson Seedless, Black Malvoisie, and Rose of Peru are also excellent table and market varieties.

BRANDY PRODUCTION.

Brandy production has increased very much and could be increased still more if all inferior wines, instead of being fixed up so as to pass

for so called "standard," were distilled. It is also the best way to dispose of the second-crop Muscats, the yield of which is very heavy, and will not make first-class raisins. The shipment from the State amounted in 1896 to 42,504 gallons, valued at $40,861. The Vina vineyard, established by the late Senator Stanford, is the largest in the State, comprising in all 3,054 acres. This vineyard was planted with the benevolent intention of the owner to furnish a cheap, pure wine to every laborer, but the grapes being found unfitted for light, dry wines, the crop is now almost entirely devoted to the production of brandy and sweet wines, and the brandies made therefrom have won a high reputation. Some of the choicest brandies are made at El Pinal vineyards, the property of Mr. George West, at Stockton, which is also one of the largest sweet wineries in the State, with a branch in Fresno County. It is considered that it takes about 5 gallons of dry wine of about 10 to 12 per cent alcoholic strength to make a gallon of good brandy, and during the low prices of wine a great deal was distilled and thus utilized. Large shipments were made to Hamburg and Bremen, where they were favorably received.

INFLUENCE OF LOCALITY ON QUALITY OF GRAPES.

The influence of locality upon the quality of the grape is very marked, even in the same counties and districts. No one who has not lived in the State a number of years can estimate fully this influence. The effects may be summed up by noting a few general characteristics. The deep lands of the river bottoms will produce the greatest quantity of grapes, while the hillsides will yield the best quality at the sacrifice of quantity, and the higher the elevation the more marked this difference will appear. Then, again, there are certain districts which will furnish the best grapes for light, dry wines, while others will produce only fruit for fine sweet wines, raisins, and brandy. Thus, the counties clustering around the bays of San Francisco and San Pablo, Napa, Sonoma, Solano, Alameda, Contra Costa, and Santa Clara, are considered to make the finest light, dry wines. To these the writer thinks the counties of Lake, Mendocino, and Humboldt may be added, though viticulture is not in an advanced condition because of the lack of railroad facilities. Santa Cruz also furnishes some fine wines. The central and southern counties are better adapted to grapes for sweet wines, raisins, and brandy, though there are undoubtedly locations in all of these, in the mountainous districts, where grapes for fine dry wines can be grown.

CONCLUSION.

The foregoing is but a sketch of the development of the grape industry in California. The field is too large and varied to be fully covered in the limits of a single paper, even if any one individual could be found who is fully competent to handle the subject. The

writer can truthfully say that the question has received his best thought and study, and it is his earnest conviction that grape culture has found a true home in California; that it will expand and grow, as it only can in congenial soil, and that the time will come when it will triumph over all obstacles and become a useful and profitable industry—when California wines and raisins will be known and appreciated throughout the world. California has all the material to accomplish this. The day may be far distant, and the present generation may not live to see it, but that it will come eventually there is not a doubt.

THE HAWAIIAN ISLANDS.

By WALTER MAXWELL.

Director and Chief Chemist of Hawaiian Sugar Planters' Association

AREA AND POPULATION.

The Hawaiian group comprises some eight distinct islands, seven of which have a registered population. These islands are separated from each other by ocean channels that vary in width from the narrowest, covering 6 miles of sea, to the broadest, measuring 61 miles. The archipelago lies within the limits of latitude 19° to 22° 15′ north and of longitude 154° 48′ to 160° 20′ west.

The superficial areas composing the group, with their respective populations, are as follows:

Area and population.

Islands.	Areas.	Population.
	Acres.	
Hawaii	2,000,000	33,285
Maui	400,000	17,726
Oahu (seat of government)	360,000	40,205
Kauai	350,000	15,228
Molokai	200,000	2,307
Lanai	100,000	105
Niihau	70,000	164
Kahoolawe	30,000	.....
Total	3,510,000	109,020

The population record is the result of the census of 1896. Since that time, however, the total given has been appreciably added to, and the growth is in progress.

CLIMATIC CONDITIONS.

In relation to the small land areas, the variations in temperature and rainfall are extremely great. These variations are due, first, to land altitudes and, second, to the exposure to rain-bearing winds. Taking Honolulu as an example, the average of temperature for the year is 73° F., with an average of night temperatures of 68° F., and with 80° as the average of the year's day temperatures. The extremes of variation are 48° F. and 87° F. during the year's course. Locations at sea level, corresponding to Honolulu, with leeward

exposures, present the same conditions, some having temperatures 1° to 3° higher, others 1° or 2° lower; while sea-level temperatures with a windward exposure are generally lower, in some cases 5° to 7°. Leaving the sea level, the air temperature falls with increasing altitude; in certain ascertained locations it falls at the rate of 1° F. for each 200 feet. The rate of decrease of temperature, however, is very variable, being affected by such factors as prevailing winds, open or forest-covered areas, level or extremly broken up land surfaces, and the prevalence of deep valleys and alternating ridges. Due to these factors, climate is extremely local, varying with the prevalence of conditions confined within very small areas. Yet, there is the general decrease in temperature with the increase in altitude, this rule progressing until a temperate climate is reached, the variation in temperature moving between above freezing point and 70° F. Finally the elevation depresses the mercury below freezing point, from which level the ascent leads up to the great mountain altitudes of from 8,000 to 14,000 feet, where many degrees of frost have been recorded, and where the snow lies during most, and in some places all, of the months of the year.

The variations in rainfall are as great as in temperature, the factor of altitude being the main cause of variation. At the sea level in Honolulu the rainfall is some 32 inches per annum; at an altitude of 900 feet the rainfall is 116 inches. On the island of Maui in one district the rainfall at sea level was 28 inches, and, during the same period, at an altitude of 2,800 feet the yearly rainfall was 179 inches. Exposure to rain-bearing winds, especially where the land surfaces are covered with forest, is also a controlling factor, in unison with the factor of elevation. In the driest district the rainfall rises with the altitude; but, taking the island of Hawaii as an example, between districts of the same island, and at corresponding altitudes, the actual records show variations in rainfall between 60 and 160 inches per annum. The extremes of variation in recorded rainfalls, covering the four chief islands, are between 12 inches and 19½ feet of rain per year.

These varying conditions of climate, due mainly to altitude, provide most reassuring possibilities in respect to the public health. It is also apparent that these great variations in temperature, by which even the limited area of these islands is resolved into actually tropical and temperate zones, constitute a basis upon which a most diverse agriculture can be built up.

SOILS OF THE ISLANDS.

Over the sites upon which the several islands rest to-day the waters of the Pacific rolled, and but a short time ago. The islands are the result, on the one hand, of vast internal earth movements, whereby submarine levels were lifted up, and even raised sheer out of the

water; on the other hand, continuous or successive periods of eruption, which were at first submarine, by vast outpourings of lava laid the broad foundations of the islands beneath the ocean surface, and finally raised the superb mountain cones and heights, reaching up to as much as 14,000 feet above the level of the sea. The whole islands, therefore, are of volcanic origin, and, geologically speaking, they are of very recent date.

In consequence of the volcanic origin of the islands, the soils are wholly derived from basaltic lavas. In respect of color and geological and chemical composition and nature they fall into the following classes:

(1) DARK-RED SOILS.—Soils formed by the simple decomposition of normal lavas under climatic action, and more particularly where great heat and small rainfall have prevailed.

(2) YELLOW AND LIGHT-RED SOILS.—Soils which differ not only in color but also in their composition from the dark-red soils, these differences being due to special physical and chemical influences which marked their origin.

(3) SEDIMENTARY SOILS.—Soils derived from the decomposition of lavas at high altitudes, the decomposed matter being removed by rainfall and deposited over lower levels.

LOCATION AND CHARACTERISTICS OF THE SOILS.

On account of the gradual rise in altitude of the lands from the sea level to the mountain elevations already described, the soils have come to be spoken of also as "lowland" and "upland" soils. The measure of increase in altitude is, on an average, some 300 feet per mile, thus furnishing the acute slopes which have caused the formation of the sedimentary soils.

The "sedimentary soils" cover the levels and flats bordering on the sea, forming also the deltas receiving the wash from mountain gorges and valleys. These soils, almost without exception, are very fertile, and because of their great depth over considerable areas the fertility will be of long duration.

The "dark-red soils" are chiefly confined to the areas located immediately above the sedimentary flats and lowlands, on the leeward and dry sides of the islands. These soils are also of great depth and uniform composition, and their fertility, so far, is equal to that of the lower lands.

The higher lands, or such as range from 200 to 500 feet above sea level up to 2,000 feet, are extremely different in type and composition. Due to the heavy rains that fall upon the uplands, the decomposing lavas and soils have been largely borne down to the lower levels, and, as a result of the climatic conditions, those highland soils are not only of small depth, but they also have been largely depleted of the more soluble elements upon which vegetation thrives. These soils

therefore are less fertile, and their virgin fertility becomes comparatively quickly exhausted. In general, however, Hawaiian soils are of great virgin fertility. Agriculturally, they are young and in a state of primary freshness as compared with the soils of old continents and islands.

PRODUCTS OF THE ISLANDS.

The Hawaiian Islands are wholly dependent on agriculture for their industrial maintenance. There has been no industry not directly agricultural up to the present date of their history. This fact makes it very urgent that the agricultural resources, so far the only source of wealth of the islands, should be developed along all possible lines and to the utmost limit.

SUGAR.

The production of sugar employs the major portion of the capital and labor upon the Hawaiian Islands; it also furnishes the bulk of the exports, and provides the wealth and maintenance of the great majority of the people.

It is about sixty years since sugar was first produced for sale upon the islands. At that time the methods of cultivation and manufacture were very crude and the production was small. Even so late as the year 1880 the total output is recorded as having been 30,000 tons. Without taking the time and care to traverse each stage in detail in order to show the "ups and downs" of the industry and by what efforts it has reached the present dimensions, it will be sufficient to state the total value of Hawaiian exports for 1897 and the proportion of that value accruing from the shipment of sugar: The total of Hawaiian exports for the year named amounted to $16,021,775.19, while the sales of sugar amounted to $15,390,422.13. These figures present at a glance both the sum of the trade which the islands transacted in 1897 with foreign countries (over 99 per cent of which was with the United States) and the dominant and vital part that sugar plays in the industrial existence of the country.

Sugar is grown on Hawaii, Maui, Kauai, and Oahu, the four largest islands in the group, and its cultivation is about to commence on the islands of Molokai and Lanai. There are some sixty plantations now in operation, each one having its own mill or factory equipped for the manufacture of raw sugar. The sugar-growing and sugar-making capacities of these estates vary between less than 1,000 tons up to near 20,000 tons of sugar per annum.

Much of the low, level, sedimentary areas bordering on the seashore is used for growing sugar, while the areas of rich, dark-red soils, located at comparatively low altitudes, are used exclusively for this purpose. Very considerable breadths of the less fertile yellow and light-red soils, with larger stretches of uplands that reach up to 1,500 feet, and in locations as high as 2,000 feet, above the sea, are also used, so far as it is found profitable, for sugar growing.

The relative fertility and values of the several soils are shown in the following statement from an official investigation, which embraces the average results of three successive crops:

Productiveness of soils.

	Pounds of sugar per acre.
Dark-red soils	10,411
Sedimentary soils	10,301
Yellow soils	6,291

On an average two years are required to make a crop of sugar in Hawaii, while only one year is required in Louisiana, so that the sum of the Hawaiian yield requires to be cut in two in order to compare it more accurately with the annual production of Louisiana.

The area of arable lands used in growing sugar in Hawaii may be deduced from the figures in the following table, which also shows the annual production of sugar:

Annual production of sugar in Hawaii.

Year.	Cane manufactured.	Sugar made.	Yield of sugar per acre.
	Acres.	*Tons (2,000 pounds).*	*Pounds.*
1895	47,399½	153,419½	6,472
1896	55,729	227,093	8,148
1897	53,825½	251,126	9,331

The average number of acres of cane manufactured for the three years given was 52,318. As the crop requires most of two years to mature, and as two crops are always in course of growth at the same time, it is seen that the acreage under cane is not less than 105,000 acres. Since some small areas of extreme uplands are two and one-half years in reaching maturity, the above area must be considerably added to. Considering the further fact that some portion of the total area is always lying out for rest, we are justified in concluding that the land in use for cane growing is 125,000 acres.

RICE.

At the present time rice occupies the second place in the area of production and in the value of product. The total production can not be exactly estimated, since a part is consumed upon the islands. The exports of rice for 1897 were 5,499,499 pounds, valued at $225,575.52.

The home consumption is large and would greatly augment the production indicated by the exports.

The lands used for rice are chiefly the lowest flats found at the outlets of valleys and close on the sea. These lands are generally fertile,

but often too low and swampy for cane culture. These locations are favored with an abundance of sweet water, which is discharging to the sea, and this is a first essential condition in rice culture. During the growth of the crop and up to the time of maturity the lands bearing rice are held under water, which is kept gradually flowing and not allowed to stagnate and sour on the ground.

The rice growers are almost wholly Chinamen. This race is able to work and thrive in conditions of location and climate which other peoples do not appear able to endure. From lowland climatic action, which is liable to induce low fever, especially among Japanese, the Chinaman is apparently immune. Certain small areas of low bog lands in and about the suburbs of Honolulu are being rapidly drained, cultivated, and planted with vegetables or fruits or overflowed with sweet running water to support the rice crop.

The area of rice lands is not appreciably increasing. There is a tendency to use certain of these lands, which allow of it, for sugar growing, the present prices of sugar being very tempting.

COFFEE.

The coffee berry is a natural product of Hawaii. It is growing wild in locations upon several of the islands. These wild trees have reached a large growth, and they are still furnishing berries to the native Hawaiians. When the berry was first introduced into the country is not known. It passes as one of the growths native to the islands and their conditions.

The interest taken in coffee to-day, however, with its prospective value, is lifting the question of production from a wayside matter into one of the most engaging industries of the islands.

Coffee is being cultivated upon the four larger islands. On Maui and Kauai the work has not passed the experimenting stage in areas and results. On Oahu the production is, in one district, getting on to a commercial basis. It is to the island of Hawaii, however, that one must go in order to see what is being done and to estimate the possibilities of the industry.

There are four main coffee districts on the island of Hawaii, namely, Puna, Olaa, Kona, and Hamakua. A census of the areas in the several districts that are at this time under coffee has been attempted, but the data do not justify a precise statement regarding the number of acres and accomplished results. Many planters express areas by number of trees, but as the distances between trees are not uniform acreage can not be reliably deduced. In the district of Olaa, which claims the largest total area and the greatest number of planters, the land actually under coffee is about 6,000 acres. The other districts have relatively smaller areas under plant than Olaa, but this present circumstance does not necessarily indicate the future relative importance of the several districts. The matter of soil, with the essentially

associated climatic conditions, are the prime factors which will ultimately determine the values of the respective districts for permanent coffee growing.

An idea is had of the commercial importance of the coffee industry by observing the exports of the berry to other countries. Foreign shipments, however, do not express anything like the volume of the total production, since the coffees used on the islands are chiefly home grown. The exports for 1897 were 337,158 pounds, valued at $99,696.62.[1] These figures, however, not only do not represent the volume of production for the year stated, but they fall still further short of indicating the present basis of the industry. The coffee tree requires several years of growth in coming to economic bearing. This means that while the present area of actually bearing lands is so much, a larger or smaller area may be in course of coming up and will be added to the actually producing lands within a year or so. This fact is well illustrated by the following conditions now obtaining in the Olaa district: Coffee area—under one year old, 1,821½ acres; one to three years old, 2,749½ acres; over three years old, 1,344 acres.

Certain of the areas of "from one to three years old" in 1897 are now bearing, and other areas are closely approaching that state.[2]

The coffee industry of Hawaii is not destined to impress the world by the great areas under cultivation or the volume of shipments corresponding to the production of other countries. Hawaiian coffees, however, are on the way toward a permanent reputation for high and specific quality. They have their own aroma and marked flavor as distinctly as does the Hawaiian pineapple, which makes it aromatically superior to most known pineapples. With the delicate flavor is also associated a mildness and freedom from the acridness that marks many individual and unmixed coffees that are on the market. Hawaiian coffee is complete in itself, and no known mixture adds to its native excellence. Prices already obtained for selected samples sold abroad justify the view that this coffee is capable of reaching a unique position, where quality and not price is the first consideration of the consumer. This consideration of "quality" makes it necessary in the highest degree that the culture shall receive specially intelligent care. It is further and equally necessary that the utmost attention shall be given first to the cleaning, and then to the grading of the berries, in order to place them on the market in presentable and advantageous form.

The coffee industry is in the hands of men of varied nationalities. Among these are found Germans, Portuguese, Americans, Englishmen, and Asiatics. The great body of coffee growers, however, are Anglo-Saxons. These men are, in the main, prospective and permanent settlers. If they succeed in their undertakings the country will be

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[1] Report of Hawaiian Collector-General of Customs, U. S. Treasury, 1897.

[2] For areas and conditions more in detail, see report of Consul-General Haywood to the State Department.

benefited by the addition of an industry which will bring with it a class of weighty and valuable citizens.

It is not possible at this time to speak with full detail and assurance upon the present economic condition of the industry. There are concerns which are reported to be already upon a paying basis and where good interest is being received upon the capital invested. There are others which have not yet reached the stage of returns on the outlay, and there are cases where loss and failure have resulted. These cases of actual failure, however, should not be allowed to prejudice the situation of the industry. The causes of failure in certain cases have been just those causes which would have induced failure in any undertaking. For example, where a man has gone into coffee with too little capital he has not been able to hold out until the crop reached the bearing stage, or stage of returns. Again, men have gone into coffee culture without knowledge of, and experience in, the work, and loss and failure have followed in those cases also. It is most liable to be the case, however, that the man of small capital is also a man of little experience, since where there is more capital at stake and more experience to direct its expenditure men move slowly. Where both want of capital and of experience come together then the result is sure and not far off. Apart from individual cases, it must be said that natural conditions, such as soil and climate, the state of the younger plantations that are on the way to the bearing stage, with certain actual results from older plantations—all these justify the belief that coffee growing can become a sound and paying industry in these islands. Any tendency in growers to give up coffee for sugar, where it is possible, at this time is very doubtful policy; not because the sugar industry may become less profitable but rather that the lands that are now in, and going into, coffee are not suitable for continuous sugar planting, of which there is abundant proof.

The scale upon which it will be most profitable to carry on coffee planting has not yet been determined. The small planter may be able to make it work with coffee as the money-yielding crop, but producing most of the articles of food for himself and family. By men of capital, who have looked into the question more precisely from the financial standpoint, it is definitely stated that, in order to make coffee a permanent industry and capable of taking its place with other industries, the plantations must be on a comparatively large scale, so that it will be possible to engage a steady supply of labor for them and provide the best mechanical means for the cleaning and grading of the berries. One other view is that coffee will become the most remunerative as an adjunct to existing sugar plantations, chiefly on account of the matter of labor. It is strongly represented that as the altitude for coffee planting commences where sugar planting ceases, the industries are naturally contiguous, and by an adjustment of the labor staff could be made interdependent. There are two examples which indicate that this latter view may develop into a reality.

FRUITS.

The fruits that are grown in quantities to amount to items of export are bananas and pineapples. The total production of these fruits it is not possible to give. The home consumption of each fruit is very considerable, being consumed by all classes of the community. The exportations of the two fruits, respectively, for the year 1897, most of which went to the United States, with a fractional portion to Canada, were as follows: Bananas, 75,835 bunches, valued at $75,412.50; pineapples, 149,515 pecks, valued at $14,423.17.

These are the two chief fruits of the islands, for which there is an ample market in the United States free from competition with the American articles. Any other fruits, such as oranges, limes, and lemons, or stone fruits, although capable of being grown in abundant quantities to meet the island requirements, can not be grown for export to enter into competition with the fruits of California.

The bananas grown on the islands are well known for their extremely good quality. Chinamen are the chief cultivators of the banana, which flourishes in rich, deep, alluvial or deposit soils on the low levels near the sea and in the rich and protected valleys. White men with their better methods surpass Chinamen in the cultivation of this fruit.

The pineapple culture has been taken up by Americans and other white culturists. The very finest fruit, however, is the small native pineapple, which has an extremely delicate aromatic flavor. The latter has been grown an indefinitely long time and chiefly by the native Hawaiians.

The capabilities of the Hawaiian soils and climates for variety and excellence of fruit production have not yet been amply tested. There are individual locations and private grounds where experiments are seen in course of trial which indicate that fine quality and an enormously increased quantity of the fruits mentioned and numerous others can be grown with full success.

VEGETABLES.

The city of Honolulu is almost wholly supplied as to its table needs by Chinamen, who occupy suitable lands within and around the city limits. The mode of distribution or service of houses is fairly good, but the quality and variety are limited and poor. Without specifying in detail, there is an ample field for improvement in the methods of supplying the tables of the city with green food of well-developed quality and freshness. The country districts provide themselves, yet hardly any surplus reaches Honolulu excepting native taro and a few bags of Irish potatoes.

NEW CULTURES AND INDUSTRIES.

Concerning the addition of new cultures and industries to the ones that have been described very considerable may be indicated. Most prominent among probable successes is grape culture. There are

numerous examples upon a small scale in several of the islands which attest beyond question that much can be done in grape and wine production. It is not possible to say at this time what action the soils may have upon the character of the juice and its products, excepting that much of these lands naturally tends to produce high purity and quality in the saps and juices of vegetable organisms generally as compared with the soil and atmospheric conditions of other lands.

Also, in addition to fruits and their products that may be added to the present industries of the islands, it is quite within the limits of probability to say that the soils and climates of the islands will be found favorable for the culture of plants and trees that yield "barks" and "milks" from which medicinal preparations are made. The cinchona barks can certainly be produced on the sheltered altitudes of the islands. Again, there are the conditions here for producing growths yielding flavors and dyes.

Further, there is room for a great expansion in fruits and growths that thrive specially well in salt soils near the sea. The cocoanut trees thrive admirably in these locations, and in time would be remunerative as an incidental culture.

Some note is to be made of possibilities in cereal production. The great differences in climatic conditions, that is, in temperature and rainfall, of which account has been given, indicate that there probably exist locations at temperate altitudes where wheat, barley, oats, and corn (maize) can be, and in fact are, successfully grown. At an earlier time wheat was grown in small amounts for bread making. Patches of oats may be seen to-day, while very recent experiences with American corn have shown that this cereal grows and matures perfectly. These observations are of special moment, since the successful establishing of small holdings and permanent settlers upon the available lands not under sugar will largely depend upon the ability of those small farmers to provide all the feed required by their animals, as well as most of the sustenance for themselves and their families. It is thus fortunate that the conditions suitable for growing coffee are also the conditions in which corn, sorghum, rye, and other cereals, and all common vegetables can be produced.

FORESTS.

The forest areas of the Hawaiian Islands were very considerable, covering the upland plateaus and mountain slopes at altitudes above the lands now devoted to sugar growing and other cultures. These areas, however, have suffered great reduction, and much of the most valuable forest cover has been devastated and laid bare. The causes given, and to-day seen, of the great destruction that has occurred are the direct removal of forest without any replacement by replanting. Again, in consequence of the wholesale crushing and killing off of forest trees by cattle, which have been allowed to traverse the

woods and to trample out the brush and undergrowth which protected the roots and trunks of trees, vast breadths of superb forests have dried up, and are now dead and bare. All authorities of the past and of the present agree in ascribing to mountain cattle, which were not confined to ranching areas but allowed to run wild in the woods, the chief part in the decimation of the forest-covered lands.

Forest areas reserved with respect to location and maintained in a state of vigor and sound growth are of the first importance to the agriculture of the islands. The greater number of the sugar plantations and all of the rice and banana fields are depending upon an elaborate and costly system of irrigation for their water supply, and the operation and availability of the irrigating waters are largely depending upon the area and state of the forests upon the mountain altitudes. It is not only claimed that cool forest covers cause precipitation of rain, but that the thick undergrowth and brush assist in conserving the water and in preventing its precipitous discharge to the sea, which conditions are indispensable in maintaining a regulated supply of water for distribution over lower lands.

Efforts have been made to restore the forest where it has been killed out. Several of these individual efforts have not only resulted in great benefit to the localities where the experiments have been made, but they are serving as object lessons, showing the immediate need of inclosing given forest areas and defending them against the action of cattle, thus allowing the depleted undergrowth and trees to come up again, a result which has followed in every case where inclosure has been adopted. Local efforts, however, do not meet the demands of the forest question from the standpoint of the interests of the islands as a whole. What appears to be the most immediate needs are a thorough expert examination of the islands and of their requirements in permanent forest areas, an inspection of the existing forests, and the adoption of means for improvement and maintenance. It may be possible for such an expert survey to show that portions of lands still under forest could be cleared for cropping without prejudice to the immediate or to distant localities, and, on the other hand, to indicate that the disturbance of existing forest areas in given locations would result in detriment to agriculture all around. Because of its bearing upon the immediate and permanent interests of agriculture, there is no question which demands at once a more careful and expert investigation than the state of these island forests.

INSECT PESTS AND PLANT DISEASES.

In reference to insect pests and plant diseases, a statement from Prof. A. Koebele, official entomologist of the Hawaiian Islands, bearing upon the existence of or liability to plant diseases, is here given, as follows:

Dr. WALTER MAXWELL,
United States Special Agent, Hawaiian Islands.

DEAR SIR: In reply to your inquiries, I will say that it appears to me that little fear need be entertained in regard to the introduction of scale and other insects, since we have here an abundance of parasites and predatory insects preying upon and keeping the same in check.

Strict attention, however, should be paid toward guarding against the introduction of Melolontid, Elateria beetles, etc., destructive to living roots of plants, as well as to any fungoid diseases destructive to vegetation that are liable to reach the islands with soil or plants imported.

Respectfully, A. KOEBELE.

JANUARY 5, 1899.

The labors and experiences of Professor Koebele upon the islands amply qualify him to speak upon the matter in question, and his statement gives the assurance desired within the limits spoken of.

RANCHES.

Up to the present time the Hawaiian Islands have been supplied by home-grown meats, and the supply has been ample. In fact, it is recorded that the number of cattle ranging the grazing areas some years ago was so large in proportion to the consumption of meat, that they were slaughtered chiefly for the hides, the carcasses having but very small value. Since that period the meat-eating population has increased, while the areas devoted to grazing and the number of cattle have gradually diminished, so that at the present time we are face to face with a situation in which the supply will no longer cover the demand. The supply of the country districts is furnished by the immediate localities. In some cases the sugar plantations have cattle lands which meet the demands of the plantation labor and of local private requirements. There are also large independent ranches. After the local demands have been satisfied the surplus of meat cattle produced upon the several islands is gathered up and shipped to Honolulu, to meet the consumption of the city tables. It is thus seen that the first indications of short supply will be felt in Honolulu, and the meat supply associations state that this is already the case.

It has been found by investigation that districts upon the islands, notably Kauai, which formerly had a large surplus for shipment, are at this time barely meeting the increased and increasing local demands. Ranchmen report that "in given districts the supply is now hardly adequate to the immediate local calls." In view of these facts, it is at once apparent that the future meat supply of the islands, and

particularly of Honolulu, will depend upon new factors and conditions. The present requirements of the city and of vessels making port at Honolulu are shown by the animals slaughtered in 1898, as follows: Cattle, 8,780; calves, 1,578; sheep, 9,171; swine, 7,266. These data were furnished by William T. Monsarrat, veterinary surgeon and Government inspector of meats. Mr. Monsarrat not only possesses all data relating to the number of cattle slaughtered, but he can also report upon the state of health of Hawaiian cattle. Concerning cattle slaughtered outside of Honolulu data are not available.

The course through which ranching may develop into a more remunerative industry and the means by which the home supply of meats may be rendered a sure factor and more nearly adequate to the growing demands of the community are bound up with the future character of other industries, more notably that of sugar.

Formerly, and but little more than a quarter of a century ago, cattle were more numerous upon the islands. They had wider ranges to rove over and feed upon; they were the possessors of the land, and their value consisted chiefly in the labor and hides which they yielded. At that time the plantations, which were of smaller areas than now, were almost wholly worked by bullock labor. Even to-day there are still thousands of oxen used in plowing and hauling, their energies being utilized as mechanical force instead of in the form of meat. In the course of time, and that very recent, the sugar industry has undergone great expansion. The lands, some of which formerly were among the best for meat-making uses, have been absorbed by the plantations, and the cattle have been gradually forced within narrower limits at higher altitudes. With the increase in sugar the number of cattle has become relatively and constantly less. A first result of this change was that an adequate supply of "cattle labor" was not available. Room was thus made for mule and horse labor; more recently steam, as applied to the plow, has come in, and in some districts has almost wholly superseded animal labor in the field. With the extension of the use of steam for plowing and hauling and the introduction of electricity where steam is less practicable, it appears a question of only a short time when the bullocks will be forever released from their yokes and the island cattle will be grown and used only for meat purposes. The present trend is wholly in the direction of a higher condition of things and the rate of change is distinctly rapid. Any change or reversion of the present relations of the sugar and cattle industries must depend chiefly upon the relative values of sugar and meat. At the present prices of sugar even the thinnest upland soils pay to plant with sugar cane. As an immediate fall in sugar values is not imminent, it is not apparent that any immediate change in the relations of the two industries will take place. However, this is not positive. When sugar declines from the present prices, which the cost of production makes probable in the

near future (within the comparatively short time of three to five years, as regarded by most authorities) and the price of meat goes up, then the land areas, respectively under sugar and meat production, will undergo some change. A fall of from 1 to 1½ cents per pound in the price of sugar and an increase of the same amount in the price of meat will put back certain areas of the uplands to meat production. This change would very materially aid the increased production of meat, and would not seriously, if at all, curtail the output of sugar, since those poorer uplands are the least productive in sugar, although among the best quality for grazing at certain seasons of the year. Moreover, experience has shown that a greater and more permanent increase in sugar production is practicable by leaving out the worst of the uplands from sugar and concentrating labor, fertilization, and costly water upon the richer and more durable lowlands. With a reversion of a part of the uplands to grazing purposes the sugar production can still continue to expand to the limits that have been stated.

There are other conditions than the relative values of sugar and meat that control the remuneration from ranching, and which depend upon the ranch owners. In the first place is mentioned the quality of the cattle, which is dependent upon the management of the herds. Very considerable sums of money have been expended by well-known ranchmen and patrons of cattle breeding for high-class bulls. Pedigree animals of such breeds as Shorthorns, Devons, and Scotch Angus (also some of the finer milk-yielding Jerseys and Alderneys) have been introduced and let loose upon the ranches. Considerable improvement has resulted from the use of these high-bred animals, yet the permanent results have not been anything like so great as they should have been, and for the following reasons: In the first place, the influence of the pure-bred bulls, when let loose in the herds, was spread over cows and heifers of all sorts and sizes instead of their service being confined to selected animals that would have rendered the most immediate benefits from crossing with good blood. Of course, it is not so practicable a matter to isolate and paddock cattle on a large ranch as it is upon a modern farm. Again, the stock coming from the high-bred crosses were not made the most of. The selection, omitted in the first coming together of the imported bulls and ranch heifers, continued to be neglected, no "culling" of the weaklings and undersizes being practiced, the breeding continuing from big and little, good-grade and scrub cows alike. These matters have been reported to the writer by several of the better-known ranch owners, and the results are apparent. With better values in prospect for home-grown meats, the management of the ranching properties will be brought under the more modern systems in respect of the methodic introduction and changing of blood and a careful selection and culling of the breeding stock. At no previous time have the inducements to do good work on the ranches

been so great, nor has the certainty of remuneration been so sure for investments in meat production on the islands. Ranchmen will be prudent if they take immediate advantage of the present situation; if they do not, and the supply of home-grown meat declines still further, the country will be obliged to enter upon the importation of frozen meats. This will only be profitable if done on a considerable scale; if large importations of meats are made it seems necessary for prices to fall, and home-meat producers will be the first sufferers. The meat supply is a matter of prime concern to the city of Honolulu. It is in the first degree desirable that fresh meats shall be available for daily use. Frozen meats that have been a long period on the ice, and subjected to changes of temperature during movements in transit, are not the same as meats killed on the ground and kept in cool chambers for a few hours, or at the most a day or two, before being consumed. It is found that meats and fowls that have been long on the ice spoil very rapidly in warm countries after removal from the ice. But the argument for the necessity of a home-meat supply in view of the contingencies of a war does not obtain, since if an enemy were able to cut off the islands from the mainland of the United States, it would be a much more simple matter to stop shipments between the islands, when Honolulu would be just as effectually starved out.

DAIRYING.

The requirements in milk and butter of the country districts of the islands are supplied locally. The milk demands of Honolulu are met by suburban dairies, which also furnish a part of the butter consumed, but the chief supply of butter is by importation.

The milk supply of Honolulu is also a matter of some concern. During the past year it has barely met the city's demands. This was, in part, due to the presence of United States troops, who were quartered near the city for some months. When considerable numbers of the soldiers were in the hospitals and in special need of milk extreme difficulty was experienced in obtaining anything like an adequate supply from the public dairies. In consequence several private families turned over their individual cows to the service of the United States military authorities.

The current price of milk (10 cents per quart) indicates the inadequacy of the supply; although it has to be considered that the cost of maintaining a dairy in or near Honolulu is greater in proportion to the number of cows kept than on farms in the United States. This is due partly to the price of imported feedstuffs and also to the prices of lands and the cost of applying irrigation water within the city limits.

The interests and protection of milk and meat consumers have been undertaken by the board of health, this organization having instituted examinations of meats and of dairy animals in respect of the existence or prevalence of liver fluke, tuberculosis, and other diseases. Recent

examinations, covering the year 1898, have furnished the following data upon the condition of herds and dairies:

Condition of meat cattle slaughtered.

Animals.	Number slaughtered.	Number with liver fluke.	Number with liver abscess.	Number condemned from tuberculosis.	Total condemned.
Cattle	8,780	2,589	21	15	17
Calves	1,578	433			
Sheep	9,171	50			
Swine	7,266				

Inspections of milch animals are given as follows: Number of cows inspected, 286; number of cows affected with tuberculosis, a majority; number of cows condemned, 10.

Mr. Monsarrat states that several of the worst affected cows were the individual animals of private families. These data, although not worse than are furnished by other countries, show the need of vigorous care.

The increase in the population of the city, with a permanent establishment of United States military headquarters, will increase the call for fresh meats and fresh milk and butter. Therefore dairymen, as well as ranchmen, will be amply remunerated for a more systematic and careful selection of animals from the standpoint of the public health, for a more rational management upon the ranches, and in the providing of food for the dairies. The people of Honolulu are prepared to pay a just price for these cardinal articles of diet, but they may demand that the wholesomeness of the supply shall be guarantied by the health authorities.

LABOR CONDITIONS.

The hired labor of the islands is used chiefly upon the sugar plantations, other industrial labor requirements being small in comparison.

In line with the expansion of sugar production, the demands for labor have increased. Originally the labor was done almost wholly by Hawaiians, but as the requirements increased, coupled with the somewhat native objection of many Hawaiians to hire at regular labor, the leaders of the sugar industry were obliged to look elsewhere, and this led to the introduction of Asiatic and other labor. In the following table is presented a view of the component nationalities of the population, and the relative numbers of each nationality engaged in plantation labor:

Population and plantation labor.

1897.	Hawaiians.	Chinese.	Japanese.	Portuguese.	Other foreigners.	Total.
Population	39,504	21,616	24,407	15,191	8,302	109,020
Labor	1,497	8,144	12,038	2,218	756	24,658

These figures amply illustrate the labor relations of the respective nationalities to the main agricultural industry of the islands. The Hawaiians, relative to their number, do not seek plantation work, and when they do, it is chiefly as teamsters, in which work they are good and desirable. The inclination of the Hawaiian is to personal occupation rather than to labor for others. This is, in part, due to an objection to continuous labor, but more to the native instinct, which is averse to subjection, unless to Hawaiians of high standing or white people of authority. The writer hopes to see this characteristic of the Hawaiians maintained, and that the pride of the native people will assume such a course as to accommodate them to the new conditions in such a way that the race will yet reestablish for itself a permanent economic position in the community.

A reference to the figures of the above table also shows that the Portuguese do not generally go to plantation labor. These people are very energetic and thrifty. They are inventive along the line of introducing new, small horticultural growths, such as the grape, etc. When they do work on plantations it is usually as teamsters, and they are comparatively highly paid for unskilled labor.

The burden of agricultural labor is borne by the Asiatics. One-third of the Chinese and one-half of the Japanese populations are engaged in plantation labor. The large remainder of the Chinese is privately occupied in rice, or fruit and vegetable culture, or in domestic service.

Concerning the conditions of the Asiatic laborers, it may be said, in general, that the presence of these peoples here demonstrates that the wages and personal comforts are greater in their present situation than they were in their native countries. This is further accentuated, in the case of the Japanese especially, by their disposition to settle permanently on the islands.

In regard to the question of compensation, a bare statement of wages does not cover the situation nor furnish a full comparison of the conditions that obtain here with the compensation of labor in other countries. The cost to the laborer of providing himself with fuel, clothing, and food is less upon these islands than, for example, in Louisiana, or in any other section of the United States. On the other hand, the value of labor to the employer, where the labor is paid at so much per man per day, depends upon the laborer and his power to work. From this standpoint it is found that different nationalities are capable of rendering different amounts of labor per day, and they are thus paid different wages. The power to work and the rate of wages of the Asiatics are less than in the case of white men (and of colored peoples in cooler climates) where the conditions of climate allow the latter to work. Where the climatic conditions exclude the white man the labor power of other races is also low.

General statements, however, upon this and all similar subjects are not of much value, so that a summary is here given of the labor roll

for the month of December, 1898, from the largest sugar-making estate on these islands, the Ewa Plantation Company. All skilled labor, composed of Americans, British, Germans, and Norwegians, is excluded, only Portuguese and Asiatics being included:

Laborers and wages.

Laborers.	Number of laborers.	Wage per month.	Monthly total.
Portuguese	34	$27.55	$930.70
Contract Chinamen	204	15.16	3,092.64
Day Chinamen	67	16.73	1,120.91
Contract Japanese	380	15.66	5,950.66
Day Japanese	100	18.04	1,804.00
Total	785		12,899.05

The differences between "day" and "contract" men are chiefly due to the fact that the day men are ex-contract and experienced laborers. It is thus seen that 785 laborers receive $12,899.05 in money, which is $16.43 per man per month, or 63 cents per day. Where overtime is made by the laborers, either contract or day men, the time is duly paid for. If all the plantations were canvassed the mean monthly wage would be found to be slightly higher than that in the example given, since on the larger plantations the number of higher-priced men is relatively smaller than on smaller plantations. This is still more specially the rule in respect to skilled labor.

The table gives only the payment in money per month. All the laborers, however, receive free lodging, free fuel, and free medical attendance, and their children free education.

More point will be given to the statement of wages paid to labor on these islands if a comparison is made with the values of labor in corresponding conditions in the United States. For this purpose Louisiana is selected. In 1896 data upon the prices of plantation labor in Louisiana were furnished to the writer by the Hon. John Dymond, planter, editor, and sugar statistician of New Orleans. Mr. Dymond states in reply to questions: "The average monthly wage for years has been and is $20, or 75 cents per day. This does not cover the grinding season (of some sixty days), when about $1 per day is paid." The grinding season in Hawaii lasts one hundred and fifty days or more, when special wages are earned by overtime. For the purpose of comparison the special wages are excluded in both cases, although that item is in favor of the Hawaiian laborer. Mr. Dymond further says, "The plantation laborers are furnished free house room; they steal their fuel, and require but little medical attention; work stopped by weather stops also the wages." These conditions are partly similar, but less favorable than corresponding

conditions on Hawaiian plantations, the difference being decidedly in favor of the Hawaiian laborer. Again, the Hawaiian laborer requires less clothing, and, what is more important, he does not need to lose one day in the year from the weather. These considerations cause the comparison to be drawn as follows:

Comparison of wages in Louisiana and Hawaii.

Place.	Wage per day.	Wage per month.
Louisiana	$0.75	$20.00
Hawaii	.70	18.20

A detailed comparison, including the extra money earned by overtime, would make the wages paid in the two localities almost, if not exactly, equal.

So far, the case has been stated for the laborer, showing the value of his labor to him. The cost of labor to the employer in Hawaii may now be shown. In addition to the 63 cents per day paid in money, the employer furnishes fuel, which is very dear (coal, $10 per ton; wood relatively dear), and a free doctor in addition to what is allowed in Louisiana. These extras raise the cost to 66 cents per day per man, but these extras are trifling in comparison with the extra cost per laborer per day that arises from the difference in the ability of the several nationalities to work. In the example given, the Portuguese receive, on an average, $27.55 per month, and the Asiatics $15.93 per month, which indicates that the latter possess a power to work, and consequently are paid 43 per cent less than the Portuguese. Mr. Dymond states that where men in Louisiana are on piecework the variation in their earnings is 37½ per cent. These examples are very pronounced, and probably extreme. It appears quite safe, however, to put the labor power of the Asiatic at 18 per cent less than that of the mixed labor of Louisiana, which is equivalent to saying that four Louisiana laborers are equal to five Asiatics. The difference is greater rather than less than is stated. Then, in view of these special considerations, at least 18 per cent has to be added to the 66 cents per day that the Hawaiian employer has to pay for his laborers, and this raises the cost of labor per day to 81 cents, which is 6 cents per day more than the average rate of wages in Louisiana, as stated by Mr. Dymond.

There is extreme confusion existing in the matter of labor values in different countries, which is due to the fact that the daily wage is taken as the sole evidence of cost. This applies to other kinds as well as to agricultural labor. A house carpenter in Boston receives from 25 cents to 75 cents per day more than a corresponding carpenter

in Honolulu, but the Boston man, due to total suspension of business for about four months in the winter, earns very considerably less annually than the man in Honolulu, who practically has not to lay off a day in the year; and between what is called coolie labor, operating in warm climates, and mixed American labor, or selected Asiatic labor, working in cooler climates, there are differences in labor power which cause extreme variations in the values and cost per day of those kinds of labor.

NOTES ON SOME ENGLISH FARMS AND FARMERS.

By Geo. Wm. Hill,
Chief of the Division of Publications.

GENERAL REMARKS.

With distance and time virtually annihilated and the cost of transportation greatly reduced, the farmers of the whole world are now, in one sense, near neighbors. Competition is keener to-day between farmers of the Northwestern States and those of Argentina, India, and Russia than it was fifty years ago between the farmers of almost adjoining States. The cotton and cotton seed of Egypt are sold in the same markets as the same products from the Southern States of this country. The man who raises butter and hogs in the Mississippi Valley finds an active and keen competitor in Denmark, small as that country is, while Australia and Canada have long outstripped the United States and now threaten Danish supremacy in the London markets.

Under these circumstances it must be not only interesting but useful to learn something of the conditions under which the farmers of foreign countries, whether consumers of our products or competitors of our producers, pursue their avocation. What advantages they enjoy that American farmers lack, and what disadvantages they endure that our farmers are free from, are matters of interest; but still more useful is it for the farmers of this country to know how their contemporaries in other lands improve their advantages or temper their disadvantages, for by such knowledge they themselves can certainly profit.

While, as stated, a general review of the conditions under which farming is pursued in the Old World would be interesting and instructive, the limitations of this paper will only permit the presentation of some brief notes regarding a few farms in England. The farms selected for consideration, it is believed, furnish certain features which will be of interest to all farmers in this country.

VISITS TO ENGLISH FARMS.

British farms and farmers are visited from time to time by members of the Royal Agricultural Society of London for the purpose of ascertaining the conditions of the farms and the methods of the farmers, and detailed accounts of these visits, as well as contributions on general farming topics, are published in the Journal of the

society. From this source, therefore, much may be learned on the subject. For instance, in the Journal of September, 1896, Mr. Thomas Stirton, of West Stratton, Hampshire, reports on 16 farms in the counties of Leicester and Rutland, which he divided into three classes: (1) Dairy farms; (2) stock-breeding farms; (3) stock-feeding farms.

GENERAL FARM CONDITIONS IN TWO ENGLISH COUNTIES.

Before discussing any individual farm a few general particulars in regard to farm conditions in the counties of Leicester and Rutland will not be out of place. The two counties contain, in round numbers, an aggregate area of 610,000 acres, while the farms inspected by Mr. Stirton contained a little over 6,000 acres. Of these 6,000 acres and over, 2,982 acres were arable and 3,287 acres were in pasture. Much of the soil is described as rich and loamy, but the particulars given of individual farms record extremes of stiff clay and loose sand. In both counties during the past twenty-five years many thousands of acres have been converted into permanent pasture. In laying down the pastures bone was used with conspicuous success, about 5 hundredweight being applied per acre. It is hardly necessary to say that in every case a fixed rotation was rigidly followed in cropping, the root crops especially being very heavily manured. The rents paid show a general downward tendency, an average reduction being reported since 1880 of from 22 to 25 per cent on grass lands and as much as 33 per cent on holdings of two-thirds grass and one-third arable. The average rents of the farms under consideration, only one of which was farmed by the owner, amounted to $5.30 per acre, to which should be added the rates or taxes paid by the tenant, which averaged about 50 cents per acre. Markets, especially for the disposal of grain and cattle, are reported excellent, but it will not surprise American farmers to learn that many serious complaints are made by the farmers as to the rates charged by the various railroad companies. It must be admitted, however, that the railroad charges in Great Britain seem to be higher than those in the United States. What would be regarded in this country as a large amount of labor is employed on these English farms, this item of expense amounting in one instance, a dairy farm, to over $17 per acre, the lowest rate recorded, on a stock-feeding farm, being about $2. The average labor expense, however, seems to be slightly over $5 per acre. The amount of labor thus secured is, however, greater than the same amount of money would command in this country, as will be understood by a statement of the wages paid to farm laborers. The wages of laborers around Leicester are reported to have increased about 2 or 3 shillings a week, the present average being $4.50 to $5 per week. In the smaller villages the rate is about $3.75, with a slight increase during the ten weeks of hay harvest. The better class of laborers, including

shepherds and stockmen, get from 1 to 2 shillings a week more than an ordinary laborer, with a cottage and garden rent free. In Rutland wages are a little lower. The laborers' cottages are all reported as well-built, clean, and comfortable, in every instance having a good vegetable and fruit garden.

The price of butter was reported as very low, averaging about 16 cents per pound, and it is admittedly, as might be expected, of an inferior quality. Most of the dairy farms reported on were devoted to the manufacture of Stilton cheese, one farmer reporting an annual sale of 4,400 Stiltons, while another reported an annual product of 3,500. These large cheese makers purchased considerable milk from other farmers, the ruling price of the milk being 11 to 12 cents per imperial gallon (10 pounds, or about 25 per cent more than the ordinary gallon). So much for some of the general conditions prevailing in the section where the farms to be considered are situated.

INDIVIDUAL FARM CONDITIONS.

The first farm mentioned in the report of Mr. Stirton is farmed by the owner, whose labor bill reaches the high figure of $17 and over per acre. The fact that no rent is paid no doubt has something to do with this liberal expenditure for labor. The chief revenue from this farm is derived from the sale of milk, 130 cows and heifers being reported on the farm, besides calves and several steers. The farm carried, moreover, some 430 head of sheep. The milk sales recorded show great depreciation in value since 1878. The milk sales of that year realized $21,800, and the amount fell gradually to $13,060 in 1895, although more cows were kept in the last-named year than in 1878. The manuring on this farm is very abundant, and all the liquid manure from the cattle sheds is saved and applied to the grass lands.

Another farm reported on contained 193 acres, 52 arable and 141 in pasture. For this farm the tenant paid for rent $1,100; for taxes, $119; for labor, per acre, $5.25—a total for rent, taxes, and labor of $2,300, or just about $12 per acre. The stock included at the time of Mr. Stirton's visit 34 cows, 5 steers, 15 horses, 126 sheep, and 112 pigs. A five-year rotation is practiced. The chief industry is cheese making, and the farmer buys milk largely from neighboring farmers. Four thousand four hundred and four Stilton cheeses were made in 1895. All the home-grown grain is fed on the farm, the cows being, moreover, allowed in summer 3 pounds each of linseed cake per day, and in winter straw chaff with 3 pounds of mixed oats and maize, besides beans and decorticated cake.

Another farm, scheduled as No. 6, contains 1,100 acres, 917 arable and 183 in pasture. The rent paid is $4,250 (reduced from $5,020 in 1886), and is regulated by a curious but sensible sliding scale. For every 2 shillings 6 pence below 40 shillings per quarter in the price of

wheat (that is, for every 8 cents below $1 per bushel) 5 per cent is deducted from the rent; rates or taxes amount to $420, and $5 per acre is expended for labor. The live stock includes 143 head of cattle, of which 72 are bullocks or steers, 34 horses, and 1,559 sheep. A five-year rotation is practiced, and the manuring of roots is heavy, including, besides farm manure, 6 hundredweight of superphosphates applied to mangels, 4 hundredweight to turnips, and 6 hundredweight to Swedes. That the farming is good is shown by crops of 24 to 32 bushels of wheat per acre, the same of barley, and as much as 48 bushels of oats. The amount of food consumed by the animals during the year included some 2,000 bushels of home-grown grain and purchased feed costing $3,000.

A summary of the chief expenses on this farm shows for rent and taxes, $4,675; labor, $5,500; amount of purchased feed, $3,000; aggregating, without counting artificial manure, cost of which is not given, an annual outgo of $13,000 and over on the 1,100 acres, or nearly $12 per acre before the first cent of profit can accrue to the farmer, to say nothing of interest on his investment in live stock, implements, etc. The principal source of income is in live stock. Of the sheep, 387 were fattening and 557 were lambs, while, as already stated, of the cattle 72 were steers.

Farm No. 8 of the report includes 495 acres, 390 of which are in pasture. The tenant paid for rent, $1,875; for taxes, $150; labor, per acre, $3.10; aggregating $3,559.50, something over $7 per acre. Like the last mentioned, this is a stock-breeding farm. The live stock includes 40 cows, 56 steers, 10 horses, and 472 sheep. Of the cows, 35 were milch cows, and the milk was delivered in London at 1 shilling 1 penny, or about 26¼ cents per ordinary gallon. The average sum realized per cow was $75, showing a yield per head of but little over 2,300 pounds of milk. About 100 acres of grass are cut each year, and some of the hay was sold at $25 per ton. To these hundred acres manure is applied during the winter. The rent of this farm to the previous tenant was $5,000, a reduction to the present tenant of $3,125.

Among the most interesting of the farms visited were Nos. 9 and 10, both farmed by the same tenant. Farm No. 9 consists of 236 acres, 126 acres arable and 110 in pasture, the yearly rental being $2,100, a reduction since 1885 of 20 per cent. With this farm the tenant secures a 66-acre pasture at $400 a year rent. Farm No. 10 embraces 497 acres, of which 444 are arable, and the rent paid is but $1,200, or a trifle over $2.50 per acre. The total rent thus foots up $3,700 for 799 acres, or less than $5 per acre, notwithstanding the comparatively high rent of the first farm of 236 acres. The total rates, or taxes, aggregate $312, which, added to the rent, make a rental and tax charge of $4,012 annually. At the time of Mr. Stirton's visit the live stock on both farms, which for present purposes will be

treated as one, was as follows: Cattle, 100 head, of which 70 were steers; horses, 32; sheep, 566, of which 128 were feeding sheep and 166 lambs. The cost of labor aggregated $5,246, being at the rate of $6.75 per acre on the smaller and $7.35 per acre on the larger farm. During the year under consideration a total value of $4,990 of feed was consumed by the cattle, a large sum, considerably in excess of $1,000, being paid for cotton cake, linseed, and other feeding stuffs. We have thus for rent, taxes, labor, and purchased feed, $10,258.

The tenant of these farms manures heavily, as the crop yields show. In 1882, in barley, 79½ acres yielded $60.75 per acre, the best results in fifteen years. In 1889, barley, 67 acres, brought only $32.50 per acre. The amount realized from all grains varied from $4,800 in the early eighties to as little as $1,515 in 1895, a difference due not so much to variation in yield as to variation in prices, with a general downward tendency, which must have been truly discouraging.

Perhaps the most remarkable thing to one accustomed to the ways of the average American farmer is the detailed statement of receipts and expenditures furnished by the tenant of these farms for a period of fifteen years, giving for each year the acreage of each crop, the exact proceeds per acre, the number of cattle, sheep, horses, and pigs sold, the prices obtained, and the amount of sales, and even the exact proceeds of the dairy and poultry, together with expenditures, showing amount paid yearly for feeding stuffs, for artificial manures, for labor, and for taxes, all these figures being taken from the tenant's books, which, adds the reporter, are "models of neatness and lucidity."

From the figures given there may be deduced a discouraging fact for the British farmer. In every five-year period there has been a marked reduction in the profits of this most intelligent and careful tenant. "In ten years," says the report, "his receipts had declined 30 per cent, while his profits had fallen from 5¾ per cent on the larger turnover of 1886 to 2½ per cent on the smaller turnover of 1896." During the five years ending with 1885 this farmer showed average yearly proceeds from his farms of more than $15,000; in the five years ending with 1890 this average was reduced to $10,400, while in the five years ending with 1895 the average yearly proceeds had fallen to $8,500.

Another farm reported on is one of 200 acres, evenly divided into 100 acres each of pasture and arable; rent, $1,418; rates or taxes, $250; labor cost, $11 per acre. The stock, when the farm was visited, included 34 head of cattle, 10 horses, and 317 sheep. A five-year rotation is followed, and the farm is very heavily manured; about 300 tons of farmyard manure is made and used upon the farm, and the town of Leicester being but 5 miles distant, 500 tons of town manure is also purchased, besides 300 tons of gas lime. The artificial manures are applied to the root crop and the gas lime to the wheat and oat crop. The average yield of wheat per acre is

48 bushels, and of barley 56 bushels; the average for peas and oats is 40 bushels each. There were sold from this comparatively small farm during the year under consideration $1,920 worth of grain and $515 of hay, the latter being the product of 10 acres. During the year the tenant also fed off 60 head of cattle. From the sale of the cattle and sheep during the year over $8,000 was realized. It may be worth noting that this comparatively successful farmer expresses a preference for silage over roots as feed for cattle.

Here then is a medium-sized farm which affords an interesting example of British farming methods and conditions. The main expenditures are as follows: Rent and taxes, $1,668, and labor, $2,200, while the town manure alone, according to figures given in the report for another farm, cost over $500, these three items footing up about $4,400 or $22 per acre, to say nothing of the cost of other manure or the cost of cattle feed purchased, which are not given, but must have been very heavy. This heavy expense had therefore to be met before a penny could be devoted to remunerating the farmer for his labor or as interest on his investment.

Another farm reported on included 534 acres, the rent paid being $1,724, with rates or taxes of $435, and a labor bill of $2,536, equal to $4.75 per acre. Among other expenses is one item of $1,630 paid for feed and $150 for timber for repairing fences, making a total for rent and taxes, labor, feed, and fences of $6,475 or something over $11 per acre. The amount paid for artificial manure is not given. This tenant reported the following stock: Cattle, 144 steers and 2 cows; horses, 11; sheep, 770, including 330 lambs and 170 feeding sheep. The tenant estimates $50 per acre as a fair sum for properly stocking the farm—over $25,000.

One of the interesting features in connection with this farm is the fact that for nearly two hundred years the tenants have been from the same family. The condition of the pasture lands is highly commended as the result of the clean state of the land when laid down and of the free application of barn manure.

Another farm, occupied by the same tenant for thirty-four years, consisted of 360 acres. For this farm a rent was paid of $2,300, taxes $155, and labor $2,070 (equal to $5.75 an acre), an aggregate for these three items of $4,525, a trifle over $12.50 per acre.

FEATURES OF THE FARMS REPORTED ON.

There are a few features in the foregoing brief notes which seem to be characteristic of all the farms reported on. The farms are all heavily stocked, and the proportion of sheep seems very large. To judge by such returns as are available, the sheep industry is a profitable branch of stock raising. All the sheep belong to the principal mutton breeds.

The large amount of capital which these farmers, though merely

tenants, have invested, and the systematic, businesslike methods with which their farming operations are conducted are very striking. To the majority of American farmers these facts must appear as remarkable features of British farming. The British farmer is evidently not only a farmer, but a business man, and it is no doubt due to this fact that, in the face of continued and increasing depression in prices and an apparently ever-growing competition, he is able to hold his own at all and achieve the means of subsistence, if nothing more. The care and accuracy with which these farmers keep their accounts will certainly be something of a revelation to many people of this country, and it should be an example to farmers who are not particular in this matter. Many farmers in the United States would be puzzled, indeed, if called upon to produce their books or to prepare accurate statements of their receipts and expenditures for any number of years.

CONCLUSIONS.

Even after making all due allowance for the important advantage of proximity to such markets as Great Britain affords, it does not seem that the American farmer by comparison with his British contemporaries has occasion for anything, so far as conditions are concerned, but self-congratulation. Tenants having an invested capital equal to $40 or $50 per acre, representing an interest charge of $1.50 an acre, with expenditures for rent, taxes, labor, artificial manures, and feed averaging $13 or $14 an acre more, need certainly excite no envy among the farmers of this country; but we may readily pay full tribute to the intelligent, patient industry, and particularly to the business capacity displayed by the British farmers in the face of many untoward circumstances.

APPENDIX.

SUMMARY OF INFORMATION ON VARIOUS SUBJECTS OF INTEREST TO THE FARMER.

CONTENTS.

APPENDIX.

ORGANIZATION OF THE DEPARTMENT OF AGRICULTURE, DECEMBER 31, 1898.

SECRETARY OF AGRICULTURE, James Wilson.

The Secretary of Agriculture is charged with the supervision of all public business relating to the agricultural industry. He appoints all the officers and employees of the Department, with the exception of the Assistant Secretary and the Chief of the Weather Bureau, who are appointed by the President, and directs the management of all the divisions, offices, and bureaus embraced in the Department. He exercises advisory supervision over the agricultural experiment stations deriving support from the National Treasury, and has control of the quarantine stations for imported cattle, and of interstate quarantine rendered necessary by contagious cattle diseases.

ASSISTANT SECRETARY OF AGRICULTURE, Joseph H. Brigham.

The Assistant Secretary performs such duties as may be required by law or prescribed by the Secretary. He also becomes Acting Secretary of Agriculture in the absence of the Secretary.

CHIEF CLERK, Andrew Geddes.

The Chief Clerk has the general supervision of the clerks and employees; of the order of business, records, and correspondence of the Secretary's office; of all expenditures from appropriations for contingent expenses, stationery, etc.; of the enforcement of the general regulations of the Department; and of the buildings occupied by the Department of Agriculture.

APPOINTMENT CLERK, Joseph B. Bennett.

The Appointment Clerk is charged by the Secretary with the preparation of all papers involved in making appointments, transfers, promotions, reductions, furloughs, or dismissals, and has charge of all correspondence of the Department with the United States Civil Service Commission. He deals with all questions as to positions in the Department which are under civil-service rules.

CHIEF OF SUPPLY DIVISION, Cyrus B. Lower.

The Supply Division has charge of purchases of supplies and materials paid for from the general funds of the Department.

BUREAUS, DIVISIONS, AND OFFICES.

WEATHER BUREAU (corner Twenty-fourth and M streets NW.).—*Chief*, Willis L. Moore; *Chief Clerk*, Henry E. Williams; *Professors of Meteorology*, Cleveland Abbe, F. H. Bigelow, Henry A. Hazen, Charles F. Marvin, Edward B. Garriott.

The Weather Bureau has charge of the forecasting of weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gauging and reporting of rivers; the maintenance and operation of seacoast telegraph lines, and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature and rainfall conditions for the cotton, rice, sugar, and other interests; the display of frost and cold-wave signals; the distribution of meteorological information in the interests of agriculture and commerce; and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties.

BUREAU OF ANIMAL INDUSTRY.—*Chief*, D. E. Salmon; *Assistant Chief*, A. D. Melvin; *Chief Clerk*, S. R. Burch; *Chief of Inspection Division*, A. M. Farrington; *Chief of Miscellaneous Division*, Tooie A. Geddes; *Chief of Pathological Division*, Victor A. Norgaard; *Chief of Biochemic Division*, E. A. de Schweinitz; *Chief of Dairy Division*, Henry E. Alvord; *Zoologist*, Ch. Wardell Stiles; *In charge of Experiment Station*, E. C. Schroeder.

The Bureau of Animal Industry makes investigations as to the existence of contagious pleuro-pneumonia and other dangerous communicable diseases of live stock, superintends the measures for their extirpation, makes original investigations as to the nature and prevention of such diseases, and reports on the condition and means of improving the animal industries of the country. It also has charge of the inspection of import and export animals, of the inspection of vessels for the transportation of export cattle, and of the quarantine stations for imported neat cattle; supervises the interstate movement of cattle; and inspects live stock and their products slaughtered for food consumption.

DIVISION OF STATISTICS.—*Statistician*, John Hyde; *Assistant Statistician*, George K. Holmes.

The Division of Statistics collects information as to the condition, prospects, and harvests of the principal crops, and of the numbers and status of farm animals, through a corps of county correspondents and the aid of a supplementary organization under the direction of State agents, and obtains similar information from European countries monthly through the deputy consul-general at London, assisted by consular, agricultural, and commercial authorities. It records, tabulates, and coordinates statistics of agricultural productions, distribution, and consumption, the authorized data of governments, institutes, societies, boards of trade, and individual experts, and issues a monthly crop report and occasional bulletins for the information of producers and consumers, and for their protection against combination and extortion in the handling of the products of agriculture.

SECTION OF FOREIGN MARKETS.—*Chief*, Frank H. Hitchcock.

The Section of Foreign Markets makes investigations and disseminates information "concerning the feasibility of extending the demands of foreign markets for the agricultural products of the United States."

OFFICE OF EXPERIMENT STATIONS.—*Director*, A. C. True; *Assistant Director*, E. W. Allen.

The Office of Experiment Stations represents the Department in its relations to the experiment stations which are now in operation in all the States and Territories. It seeks to promote the interests of agricultural education and investigation throughout the United States. It collects and disseminates general information regarding the colleges and stations, and publishes accounts of agricultural investigations at home and abroad. It also indicates lines of inquiry of the stations, aids in the conduct of cooperative experiments, reports upon their expenditures and work, and in general furnishes them with such advice and assistance as will best promote the purposes for which they were established. It is also charged with investigations on the nutritive value and economy of human foods. The collection of valuable matter on irrigation from agricultural colleges and other sources, as provided in the appropriation bill, is conducted by this office.

DIVISION OF CHEMISTRY.—*Chemist*, Harvey W. Wiley; *Assistant Chemist*, Erwin E. Ewell.

The Division of Chemistry makes investigations of the methods proposed for the analyses of soils, fertilizers, and agricultural products, and such analyses as pertain in general to the interests of agriculture. It can not undertake the analyses of samples of the above articles of a miscellaneous nature, but application for such analyses should be made to the directors of the agricultural experiment stations of the different States. The division does not make assays of ores nor analyses of minerals except when related to general agricultural interests, nor analyses of water.

DIVISION OF ENTOMOLOGY.—*Entomologist*, L. O. Howard; *Assistant Entomologist*, C. L. Marlatt.

The Division of Entomology obtains and disseminates information regarding insects injurious to vegetation; investigates insects sent to the division in order to give appropriate remedies; conducts investigations of this character in different parts of the country; and mounts and arranges specimens for illustrative and museum purposes.

DIVISION OF BIOLOGICAL SURVEY.—*Chief*, C. Hart Merriam; *Assistant Chief*, T. S. Palmer.

The Division of Biological Survey studies the geographic distribution of animals and plants, and maps the natural life zones of the country; it also investigates the economic relations of birds and mammals, and recommends measures for the preservation of beneficial and the destruction of injurious species.

DIVISION OF FORESTRY.—*Forester*, Gifford Pinchot; *Superintendent of Working Plans*, Henry S. Graves.

The Division of Forestry is occupied with experiments, investigations, and reports dealing with the subject of forestry, and with the dissemination of information upon forestry matters.

DIVISION OF BOTANY.—*Botanist*, Frederick V. Coville; *Chief of Section of Seed and Plant Introduction*, O. F. Cook.

The Division of Botany investigates botanical agricultural problems, including the purity and value of agricultural seeds; methods of controlling the spread of weeds or preventing their introduction into this country; the dangers, effects, and antidotes for poisonous plants, the native plant resources of the country, and other subjects of economic botany.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.—*Pathologist*, B. T. Galloway; *Assistant Pathologist*, Albert F. Woods.

The Division of Vegetable Physiology and Pathology has for its object a study of the normal and abnormal life processes of plants. It seeks by investigations in the field and experiments in the laboratory to determine the causes of disease and the best means of preventing the same. It studies plant physiology in its bearing on pathology.

DIVISION OF AGROSTOLOGY.—*Agrostologist*, F. Lamson-Scribner; *Assistant Chief*, Jared G. Smith.

The Division of Agrostology is charged with the investigation of the natural history, geographical distribution, and uses of grasses and forage plants, their adaptation to special soils and climates, the introduction of promising native and foreign kinds into cultivation, and the preparation of publications and correspondence relative to these plants.

DIVISION OF POMOLOGY.—*Pomologist*, Gustavus B. Brackett; *Assistant Pomologist*, W. A. Taylor.

The Division of Pomology collects and distributes information in regard to the fruit interests of the United States; investigates the habits and peculiar qualities of fruits, their adaptability to various soils and climates, and conditions of culture, and introduces new and untried fruits from foreign countries.

DIVISION OF SOILS.—*Chief*, Milton Whitney; *Assistant Chief*, Lyman J. Briggs.

The Division of Soils has for its object the investigation of the texture and other physical properties of soils and their relation to crop production.

OFFICE OF PUBLIC ROAD INQUIRIES.—*Director*, Roy Stone.[1]

The Office of Public Road Inquiries collects information concerning the systems of road management throughout the United States, conducts investigations regarding the best method of road making, and prepares publications on this subject.

DIVISION OF GARDENS AND GROUNDS.—*Horticulturist and Superintendent of Gardens and Grounds*, William Saunders.

The Division of Gardens and Grounds is charged with the care and ornamentation of the park surrounding the Department buildings, and with the duties connected with the conservatories and gardens for testing and propagating economic plants.

DIVISION OF PUBLICATIONS.—*Chief*, Geo. Wm. Hill; *Assistant Chief*, Joseph A. Arnold; *Assistant in Charge of Document Section*, R. B. Handy.

The Division of Publications exercises general supervision of the Department printing and illustrations, edits all publications of the Department, has charge of the printing and Farmers' Bulletin funds, and distributes all Department publications with the exception of those turned over by law to the Superintendent of Documents for sale at the price affixed by him; it issues, in the form of press notices, official information of interest to agriculturists, and distributes to agricultural publications and writers synopses of Department publications.

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[1] Hon. Martin Dodge was Director for six months in 1898, when General Stone was absent as a Brigadier-General of Volunteers in the United States Army.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.—*Chief*, Frank L. Evans; *Assistant Chief* (in charge of Weather Bureau disbursements), A. Zappone; *Cashier*, Everett D. Yerby.

The Division of Accounts and Disbursements is charged with the adjustment of all claims against the Department; decides questions involving the expenditure of public funds; prepares contracts for annual supplies, leases, and agreements; issues requisitions for the purchase of supplies, requests for passenger and freight transportations; and attends to all business relating to the financial interests of the Department, including payments of every description.

DIVISION OF SEEDS.—*Chief*, Robert J. Whittleton.

The Division of Seeds is charged with the purchase and distribution of valuable seeds, a certain portion of which are collected and purchased from foreign countries for experiments with reference to their introduction into this country. They are distributed in allotments to Senators, Representatives, Delegates in Congress, agricultural experiment stations, and by the Secretary of Agriculture, as provided by law.

LIBRARY.—*Librarian*, W. P. Cutter.

The Librarian has charge of the Library and supervises the arrangement and cataloguing of books, the preparation of bibliographies and similar publications, and the purchases of new books.

APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEARS ENDING JUNE 30, 1897, 1898, AND 1899.

	1897.	1898.	1899.
Salaries, Department of Agriculture	$313,860	$319,300	$319,300
Furniture, cases, and repairs, Department of Agriculture	12,000	9,000	9,000
Library, Department of Agriculture	7,000	7,000	6,000
Museum, Department of Agriculture	3,000	3,000	1,500
Postage, Department of Agriculture	3,000	3,000	2,000
Contingent expenses, Department of Agriculture	25,000	25,000	25,000
Animal quarantine stations	12,000	12,000	12,000
Collecting agricultural statistics	110,000	110,000	105,000
Botanical investigations and experiments	15,000	15,000	20,000
Entomological investigations	20,000	20,000	20,000
Vegetable pathological investigations	20,000	20,000	20,000
Biological investigations	17,500	17,500	17,500
Pomological investigations	6,000	8,000	9,500
Laboratory, Department of Agriculture	12,400	12,400	12,400
Forestry investigations	20,000	20,000	20,000
Experimental gardens and grounds, Department of Agriculture	20,000	25,000	20,000
Soil investigations	10,000	10,000	10,000
Grass and forage plant investigations	10,000	10,000	10,000
Fiber investigations	5,000	5,000	----------
Agricultural experiment stations [$750,000, 1897; $755,000, 1898; $760,000, 1899] [1]	30,000	35,000	40,000
Nutrition investigations	15,000	15,000	15,000
Public road inquiries	8,000	8,000	8,000
Publications, Department of Agriculture	70,000	65,000	65,000
Sugar investigations	----------	5,000	7,000
Purchase and distribution of valuable seeds	150,000	130,000	130,000
Salaries and expenses, Bureau of Animal Industry	650,000	675,000	900,000
Irrigation information	----------	----------	10,000
Total	1,564,760	1,584,200	1,814,200
Weather Bureau.			
Salaries, Weather Bureau	150,540	150,540	153,340
Fuel, lights, and repairs, Weather Bureau	8,000	8,000	8,000
Contingent expenses, Weather Bureau	8,000	8,000	8,000
General expenses, Weather Bureau	717,232	717,162	765,162
Meteorological observation stations	----------	----------	75,000
Erection of building at Sault Ste. Marie, Mich.	----------	----------	3,000
Repairs to buildings and grounds, Bismarck, N. Dak.	----------	----------	3,000
Total for Weather Bureau	883,772	883,702	1,015,502
Grand total	2,448,532	2,467,902	2,829,702

[1] Of these amounts $720,000 is annually paid directly to the experiment stations by the United States Treasury.

AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES HAVING COURSES IN AGRICULTURE.

States and Territories.	Name of institution.	Location.	President.
Alabama	State Agricultural and Mechanical College (Alabama Polytechnical Institute).	Auburn	W. L. Broun.
	State Normal and Industrial School.	Normal	W. H. Councill.
Arizona	University of Arizona	Tucson	M. M. Parker.
Arkansas	Arkansas Industrial University	Fayetteville	J. L. Buchanan.
California	University of California	Berkeley	M. Kellogg.
Colorado	The State Agricultural College of Colorado.	Fort Collins	A. Ellis.
Connecticut	Storrs Agricultural College	Storrs	G. W. Flint.
Delaware	Delaware College	Newark	G. A. Harter.
	State College for Colored Students.	Dover	W. C. Jason.
Florida	Florida Agricultural College	Lake City	W. F. Yocum.
	Florida State Normal and Industrial College.	Tallahassee	T. De S. Tucker.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White.
	Georgia State Industrial College	College	R. R. Wright.
Idaho	University of Idaho	Moscow	J. P. Blanton.
Illinois	University of Illinois	Urbana	A. S. Draper.
Indiana	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	T. E. Will.
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson.
	State Normal School for Colored Persons.	Frankfort	J. E. Givens.
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	T. D. Boyd.
	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill.
Maine	The University of Maine	Orono	A. W. Harris.
Maryland	Maryland Agricultural College	College Park	R. W. Silvester.
Massachusetts	Massachusetts Agricultural College.	Amherst	H. H. Goodell.
Michigan	Michigan State Agricultural College.	Agricultural College	J. L. Snyder.
Minnesota	The University of Minnesota	Minneapolis	C. Northrop.
Mississippi	Mississippi Agricultural and Mechanical College.	Agricultural College	S. D. Lee.
	Alcorn Agricultural and Mechanical College.	Westside	E. H. Triplett.
Missouri	School of Agriculture and Engineering of the University of Missouri.	Columbia	R. H. Jesse.
	Lincoln Institute	Jefferson City	J. H. Jackson.
Montana	The Montana College of Agriculture and Mechanic Arts.	Bozeman	James Reid.
Nebraska	Industrial College of the University of Nebraska.	Lincoln	G. E. MacLean.
Nevada	Nevada State University	Reno	J. E. Stubbs.
New Hampshire	The New Hampshire College of Agriculture and the Mechanic Arts.	Durham	C. S. Murkland.
New Jersey	Rutgers Scientific School (The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts).	New Brunswick	Austin Scott.
New Mexico	The New Mexico College of Agriculture and Mechanic Arts.	Mesilla Park	C. T. Jordan.
New York	Cornell University	Ithaca	J. G. Schurman.
North Carolina	The North Carolina College of Agriculture and Mechanic Arts.	West Raleigh	A. Q. Holladay.
	The Agricultural and Mechanical College for the Colored Race.	Greensboro	J. B. Dudley.
North Dakota	North Dakota Agricultural College.	Agricultural College	J. H. Worst.
Ohio	Ohio State University	Columbus	J. H. Canfield.
Oklahoma	Oklahoma Agricultural and Mechanical College.	Stillwater	G. E. Morrow.
Oregon	Oregon State Agricultural College.	Corvallis	T. M. Gatch.
Pennsylvania	The Pennsylvania State College	State College	G. W. Atherton.
Rhode Island	Rhode Island College of Agriculture and Mechanic Arts.	Kingston	J. H. Washburn.

AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES, ETC.—Continued.

States and Territories.	Name of institution.	Location.	President.
South Carolina	Clemson Agricultural College	Clemson College	H. S. Hartzog.
	The Colored Normal, Industrial, Agricultural and Mechanical College of South Carolina.	Orangeburg	T. E. Miller.
South Dakota	South Dakota Agricultural College.	Brookings	J. W. Heston.
Tennessee	University of Tennessee	Knoxville	C. W. Dabney.
Texas	State Agricultural and Mechanical College of Texas.	College Station	L. L. Foster.
	Prairie View State Normal School	Prairie View	L. C. Anderson.
Utah	The Agricultural College of Utah	Logan	J. M. Tanner.
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham.
Virginia	Virginia Polytechnic Institute (State Agricultural and Mechanical College).	Blacksburg	J. M. McBryde.
	The Hampton Normal and Agricultural Institute.	Hampton	H. B. Frissell.
Washington	Washington Agricultural College and School of Science.	Pullman	E. A. Bryan.
West Virginia	West Virginia University	Morgantown	J. H. Raymond.
	The West Virginia Colored Institute.	Farm	J. McH. Jones.
Wisconsin	University of Wisconsin	Madison	C. K. Adams.
Wyoming	University of Wyoming	Laramie	E. E. Smiley.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, DIRECTORS, AND PRINCIPAL LINES OF WORK.

Stations, locations, and directors.	Number in staff.	Number of teachers on staff.	Principal lines of work.
Alabama (College), Auburn: P. H. Mell	11	8	Botany; soils; analysis of fertilizers and food materials; field and pot experiments; horticulture; diseases of plants; feeding experiments; diseases of animals.
Alabama (Canebrake), Uniontown: W. Collins	3	2	Soil improvement; field experiments; horticulture; diseases of plants.
Arizona, Tucson: C. S. Parsons	11	3	Chemistry; meteorology; field experiments; canaigre investigations; diseases of plants.
Arkansas, Fayetteville: R. L. Bennett	8	4	Chemistry of foods; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals.
California, Berkeley: E. W. Hilgard	22	9	Physics; chemistry and geographical distribution of soils; fertilizers; field crops; horticulture; botany; meteorology; technology of wine and olive oil and zymology; chemistry of foods and feeding stuffs; entomology; drainage and irrigation; reclamation of alkali lands; introduction and acclimation of foreign culture plants.
Colorado, Fort Collins: Aldon Ellis	18	6	Chemistry; botany; meteorology; field experiments; horticulture; entomology; irrigation.
Connecticut (State), New Haven: S. W. Johnson	15	.....	Chemistry; analysis and inspection of fertilizers and foods; field and pot experiments; horticulture; seed tests; diseases of plants; chemistry of feeding stuffs and dairy products.
Connecticut (Storrs), Storrs: W. O. Atwater	6	1	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; dairying.
Delaware, Newark: A. T. Neale	6	1	Chemistry; field experiments; horticulture; diseases of plants feeding experiments; diseases of animals; entomology; dairying.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, ETC.—Continued.

Stations, locations, and directors.	Number in staff.	Number of teachers on staff.	Principal lines of work.
Florida, Lake City: W. F. Yocum	7	5	Chemistry; field experiments; horticulture; entomology.
Georgia, Experiment: R. J. Redding	7	1	Field experiments; horticulture; pig feeding; dairying.
Idaho, Moscow: Jos. P. Blanton	11	10	Physics; chemistry; botany; field experiments; horticulture; entomology.
Illinois, Urbana: E. Davenport	10	8	Chemistry; bacteriology; field experiments; horticulture; forestry; diseases of plants; feeding experiments; entomology; dairying.
Indiana, Lafayette: C. S. Plumb	11	7	Chemistry; pot and field experiments; horticulture; feeding experiments; diseases of animals.
Iowa, Ames: C. F. Curtiss	21	17	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying.
Kansas, Manhattan: Thos. E. Will	12	7	Soils; horticulture; seed breeding; diseases of plants; feeding experiments; diseases of animals; entomology.
Kentucky, Lexington: M. A. Scovell	9	3	Chemistry; soils; fertilizer analysis; field experiments; horticulture; diseases of plants; entomology; dairying.
Louisiana (Sugar), New Orleans: Wm. C. Stubbs	6	.....	Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation.
Louisiana (State), Baton Rouge: Wm. C. Stubbs	10	7	Chemistry; geology; botany; bacteriology; soils; field experiments; horticulture; feeding experiments; entomology.
Louisiana (North), Calhoun: Wm. C. Stubbs	4	.....	Chemistry; soils; fertilizers; field experiments; horticulture; stock raising; dairying.
Maine, Orono: C. D. Woods	12	6	Chemistry; botany; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; horticulture; diseases of plants; seed tests; food and nutrition of man and animals; diseases of animals; entomology; dairying.
Maryland, College Park: H. J. Patterson	13	3	Chemistry; soils; field experiments; horticulture; diseases of plants; feeding experiments; entomology.
Massachusetts, Amherst: H. H. Goodell	22	7	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; field experiments; horticulture; diseases of plants; digestion and feeding experiments; diseases of animals; entomology.
Michigan, Agricultural College: C. D. Smith	19	11	Botany and bacteriology; field experiments; horticulture; forestry; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Minnesota, St. Anthony Park, St. Paul: W. M. Liggett	13	9	Chemistry; field experiments; horticulture; forestry; plant diseases; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying.
Mississippi, Agricultural College: W. L. Hutchinson	12	4	Chemistry; soils; field experiments; horticulture; feeding experiments; dairying.
Missouri, Columbia: H. J. Waters	13	6	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; drainage.
Montana, Bozeman: S. M. Emery	7	7	Field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; irrigation.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, ETC.—Continued.

Stations, locations, and directors.	Number in staff.	Number of teachers on staff.	Principal lines of work.
Nebraska, Lincoln: G. E. MacLean	19	9	Chemistry; botany; meteorology; field experiments; horticulture; forestry; feeding and breeding experiments; diseases of animals; entomology; irrigation.
Nevada, Reno: J. E. Stubbs	7	4	Chemistry; botany; soils; field experiments; horticulture; forestry; entomology; irrigation.
New Hampshire, Durham: C. S. Murkland	11	7	Chemistry; field experiments; diseases of plants; feeding experiments; diseases of animals; entomology; dairying; road experiments.
New Jersey (State), New Brunswick: E. B. Voorhees	10	1	Chemistry; biology; botany; analysis of fertilizers and foods; pot and field experiments; horticulture; diseases of plants; food and nutrition of man; diseases of animals; entomology; dairy husbandry; bacteria of milk; irrigation.
New Jersey (College), New Brunswick: E. B. Voorhees	8	4	
New Mexico, Mesilla Park: C. T. Jordan	15	4	Chemistry; botany; field experiments; horticulture; diseases of plants; entomology; irrigation.
New York (State), Geneva: W. H. Jordan	22	----------	Chemistry; meteorology; analysis and control of fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; dairying.
New York (Cornell), Ithaca: I. P. Roberts	21	10	Chemistry of soils and feeding stuffs and dairy products; soils; fertilizer investigations; field experiments; horticulture; diseases of plants; feeding sheep and swine; diseases of animals; poultry experiments; entomology; dairying.
North Carolina, Raleigh: W. A. Withers	20	7	Chemistry; analysis and control of fertilizers; field experiments; horticulture; food adulteration; composition of feeding stuffs; digestion experiments; poultry experiments.
North Dakota, Agricultural College: J. H. Worst	12	9	Field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; dairying.
Ohio, Wooster: C. E. Thorne	15	----------	Soils; field experiments; horticulture; diseases of plants; breeding and feeding experiments; entomology.
Oklahoma, Stillwater: G. E. Morrow	11	----------	Botany; soils; field experiments; horticulture; digestion experiments; stock feeding; entomology; irrigation.
Oregon, Corvallis: T. M. Gatch	11	9	Chemistry; soils; field crops; horticulture; diseases of plants; digestion and feeding experiments; entomology; dairying.
Pennsylvania, State College: H. P. Armsby	18	8	Chemistry; meteorology; fertilizer analysis; field experiments; feeding experiments; dairying.
Rhode Island, Kingston: A. A. Brigham	12	4	Chemistry; meteorology; soils; field and pot experiments; horticulture; diseases of plants; poultry experiments; oyster culture.
South Carolina, Clemson College: H. S. Hartzog	14	8	Soils; analysis and control of fertilizers; field experiments; horticulture; dairying.
South Dakota, Brookings: J. H. Shepard	12	6	Bacteriology; chemistry of soils and soil physics; field experiments; forestry; diseases of plants; feeding experiments; entomology; irrigation.
Tennessee, Knoxville: ——— ———	10	5	Chemistry; botany; field experiments; horticulture; entomology.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, ETC.—Continued.

Stations, locations, and directors.	Number in staff.	Number of teachers on staff.	Principal lines of work.
Texas, College Station: J. H. Connell	15	.....	Chemistry; soils; fertilizers; field experiments; horticulture; feeding dairy cows; sheep husbandry; diseases of animals and plants; irrigation.
Utah, Logan: L. Foster	11	8	Chemistry; meteorology; soils; field experiments; horticulture; forestry; feeding experiments; poultry; dairying; irrigation.
Vermont, Burlington: J. L. Hills	13	6	Chemistry; analysis and control of fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; dairying.
Virginia, Blacksburg: J. M. McBryde	11	7	Chemistry; fertilizers; diseases of plants; diseases of animals; feeding experiments; entomology.
Washington, Pullman: E. A. Bryan	8	.....	Chemistry; soils; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; entomology.
West Virginia, Morgantown: J. H. Stewart	13	4	Chemistry; analysis and control of fertilizers; field experiments; horticulture; feeding experiments; poultry experiments; entomology.
Wisconsin, Madison: W. A. Henry	18	11	Chemistry; soils; field experiments; horticulture; feeding experiments; diseases of animals; dairying; drainage and irrigation.
Wyoming, Laramie: E. E. Smiley	8	6*	Geology; botany; meteorology; waters; soils; fertilizers; field experiments; food analysis; feeding experiments; entomology.

NOTES REGARDING DEPARTMENT PUBLICATIONS.

The publications of the U. S. Department of Agriculture are of three classes: (1) Serial publications, (2) scientific and technical reports, and (3) popular bulletins. The first two classes are issued in limited editions and are distributed free only to persons cooperating with or rendering the Department some service. Sample copies will be sent if requested, but generally applicants must apply to the Superintendent of Documents, Union Building, Washington, D. C., to whom all publications not needed for official use, except circulars and bulletins printed by law for free distribution, are turned over. They are disposed of by him at cost of printing.

The popular circulars and bulletins treat in a practical way of subjects of particular interest to farmers, are issued in large editions, and are for free distribution. The Farmers' Bulletins are of this class. Some of them are out of print. A list of such as are available for distribution at any time will be forwarded upon request.

There is no list of persons to whom all publications are sent. The Monthly List of Publications, issued the 1st of each month, will be mailed regularly to all who apply for it. In it are given the titles of all publications issued during the previous month, with a note explanatory of the character of each, thus enabling the reader to make intelligent application for such bulletins and reports as are likely to be of interest to him.

For the maps and bulletins of the Weather Bureau, requests and remittances should be directed to the Chief of that Bureau. Also the index (card form) of experiment-station literature is sold direct to applicants by the Office of Experiment Stations. For all other publications to which a price is affixed, application must be made to the Superintendent of Documents, Union Building, Washington, D. C., accompanied by the price thereof; and all remittances should be made to him, and not to the Department of Agriculture. Such remittances should be made by postal money order, and not by private check or postage stamps. The Superintendent of Documents is not permitted to sell more than one copy of any public document to the same person. The Public Printer may sell to one person any number not to exceed 250 copies, if ordered before the publication goes to press.

PUBLICATIONS ISSUED JANUARY 1, 1898, TO DECEMBER 31, 1898.

The following publications were issued by the United States Department of Agriculture during the year January 1, 1898, to December 31, 1898. Those to which a price is attached, with the exception of publications of the Weather Bureau, must be obtained of the Superintendent of Documents, Union Building, Washington, D. C., to whom are turned over all copies not needed for official use, in compliance with section 67 of the act providing for the public printing and binding and the distribution of public documents. Remittances should be made to him by postal money order. Weather Bureau publications to which a price is attached must be obtained from the Chief of that Bureau. Applications for those that are for free distribution should be made to the Secretary of Agriculture, Washington, D. C.

OFFICE OF THE SECRETARY.

	Copies.
Report of the Secretary for 1898	30,000
Irrigation on the Great Plains. Reprint from Yearbook, 1896	1,000
Sheep Feeding. Farm. Bul. 49. Reprint	20,000
Marketing Farm Produce. Farm. Bul. 62	40,000
Number, Status, and Compensation of Employees in the Department of Agriculture. Cir. 6. With two reprints	3,000
Sewage Disposal on the Farm, and the Protection of Drinking Water. Farm. Bul. 43. Reprint	10,000
Beet-Sugar Industry in the United States. Report of Special Agent. House Doc. 396, 55th Cong., 2d. sess	500
Farm Drainage. Farm. Bul. 40	10,000
Cultivation of Tobacco in Sumatra. 5 cents	4,000
Possible Influence of Importation of Hawaiian Sugar on Beet-Sugar Production in the United States. Cir. 7	2,000

CONGRESSIONAL PUBLICATIONS.

A Report to Congress on Agriculture in Alaska, including Reports by Walter H. Evans, Benton Killin, and Sheldon Jackson. House Doc. No. 160, 55th Cong., 2d sess	17,500
Adulteration of Wheat Flour. House Doc. No. 309, 55th Cong., 2d sess	1,722
Operations of the Bureau of Animal Industry. House Doc. No. 227, 55th Cong., 2d sess	1,722
Yearbook of the Department of Agriculture, 1897. 60 cents	500,000
Analyses of Sugar Beets Grown in Various States. From Special Report on the Beet-Sugar Industry in the United States. From House Doc. No. 396, 55th Cong., 2d sess	60,000
Bibliography of the More Important Contributions to American Economic Entomology. Part VI: June 30, 1888, to Dec. 30, 1896	1,000
Report of the Chief of the Weather Bureau, 1896-97	4,000
Fourteenth Annual Report of the Bureau of Animal Industry for the Fiscal Year 1897. 65 cents	30,000

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

Fiscal Regulations of the U. S. Department of Agriculture, together with extracts from the Revised Statutes, Decisions of Courts, Rulings of the Comptrollers, Opinions of the Attorney-General, etc	3,000
Report of the Chief for 1897. Reprint	250
Report of the Chief for 1898	250

DIVISION OF AGROSTOLOGY.

Cowpeas (*Vigna catjang*). Reprint from Yearbook, 1896	2,000
American Grasses: I. Bul. 7, revised. 20 cents	1,000
A Report upon the Grasses and Forage Plants and Forage Conditions of the Eastern Rocky Mountain Region. Bul. 12. With reprint. 5 cents	5,000
Sorghum as a Forage Crop. Farm. Bul. 50. Reprint	10,000
Studies on American Grasses: I. A Revision of the North American Species of Calamagrostis. II. Descriptions of New or Little-Known Grasses. Bul. 11. 10 cents	1,500
Gram, Chick-Pea, or Idaho Pea. Cir. 7	5,000

	Copies.
Meadows and Pastures: Formation and Cultivation in the Middle Eastern States. Farm. Bul. 66. Reprint	10,000
A Report upon the Forage Plants and Forage Resources of the Gulf States. Bul. 15. 5 cents	5,000
Grasses as Sand and Soil Binders. Reprint from Yearbook, 1894	500
The Renewing of Worn-Out Native Prairie Pastures. Cir. 4. Revised reprint	2,500
Report of the Agrostologist for 1898	500
The Red Desert of Wyoming and its Forage Resources. Bul. 13. 10 cents	3,000
Economic Grasses. Bul. 14. 10 cents	8,000
Alfalfa or Lucern. Farm. Bul. 31. Revised edition	20,000
Report of the Agrostologist for 1897	250
The Cultivated Vetches. Cir. 6, with two reprints	10,000
Cattle Ranges of the Southwest. Farm. Bul. 72	20,000
A Report upon the Grasses and Forage Plants of Central Texas. Bul. 10. 5 cents	5,000
Division of Agrostology. Reprint from Yearbook, 1897	1,000
Leguminous Forage Crops. Reprint from Yearbook, 1897	500
Lawns and Lawn Making. Reprint from Yearbook, 1897	1,500

BUREAU OF ANIMAL INDUSTRY.

Standard Varieties of Chickens. Farm. Bul. 51. Reprints	80,000
The Dairy Herd: Its Formation and Management. Farm. Bul. 55. Reprints	75,000
Facts About Milk. Farm. Bul. 42. Reprint	20,000
Hog Cholera and Swine Plague. Farm. Bul. 24. Reprints	75,000
Care of Milk on the Farm. Farm. Bul. 63. Reprints	65,000
Ducks and Geese: Standard Breeds and Management. Farm. Bul. 64. Reprints	30,000
Butter Making on the Farm. Farm. Bul. 57. Reprints	60,000
Sheep Scab: Its Nature and Treatment. Bul. 21. 15 cents	10,000
Proceedings of the Second Annual Meeting of the Association of Experiment Station Veterinarians at Omaha, September 8, 1898. 5 cents	1,500
Report of the Chief for 1898	300
National and State Dairy Laws. Reprinted from Fourteenth Annual Report of Bureau	1,000
State Standards for Dairy Products, 1898. Cir. 25, with reprint	3,500
Directions for the Pasteurization of Milk. Cir. 1. Revised reprint	2,500
Colored Spots in Cheese. Cir. 24, with reprint	9,000
The Inspection of Meats for Animal Parasites. Bul. 19. Reprints. 10 cents	6,000
List of Officials and Associations Connected with the Dairy Interests in the United States and Canada for 1898. Cir. 22	5,000
Blackleg: Its Nature, Cause, and Prevention. Cir. 23	5,000
The Milk Supply of Boston and Other New England Cities. Bul. 23. 10 cents	10,000
Some Essentials in Beef Production. Farm. Bul. 71	50,000
Bureau of Animal Industry. Reprint from Yearbook, 1897	5,000
Utilization of By-Products of the Dairy. Reprint from Yearbook, 1897	17,500

DIVISION OF BIOLOGICAL SURVEY.

The Jack Rabbits of the United States. Bul. 8. Revised reprint. 10 cents	1,000
Bird Day in the Schools. Cir. 17. Reprint	12,000
Birds that Injure Grain. Reprint from Yearbook, 1897	1,000
Some Common Birds in Their Relations to Agriculture. Farm. Bul. 54. Reprints	60,000
Cuckoos and Shrikes in Their Relation to Agriculture. Bul. 9. 5 cents	4,000
Life Zones and Crop Zones of the United States. Bul 10. 10 cents	5,000
The Geographical Distribution of Cereals in North America. Bul. 11. 10 cents	5,000
Report of the Acting Chief for 1898	500

DIVISION OF BOTANY.

Principal Poisonous Plants of the United States. Bul. 20	20,000
Report of the Botanist for 1898	500
Weeds: and How to Kill Them. Farm. Bul. 28. Reprints	20,000

	Copies.
Observations on Recent Cases of Musnroom Poisoning in the District of Columbia. Cir. 13. Revised edition	5,000
Report of Botanist for 1897	500
American Ginseng: Its Commercial History, Protection, and Cultivation. Bul. 16. With reprint. 5 cents	6,000
Division of Botany. Reprint from Yearbook, 1897	500
Chicory Growing as an Addition to the Resources of the American Farmer. Bul. 19. 5 cents	1,000
Dodders Infesting Clover and Alfalfa. Cir. 14	5,000
Additional Notes on Seed Testing. Reprint from Yearbook, 1897	500
Horse-Radish. Cir. 15	5,000

DIVISION OF CHEMISTRY.

The Sugar Beet: Culture, Seed Development, Manufacture, and Statistics. Farm. Bul. 52. Reprints	75,000
Composition of Maize (Indian Corn). Bul. 50	5,000
Food Adulteration. Reprint from Bul. 51	1,000
Experiments with Sugar Beets in 1897. Bul. 52	1,000
Foods and Food Adulterants. Cereals and Cereal Products: Bul. 13, Part 9. 15 cents	1,000
Mineral Phosphates as Fertilizers. From Yearbook, 1894. Reprint	200
Chemical Composition of the Carcasses of Pigs. Bul. 53. 5 cents	5,000
Report on an Investigation of Analytical Methods for Distinguishing Between the Nitrogen of Proteids and That of the Simpler Amids or Amido-Acids. Bul. 54. 5 cents	2,000
The Fertilizing Value of Street Sweepings. Bul. 55. 5 cents	6,000
Report of the Chief for 1898	500
Changes in and Additions to Methods of Analysis Adopted at the Thirteenth and Fourteenth Annual Meetings of the Association of Official Agricultural Chemists. Cir. 4	1,500
Every Farm an Experiment Station. Reprint from Yearbook, 1897	100
Division of Chemistry. Reprint from Yearbook, 1897	100
Report of Committee [chemists] on Standards for Volumetric Apparatus, Standard Temperatures for Specific Gravity Determinations, etc	200
Proceedings of the Fourteenth Annual Convention of the Association of Agricultural Chemists, held at Washington, D. C., October 26, 27, and 28, 1897. Bul. 51, with reprint. 10 cents	2,000

DIVISION OF ENTOMOLOGY.

The Mexican Cotton-Boll Weevil in 1897. Cir. 27, second series	4,000
The Gipsy Moth in America. Bul. 11, new series. 5 cents	3,500
The Box-Elder Plant-Bug (*Lepticoris trivittatus*). Cir. 28, second series	2,500
The San Jose Scale: Its Occurrences in the United States, with a full account of its life history and the remedies to be used against it. Bul. 3, new series. Reprint. 10 cents	3,000
The Carpet Beetle, or "Buffalo Moth" (*Anthrenus scrophulariæ*). Cir. 5, new series. Reprint	2,000
Some Miscellaneous Results of the Work of the Division of Entomology. Bul. 10, new series. 10 cents	3,500
The San Jose Scale in 1896–97. Bul. 12, new series. 5 cents	5,500
The Principal Insect Enemies of the Grape. Farm. Bul. 70	20,000
Recent Laws Against Injurious Insects in North America, together with the Laws Relative to Foul Brood. Bul. 15, new series. 5 cents	3,000
The Fruit-Tree-Bark Beetle (*Scolytus rugulosus* Ratz.). Cir. 29, second series	5,000
Insects Affecting the Cotton Plant. Farm. Bul. 47. Reprint	25,000
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[Organized January 25, 1898.]

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Creamery Association of Eastern Pennsylvania.—Secretary, Geo. R. Meloney, 1937 Market street, Philadelphia.

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An act of Congress of August 28, 1894, prohibits the importation of cattle and cattle hides, but by the act of March 2, 1895, making appropriations for the Department of Agriculture, it is provided that the prohibition may be suspended by the President whenever the Secretary of Agriculture shall certify to the President what countries or parts of countries are free from contagious or infectious diseases of domestic animals. The President, by proclamation of November 8, 1895, lifted the embargo with reference to Norway, Sweden, Holland, Great Britain, Ireland, the Channel Islands, and the countries of North, Central, and South America so as to admit cattle under sanitary regulations prescribed by the Secretary of Agriculture; also from all countries so as to admit hides under regulations prescribed by the Secretary of the Treasury.

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American Clydesdale Association.—Alex. Galbraith, Janesville, Wis., secretary.

American Hackney Horse Society.—William Seward Webb, 51 East Forty-fourth street, New York, N. Y., secretary.

American Percheron Horse Breeders' Association.—S. D. Thompson, Chicago, Ill., secretary.

American Shetland Pony Club.—Mortimer Levering, Lafayette, Ind., secretary.

American Shire Horse Breeders' Association.—Charles Burgess, Wenona, Ill., secretary.

American Stud Book. Thoroughbred.—James E. Wheeler, 173 Fifth avenue, New York, N. Y., registrar.

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[1] Under the provisions of paragraph 473 of the act of July 24, 1897, any animal imported specially for breeding purposes shall be admitted free, provided that no such animal shall be admitted free unless pure bred, of a recognized breed, and duly registered in the book of record established for that breed.

The Secretary of the Treasury, upon the advice of the Secretary of Agriculture, issued, on August 19, 1898, regulations for the importation of animals under this law, and designated the recognized breeds and the books of record established for these breeds.

American Suffolk Punch Horse Association.—Alex. Galbraith, Janesville, Wis., secretary.

American Trotting Registry Association.—J. H. Steiner, Room 1103, Ellsworth Building, 355 Dearborn street, Chicago, Ill., secretary.

French Coach Horse Society of America.—S. D. Thompson, Chicago, Ill., secretary.

German Coach Horse Association of America.—J. Crouch, Lafayette, Ind., secretary.

National French Draft Horse Association.—C. E. Stubbs, Fairfield, Iowa, secretary.

Select Clydesdale Horse Society of America.—Charles Irwin, Topeka, Kans., secretary.

The Morgan Register.—Joseph Battell, Middlebury, Vt., editor.

The National Saddle Horse Breeders' Association.—I. B. Nall, Louisville, Ky., secretary.

The Oldenburg Coach Horse Association of America.—C. E. Stubbs, Fairfield, Iowa, secretary.

SHEEP BREEDERS' ASSOCIATIONS.

National Cheviot Sheep Society.—Howard H. Keim, Ladoga, Ind., secretary.

American Cotswold Association.—George Harding, Waukesha, Wis., secretary.

American Leicester Breeders' Association.—A. J. Temple, Cameron, Ill., secretary.

American Lincoln Breeders' Association.—L. C. Graham, Cameron, Ill., secretary.

American Merino Sheep Register.—A. H. Craig, Waukesha, Wis., secretary.

American Oxford-Down Sheep Association.—W. A. Shafor, Middletown, Ohio, secretary.

American South-Down Association.—John G. Springer, Springfield, Ill., secretary.

American Shropshire Registry Association.—Mortimer Levering, Lafayette, Ind., secretary.

American Rambouillet Sheep Breeders' Association.—E. V. Burnham, Woodstock, Ohio, secretary.

American Suffolk Association.—George W. Franklin, Atlantic, Iowa, secretary.

Black Top Spanish Merino Sheep Breeders' Association.—R. P. Berry, Clokey, Pa., secretary.

Delaine Merino Sheep Breeders' Association.—J. C. McNary, Houstonville, Pa., recording secretary; J. H. Hamilton, Canonsburg, Pa., corresponding secretary.

Dickinson Merino Sheep Record Company.—H. G. McDowell, Canton, Ohio, secretary.

Dorset Horn Sheep Breeders' Association of America.—M. A. Cooper, Washington, Pa., secretary.

Hampshire-Down Breeders' Association of America.—John I. Gordon, Mercer, Pa., secretary.

Improved Black-Top Merino Sheep Breeders' Association.—L. M. Crothers, Crothers, Pa., secretary.

Improved Delaine Merino Sheep Breeders' Association.—R. B. Barber, Cedarville, Ohio, secretary.

Michigan Merino Sheep Breeders' Association.—E. N. Ball, Hamburg, Mich., secretary.

National Improved Saxony Sheep Breeders' Association.—John G. Clarke, Lagonda, Pa., secretary.

National Lincoln Sheep Breeders' Association.—H. A. Daniells, Elva, Mich., secretary.

New York State American Merino Sheep Breeders' Association.—J. Horatio Earll, Skaneateles, N. Y., secretary.

Ohio Spanish Merino Sheep Breeders' Association.—F. C. Stanley, Edison, Ohio, secretary.

Pennsylvania and Ohio Improved Delaine Merino Sheep Breeders' Association.—S. M. Cleaver, East Bethlehem, Pa., secretary.

Standard American Merino Register Association.—John P. Ray, Hemlock Lake, N. Y., secretary.

The Continental Dorset Club.—J. E. Wing, Mechanicsburg, Ohio, secretary.

United States Merino Sheep Breeders' Registry Association.—J. A. B. Walker, Enon Valley, Pa., secretary.

Vermont Atwood Club Register.—George Hammond, Middlebury, Vt., secretary.

Vermont Merino Sheep Breeders' Association.—L. H. Skiff, Middlebury, Vt., secretary.

SWINE BREEDERS' ASSOCIATIONS.

American Berkshire Association.—Charles F. Mills, 512 East Monroe street, Springfield, Ill., secretary.

American Duroc-Jersey Swine Breeders' Association.—A. V. Bradrick, Connersville, Ind., secretary.

American Essex Association.—F. M. Srout, McLean, Ill., secretary.

American Small Yorkshire Club.—George W. Harris, 3409 Third avenue, New York, N. Y., secretary.

Cheshire Swine Breeders' Association.—E. W. Davis, Oneida, N. Y., secretary.

Chester White Record Association.—W. H. Morris, Indianapolis, Ind., secretary.

American Chester White Record Association.—Carl Freigau, Dayton, Ohio, editor.

American Poland-China Record Company.—W. M. McFadden, West Liberty, Iowa, secretary.

Central Poland-China Swine Association.—W. H. Morris, Indianapolis, Ind., secretary.

Northwestern Poland-China Swine Association.—J. B. Besack, Washington, Kans., secretary.

Ohio Poland-China Record Company.—Carl Freigau, Dayton, Ohio, secretary.

Standard Poland-China Record Company.—Ira K. Alderman, Maryville, Mo., secretary.

Victoria Swine Breeders' Association.—H. Davis, Dyer, Ind., secretary.

Suffolk Swine Association.—W. F. Watson, Winchester, Ind., secretary.

National Duroc-Jersey Record Association.—Robert J. Evans, El Paso, Ill., secretary.

The American Tamworth Swine Record Association.—Edwin O. Wood, Flint, Mich., secretary.

The American Yorkshire Club.—William F. Wilcox, Benson, Minn., secretary.

ASSOCIATION OF BREEDERS OF DOGS.

American Kennel Club.—A. P. Vredenburg, 55 Liberty street, New York, N. Y., secretary.

POULTRY ASSOCIATIONS.

National and interstate organizations.

Name of association.	Secretary.	Post-office.
American Barred Plymouth Rock Club	F. J. Marshall	Middletown, Ohio.
American Dorking Club	F. H. Prentice	North Grafton, Mass.
American Buff Leghorn Club	E. P. Shepherd	Croton Falls, N. Y.
American Buff Plymouth Rock Club	W. C. Denny	Rochester, N. Y.
American Black Minorca Club	John A. Gamewell	Hackensack, N. J.
American Cochin Club	Arthur R. Sharp	Taunton, Mass.
American Cochin Bantam Club	H. S. Ball	Shrewsbury, Mass.
American Dominique Club	R. W. Roberts	Camroden, N. Y.
American Exhibition Game and Game Bantam Club.	S. Ward Doubleday	41 Wall street, New York City.
American Langshan Club	R. T. Nettle	Peoria, Ill.
American Leghorn Club	Ezra Cornell	Ithaca, N. Y.
American Minorca Association	Ed Ellis	Santa Rosa, Cal.
American Poultry Association	Theodore Sternberg	Ellsworth, Kans.
American White Wonder Club	A. P. Roscoe	Newhaven, Vt.
Eastern White Wyandotte Club	W. E. Mock	Woodstock, Vt.
Indian Game Club of America	Adam Thompson	Amity, Mo.
Minorca Club of Northwest	Dr. H. B. Fay	Minneapolis, Minn.
National Bantam Association	E. Latham	Flatbush, Long Island, N. Y.
National Bronze Turkey Club	James Garvin	Princeton, Ill.
New England Light Brahma Club	G. W. Cromack	Stoneham, Mass.
Southern Langshan Club	J. H. Davis	Hogeville, Ga.
The Waterfowl Club of America	J. C. Harvey	Brookville, N. J.
Pacific Poultry and Pigeon Association	Frank Seed	417 Sacramento st., San Francisco, Cal.
National Poultry and Pigeon Association	George E. Howard	Washington, D. C.
National Fanciers' Association	A. E. Brown	Morgan Park, Ill.
Western Poultry Fanciers' Association	Chas. H. Playter	Cedar Rapids, Iowa.

POULTRY ASSOCIATIONS—Continued.

National and interstate organizations—Continued.

Name of association.	Secretary.	Post-office.
Sunflower Poultry Association	J. E. Turner	Kansas City, Kans.
Interstate Poultry Association	Jas. H. Hamilton	Arkansas City, Kans.
Boston Poultry Association	C. Minot Weld	131 Devonshire st., Boston, Mass.
Wolverine P. P. and P. S. Association	Gus Williams	Bay City, Mich.
St. Louis Fanciers' Association	Edw. Gay Martin	St. Louis, Mo.
Mid Continental Poultry Association	F. M. Slutz	Kansas City, Mo.
St. Louis Poultry Association	C. R. Crouse	Jefferson Barracks, Mo.
Interstate Poultry Association	R. Horrocks	Falls City, Nebr.
Buffalo Poultry Association	E. C. Pease	Buffalo, N. Y.
Madison Square Garden (New York) Poultry and Pig Association.	H. V. Crawford	Montclair, N. J.
Northern Ohio Poultry and Pet Stock Association.	F. R. Hunt	Cleveland, Ohio.
Buckeye Poultry Association	Geo. B. Wetzel	Dayton, Ohio.
Tri-State Poultry Association	J. A. McIntosh	East Liverpool, Ohio.
Pittsburg Fanciers' Club	A. P. Robinson	110 Second avenue, Pittsburg, Pa.
Piedmont Poultry Association	B. W. Getsinger	Spartanburg, S. C.
Nashville Poultry Association	J. M. Hopkins	Nashville, Tenn.
Tacoma Poultry Association	Stephen Holbrooke	Tacoma, Wash.
Puget Sound Poultry Club	J. R. Waltshaw	Room 200, Burke Building, Seattle, Wash.
La Crosse Poultry Association	E. H. Hoffman	La Crosse, Wis.

Secretaries of State poultry associations.

State.	Secretary.	Post-office.
Arizona	E. A. Starr	Phenix.
Arkansas	W. H. Westbrook	Little Rock.
California	W. E. Ladd	Stockton.
Colorado	C. A. Watson	Denver (144 Lincoln avenue).
Connecticut	G. P. Merritt	Hartford.
District of Columbia	Geo. E. Howard	Washington.
Georgia	J. W. Killingsworth	Augusta.
Illinois	S. S. Noble	Bloomington.
Indiana	Major Griffin	Indianapolis.
Iowa	J. M. Scurr	Creston.
Kansas	D. A. Wise	Topeka.
Kentucky	J. R. Mount	La Grange.
Michigan	Frank W. McKenzie	Concord.
Minnesota	F. X. Marzolf	St. Paul (124 Lincoln avenue).
Missouri	Henry Steinmesch	Sutter.
Nebraska	I. L. Lyman	Lincoln.
New Jersey	C. W. Johnson	Cranford.
New Mexico	L. W. Roberts	Albuquerque.
New York	J. B. Docharty	Albany.
North Carolina	F. E. Hege	Raleigh.
Oklahoma	J. D. Lafferty	Guthrie.
Oregon	G. F. Hunt	Portland.
Rhode Island	H. S. Babcock	Providence.
Tennessee	M. P. Andes	Bristol.
Texas	R. A. Caruthers	Waco.
Vermont	F. H. Ranney	St. Johnsbury.
Virginia	R. J. N. Reid	Hamilton.

STATE VETERINARIANS AND SECRETARIES OF SANITARY BOARDS.

ALABAMA.

Dr. Jerome Cochran, Montgomery, secretary State board of health.

ARIZONA.

H. Harrison, Phenix, secretary live stock sanitary commission.
Dr. J. C. Norton, Phenix, veterinarian.

CALIFORNIA.

Dr. J. R. Laine, Sacramento, secretary State board of health.
Dr. R. A. Archibald, Oakland, veterinarian to city and county board of health.

COLORADO.

William H. Adams, Alamosa (office Denver), secretary State live stock board of inspection.
Dr. Henry Sewall, 23 Eighteenth avenue, Denver, secretary State board of health.
Dr. Charles Gresswell, Denver, State veterinary surgeon.

CONNECTICUT.

Dr. C. A. Lindsley, New Haven, secretary State board of health.
George L. Fosket, Winsted, secretary of commissioners on diseases of domestic animals.

DELAWARE.

Dr. E. B. Frazer, Wilmington, secretary State board of health.

FLORIDA.

Dr. Joseph Y. Porter, Key West, secretary State board of health.

ILLINOIS.

Dr. J. W. Scott, Springfield, secretary State board of health.
Dr. C. P. Lovejoy, Princeton, State veterinarian.
C. P. Johnson, Springfield, secretary board of live stock commissioners.

INDIANA.

Dr. J. N. Hurty, Indianapolis, secretary State board of health.
Dr. F. A. Bolser, Newcastle, State veterinarian.
Mortimer Levering, Lafayette, secretary State live stock sanitary commission.

IOWA.

Dr. J. I. Gibson, Denison, State veterinary surgeon.
Dr. J. F. Kennedy, Des Moines, secretary State board of health.

KANSAS.

Dr. H. Z. Gill, Topeka, secretary State board of health.
Taylor Riddle, Marion, secretary live stock sanitary commission.

KENTUCKY.

Dr. J. N. McCormack, Bowling Green, secretary State board of health.
Dr. F. T. Eisenman, Louisville, State veterinarian.
A. G. Herr, St. Matthews, cattle commissioner.

LOUISIANA.

Dr. Will R. Harman, New Orleans, secretary State board of health.

MAINE.

Dr. A. G. Young, Augusta, secretary State board of health.
Dr. George H. Bailey, Deering, State veterinarian.
John M. Deering, Saco, and F. O. Beal, Bangor, cattle commissioners.

MARYLAND.

Dr. John S. Fulton, 10 South street, Baltimore, secretary State board of health.
Dr. A. W. Clements, 916 Cathedral street, Baltimore, State veterinarian.
C. W. Melville, Westminster, secretary live-stock sanitary board.

MASSACHUSETTS.

Dr. Samuel W. Abbott, Boston, secretary State board of health.
Dr. Austin Peters, Boston (Commonwealth Building), president cattle commissioners.

MICHIGAN.

Dr. Henry B. Baker, Lansing, secretary State board of health.
Dr. George W. Dunphy, Quincy, State veterinarian.
Henry H. Hinds, Stanton, president State live stock sanitary commission.

MINNESOTA.

Dr. M. H. Reynolds, St. Anthonys Park, director veterinary department of State board of health.
Dr. H. M. Bracken, St. Paul (Pioneer Press Building), secretary State board of health.

MISSISSIPPI.

Dr. John F. Hunter, Jackson, secretary State board of health.
Dr. J. C. Robert, Agricultural College, professor of veterinary science.

MISSOURI.

Dr. Willis P. King, Kansas City (Fountain place), secretary State board of health.
Dr. T. E. White, Sedalia, State veterinarian.
J. R. Rippey, Columbia, secretary State board of agriculture.

MONTANA.

Dr. M. E. Knowles, Helena, State veterinarian.

NEBRASKA.

H. R. Corbet, Lincoln, secretary State board of health.
Robert W. Furnas, Brownville, secretary State board of agriculture.

NEVADA.

Dr. J. A. Lewis, Reno, secretary State board of health.

NEW HAMPSHIRE.

Dr. Irving A. Watson, Concord, secretary State board of health.
N. J. Bachelder, Concord, secretary board of cattle commissioners.

NEW JERSEY.

Dr. Henry Mitchell, Trenton, secretary State board of health.
Franklin Dye, Trenton, secretary tuberculosis commission.

NEW MEXICO.

Dr. J. M. Cunningham, East Las Vegas, secretary State board of health.
J. H. LaRue, East Las Vegas, secretary cattle sanitary board.

NEW YORK.

Dr. Baxter T. Smelzer, Albany, secretary board of health.
F. W. Smith, 709 South West street, Syracuse, secretary tuberculosis committee.

NORTH CAROLINA.

Dr. Richard H. Lewis, Raleigh, secretary board of health.

NORTH DAKOTA.

Dr. W. C. Langdon, Fargo, chief State veterinarian.
Dr. John Montgomery, Ardoch, secretary board of health.

OHIO.

Dr. C. O. Probst, Columbus, secretary board of health.
Dr. H. J. Detmers, Columbus, veterinary surgeon, State University.
Dr. D. N. Kinsman, Columbus, secretary live-stock commission.

OKLAHOMA.

Dr. C. D. Arnold, Kingfisher, superintendent board of health.
R. J. Edward, Oklahoma City, secretary live-stock sanitary commission.

OREGON.

Dr. William McLean, Portland, State veterinarian.

PENNSYLVANIA.

Dr. Benjamin Lee, 1532 Pine street, Philadelphia, secretary State board of health.
Dr. Leonard Pearson, 3608 Pine street, Philadelphia, State veterinarian.

RHODE ISLAND.

Dr. Arthur L. Parker, Providence, veterinarian to State board of health.
Dr. Gardner T. Swarts, Providence, secretary State board of health.

SOUTH CAROLINA.

Dr. James Evans, Florence, secretary board of health.
Dr. W. E. A. Wyman, Clemson College, State veterinarian.

SOUTH DAKOTA.

J. L. Harris, Webster, secretary board of health.
Dr. J. W. Ellicott, Aberdeen, State veterinarian.

TENNESSEE.

Dr. J. A. Albright, Somerville, secretary State board of health.
Dr. J. W. Scheiber, Memphis, State veterinarian.

TEXAS.

Dr. R. M. Swearingen, Austin, State health officer.
Robert J. Kleberg, Corpus Christi, secretary live-stock sanitary commission.

VERMONT.

Dr. J. H. Hamilton, Richford, secretary board of health.
C. J. Bell, East Hardwick, secretary cattle commission.

VIRGINIA.

Dr. Paulus A. Irving, Richmond, secretary board of health.
Dr. E. P. Niles, Blacksburg, State veterinarian.

WASHINGTON.

Dr. Elmer E. Heg, North Yakima, secretary board of health.
Dr. S. B. Nelson, Pullman, veterinarian agricultural experiment station.

WEST VIRGINIA.

Dr. A. R. Barbee, Point Pleasant, secretary State board of health.
D. M. Sullivan, Charleston, secretary board of agriculture.

WISCONSIN.

Dr. H. P. Clute, Milton, State veterinarian.
Dr. U. O. B. Wingate, Milwaukee, secretary board of health.

WYOMING.

Dr. A. A. Holcombe, Cheyenne, State veterinarian.
George East, of board of live-stock commissioners.

NATIONAL LEAGUE FOR GOOD ROADS.

States and Territories.	Committeemen.	Post-office.
Alabama	Maj. W. W. Screws	Montgomery.
Alaska	Governor John G. Brady	Sitka.
Arizona	Governor L. C. Hughes	Tucson.
Arkansas	G. W. Sappington	Little Rock.
California	J. A. Woodson	Sacramento.
Colorado	Louis G. Carpenter	Fort Collins.
Connecticut	Col. Chas. L. Burdett	Hartford.
Delaware	William Cooch	Newark.
District of Columbia	Gen. Roy Stone, acting president of league	Washington.
Florida	J. W. White	Jacksonville.
Georgia	Col. G. W. Harrison	Atlanta.
Idaho	James Mullany	Glenns Ferry.
Illinois	S. T. K. Prime, general western secretary of league.	Dwight.
Do	W. C. Garrard	Springfield.
Indiana	Mason J. Niblack	Vincennes.
Iowa	E. H. Thayer, chairman conference committee.	Clinton.
Kansas	F. D. Coburn	Topeka.
Kentucky	Maj. M. H. Crump	Bowling Green.
Louisiana	Guy Samuels	Baton Rouge.
Maine	F. J. Ilsley	Portland.
Maryland	D. C. Wharton Smith	Darlington.
Massachusetts	George A. Perkins	Boston.
Michigan	W. L. Webber	Saginaw, East Side.
Minnesota	A. B. Choate	Minneapolis.
Mississippi	Capt. James H. Duke	Scooba.
Missouri	John R. Rippey	Columbia.
Montana	F. H. Ray	Helena.
Nebraska	Hon. E. Rosewater	Omaha.
Nevada	Gen. John E. Jones	Carson City.
New Hampshire	Ex-Governor David H. Goodell	Antrim.
New Jersey	E. G. Harrison, general eastern secretary of league.	Asbury Park.
New Mexico	E. S. Stover	Albuquerque.
New York	J. A. C. Wright	Rochester.
North Carolina	John C. Tipton	Shelby.
North Dakota	W. W. Barrett	Churches Ferry.
Ohio	Hon. Martin Dodge	Cleveland.
Oklahoma	A. N. Spencer	Yukon.
Oregon	Jefferson Myers	Salem.
Pennsylvania	Wm. H. Rhawn, treasurer of league	Philadelphia.
Rhode Island	C. H. Handy	Warren.
South Carolina	W. D. Evans	Bennettsville.
South Dakota	O. S. Basford	Redfield.
Tennessee	Maj. C. A. Locke	Nashville.
Texas	J. S. Dougherty	Dallas.
Vermont	J. W. Votey	Burlington.
Virginia	Thomas Whitehead	Richmond.
Washington	J. Hannum Jones	Nooksack.
Wisconsin	Otto Dorner, general press agent of league	Milwaukee.
Wyoming	C. P. Hill	Cheyenne.

STATES HAVING OFFICES FOR FOREST WORK.

Kansas.—Forest commissioner, E. D. Wheeler, Ogallah.

Maine.—Forest commissioner, Charles E. Oak, Augusta.

Minnesota.—Fire warden, Gen. C. C. Andrews, St. Paul.

New Hampshire.—Forest commission, George H. Moses, secretary, Concord.

New Jersey.—Geological survey, Prof. John C. Smock, director, Trenton.

New York.—Fisheries, game, and forest commission, Col. William F. Fox, superintendent, Albany.

North Carolina.—Geological survey, Prof. J. A. Holmes, director, Chapelhill.

Pennsylvania.—Division of forestry, department of agriculture, Dr. J. T. Rothrock, chief, Harrisburg.

Wisconsin.—Forest commission, Ernest Bruncken, secretary, Milwaukee.

West Virginia.—Geological and economic survey, superintendent, Dr. I. C. White, Morgantown.

FORESTRY ASSOCIATIONS.

American Forestry Association.—President, James Wilson, Secretary of Agriculture; secretary, F. H. Newell, United States Geological Survey.

Colorado Forestry Association.—President, W. N. Byers, Denver; secretary, D. W. Wohring, Denver.

Connecticut Forestry Association.—President, Maj. Edward V. Preston, Travelers' Insurance Company, Hartford; secretary (corresponding), Miss Mary Winslow, Weatogue.

Indiana Forestry Association.—President, John P. Brown, Connersville.

Massachusetts Forestry Association.—President, Henry P. Walcott, Cambridge; secretary, Allen Chamberlain, Winchester.

Minnesota State Forestry Association.—President, W. W. Prendergast, Hutchinson; secretary, George W. Strand, Taylors Falls.

New Jersey, Forestry Association of.—President, S. Bayard Dod, Hoboken, secretary-treasurer, J. F. Hall, Atlantic City.

New York Forestry Association.—President, Morris K. Jesup, New York City; secretary, ——— ———.

North Carolina Forestry Association.—President, W. E. Petty, Seaboard Air Line; secretary, W. W. Ashe, Chapel Hill.

Pennsylvania Forestry Association.—President, John Birkinbine, 1012 Walnut street, Philadelphia; secretary, Dr. Joseph T. Rothrock, commissioner of forestry, Harrisburg; corresponding secretary, Mrs. John P. Lundy, 245 South Eighteenth street, Philadelphia.

Utah Forestry Association.—President, Dr. J. R. Park; secretary, Prof. C. A. Whiting, Salt Lake City.

Washington Forestry Association.—President, Edmond S. Meany; secretary, Albert Bryan.

California Society for Conserving the Waters and Forests.—President, Hon. J. M. Gleaves; secretary, E. H. Benjamin.

Chester County, S. C., The Forestry Association of.—President, Judge J. J. McClure; secretary and treasurer, Prof. H. A. Green.

Kansas State Horticultural Society.—President, Hon. Fred. Wellhouse, Topeka; secretary, William H. Barnes, statehouse, ground floor, north wing, Topeka.

Mazamas, The.—President, W. G. Steel, Portland, Oreg.; secretary, Frank E. Donaldson, 264 Stark street, Portland.

Minnesota State Horticultural Society.—President, W. W. Prendergast, Lake City; secretary, A. W. Latham, 207 Kasota Block, Minneapolis.

Sierra Club.—President, John Muir, Martinez, Cal.; secretary (corresponding), Prof. W. R. Dudley, ———

OFFICERS OF HORTICULTURAL AND KINDRED SOCIETIES.

AMERICAN ASSOCIATION OF NURSERYMEN, 1899.

President, A. L. Brooke, North Topeka, Kans.; vice-president, E. Albertson, Bridgeport, Ind.; secretary, George C. Seager, Rochester, N. Y.; treasurer, C. L. Yates, Rochester, N. Y.

AMERICAN CARNATION SOCIETY, 1898.

President, William Nicholson, Framingham, Mass.; vice-president, William P. Craig, Philadelphia, Pa.; secretary, Albert M. Herr, Lancaster, Pa.; treasurer, Fred Dorner, jr., Lafayette, Ind.

AMERICAN CRANBERRY GROWERS' ASSOCIATION, 1899.

President, E. H. Durell, Woodbury, N. J.; vice-president, C. L. Holman, Lakewood, N. J.; secretary and treasurer, A. J. Rider, Trenton, N. J.

AMERICAN POMOLOGICAL SOCIETY, 1898–99.

President, C. L. Watrous, Des Moines, Iowa; secretary, William A. Taylor, 55 Q street NE., Washington, D. C.; treasurer, L. R. Taft, Agricultural College, Michigan.

CHRYSANTHEMUM SOCIETY OF AMERICA, 1899.

President, Elijah A. Wood, West Newton, Mass.; vice-president, E. G. Hill, Richmond, Ind.; secretary, Elmer D. Smith, Adrian, Mich.; treasurer, John N. May, Summit, N. J.

CIDER AND CIDER-VINEGAR ASSOCIATION OF THE NORTHWEST, 1899.

President, F. C. Johnson, Kishwaukee, Ill.; vice-president, Charles C. Bell, Boonville, Mo.; secretary and treasurer, George Miltenberger, No. 213, North Second street, St. Louis, Mo.

EASTERN NURSERYMEN'S ASSOCIATION, 1898 AND 1899.

President, W. C. Barry, Rochester, N. Y.; vice-president, R. G. Chase, Geneva, N. Y.; secretary and treasurer, William Pitkin, Rochester, N. Y.

MISSOURI VALLEY HORTICULTURAL SOCIETY, 1899.

President, Homer Reed, Tenth and Broadway, Kansas City, Mo.; vice-president, Clarence V. Holsinger, Rosedale, Kans.; secretary, Clarence A. Chandler, Argentine, Kans.; treasurer, G. F. Espenlaub, Rosedale, Kans.

NORTHWEST FRUIT GROWERS' ASSOCIATION, 1899.

President, Dr. N. G. Blalock, Wallawalla, Wash.; vice-presidents, C. A. Porter, Lewiston, Idaho; E. L. Smith, Hood River, Oreg.; Frank L. Wheeler, Yakima, Wash.; secretary, C. A. Tonneson, 110 Twelfth street, Tacoma, Wash.; treasurer, W. S. Offner, Wallawalla, Wash.

PENINSULA HORTICULTURAL SOCIETY, 1899.

President, R. S. Emory, Chestertown, Md.; vice-president, Joseph E. Carter, Smyrna, Del.; secretary-treasurer, Wesley Webb, Dover, Del.

SOCIETY OF AMERICAN FLORISTS AND ORNAMENTAL HORTICULTURISTS, 1898.

President, W. N. Rudd, Chicago, Ill.; vice-president, Philip Breitmyer, Detroit, Mich.; secretary, William J. Stewart, Boston, Mass.; treasurer, H. N. Beatty, Oil City, Pa.

STATE SOCIETIES.

Arkansas State Horticultural Society, 1899.—President Frank Hill, Little Rock; vice-president, A. W. Poole, Ozark; secretary, J. T. Stinson, Fayetteville; treasurer, S. A. Williams, Fort Smith.

California State Floral Society, 1899.—President, E. J. Wickson, Berkeley; secretary, Emory E. Smith, Palo Alto.

Pomological Society of Southern California, 1898.—President, Abbot Kinney, Los Angeles; vice-president, D. Edson Smith, Santa Ana; secretary and treasurer, G. H. A. Goodwin, Los Angeles.

Connecticut Pomological Society, 1898.—President, J. H. Hale, South Glastonbury; vice-president, J. H. Merriman, New Britain; secretary, H. C. C. Miles, Milford; treasurer, R. A. Moore, Kensington.

Florida State Horticultural Society, 1898-99.—President, G. L. Taber, Glen St. Mary; secretary, Stephen Powers, Jacksonville; treasurer, W. S. Hart, Hawks Park.

Georgia State Horticultural Society, 1898-99.—President, P. J. Berckmans, Augusta; vice-president, First district, G. M. Ryals, Savannah; secretary, G. H. Miller, Rome; treasurer, Louis E. Berckmans, Augusta.

Idaho State Horticultural Society, 1898-99.—President, A. McPherson, Boise; vice-president, Robert Schleicher, Lewiston; secretary, Robert Milliken, Nampa; treasurer, R. M. Gwinn, Caldwell.

Illinois State Horticultural Society, 1898-99.—President, Henry M. Dunlap, Savoy; vice-president, H. A. Aldrich, Neoga; secretary, L. R. Bryant, Princeton; treasurer, I. W. Stanton, Richview.

Horticultural Society of Northern Illinois, 1899.—President, J. L. Hartwell, Dixon; vice-president, O. W. Barnard, Manteno; secretary, A. W. Bryant, Princeton; treasurer, L. Woodard, Marengo.

Horticultural Society of Southern Illinois, 1899.—President, J. W. Stanton, Richview; vice-president, N. L. Peal, Mount Vernon; secretary and treasurer, E. G. Mendenhall, Kinmundy.

Indiana State Horticultural Society, 1898-99.—President, C. M. Hobbs, Bridgeport; secretary, James Troop, Lafayette; treasurer, Sylvester Johnson, Irvington.

Iowa State Horticultural Society, 1898-99.—President, Charles F. Gardner, Osage; vice-president, M. J. Wragg, Waukee; secretary, George H. Van Houten, Des Moines; treasurer, W. M. Bomberger, Harlan.

Northeastern Iowa Horticultural Society, 1899.—President, Charles F. Gardner, Osage; vice-president, Elmer Reeves, Waverly; secretary, Charles H. True, Edgewood; treasurer, G. A. Ivins, Iowa Falls.

Northwestern Iowa Horticultural Society, 1899.—President, M. E. Hinkley, Marcus; vice-president, C. W. Conner, Sac City; treasurer, Ben Shoultz, Correctionville; secretary, W. B. Chapman, Washta.

Southeastern Iowa Horticultural Society, 1899.—President, W. S. Fultz, Muscatine; vice-president, W. T. Richey, Albia; secretary, C. W. Burton, Cedar Rapids; treasurer, Wesley Greene, Davenport.

Southwestern Iowa Horticultural Society, 1898-99.—President, D. W. Lotspeich, Woodbine; vice-president, J. P. Jackson, Glenwood; secretary, W. M. Bomberger, Harlan; treasurer, I. M. Needles, Atlantic.

Kansas State Horticultural Society, 1898.—President, Fred Wellhouse, Topeka; vice-president, J. W. Robison, Eldorado; secretary, William H. Barnes, Topeka; treasurer, Frank Holsinger, Rosedale.

Kentucky State Horticultural Society.—President, M. F. Johnson, Fern Creek; secretary, J. A. Hawes, Fern Creek.

Maine State Pomological Society, 1899.—President, W. M. Munson, Orono; secretary, Elijah Cook, Vassalboro; treasurer, Charles S. Pope, Manchester.

Maryland State Horticultural Society, 1899.—President, James S. Harris, Coleman; vice-president, S. B. Loose, Hagerstown; secretary and treasurer, W. G. Johnson, College Park.

Horticultural Association of Western Maryland, 1898.—President, William D. Hughes, Smithsburg; vice-president, J. Pearson Loose, Hagerstown; secretary, Arthur Towson, Smithsburg; treasurer, Samuel Welty, Edgemont.

Massachusetts Fruit Growers' Association, 1898.—President, George Cruickshanks, Fitchburg; vice-president, John W. Clark, North Hadley; secretary, S. T. Maynard, Amherst; treasurer, Ethan Brooke, West Springfield.

Massachusetts Horticultural Society, 1898-99.—President, Francis H. Appleton, Boston; vice-president, Charles H. B. Breck, Boston; secretary, Robert Manning, 101 Tremont street, Boston; treasurer, Charles E. Richardson, 101 Tremont street, Boston.

Cape Cod Cranberry Growers' Association, 1899.—President, Emulus Small, Harwick Port; vice-president, Luther Hall, Dennis; secretary and treasurer, Franklin Crocker, Hyannis.

Michigan State Horticultural Society, 1899.—President, C. J. Monroe, South Haven; vice-president, R. D. Graham, Grand Rapids; secretary, Edwy C. Reid, Allegan; treasurer, Asa W. Slayton, Grand Rapids.

West Michigan Horticultural Society, 1898.—President, Walter Phillips, Grand Haven; vice-president, N. P. Hustel, Lowell; secretary, C. A. French, Grand Rapids; treasurer, A. Hamilton, Bangor.

Minnesota State Horticultural Society, 1899.—President, W. W. Prendergast, Hutchison; vice-president, F. W. Kimball, Austin; secretary, A. W. Latham, 207 Kasota Block, Minneapolis; treasurer, C. W. Sampson, Eureka.

Southern Minnesota Horticultural Society, 1898-99.—President, J. C. Hawkins, Austin; vice-president, Jonathan Freeman, Austin; secretary and treasurer, Roberts Parkhill, Chatfield.

Missouri State Horticultural Society, 1898-99.—President, N. F. Murray, Oregon; vice-president, D. A. Robnett, Columbia; secretary, L. A. Goodman, Westport; treasurer, A. Nelson, Lebanon.

Central Missouri Horticultural Association.—President, R. L. Moore, Boonville; vice-president, D. Edwards, Boonville; secretary, C. C. Bell, Boonville; treasurer, W. A. Smiley, Boonville.

South Missouri Horticultural Association, 1899.—President, D. J. Nichols, West Plains; secretary and treasurer, J. T. Snodgrass, West Plains.

Montana State Horticultural Society, 1898.—President, S. M. Emery, Bozeman; secretary, C. H. Edwards, Missoula; treasurer, A. Hollensteiner, Lolo.

Nebraska State Horticultural Society, 1898-99.—President, George H. Marshall, Arlington; vice-president, J. H. Hadkinson, Omaha; secretary, C. H. Barnard, Table Rock; treasurer, Peter Youngers, jr., Geneva.

New Hampshire Horticultural Society, 1899.—President, C. C. Shaw, Milford; vice-president, J. W. Farr, Littleton; secretary, W. D. Baker, Quincy; treasurer, T. E. Hunt, Lakeport.

New Jersey State Horticultural Society, 1898-99.—President, S. B. Ketcham, Pennington; vice-president, David Baird, Baird; secretary, Henry I. Budd, Mount Holly; treasurer, Charles L. Jones, Newark.

New Mexico Horticultural Society, 1898-99.—President, L. Bradford Prince, Santa Fe; vice-president, W. S. Harroun, Santa Fe; secretary, Jose D. Sena, Santa Fe; treasurer, Soloman Spiegelberg, Santa Fe.

Eastern New York Horticultural Society, 1898.—President, James Wood, Mount Kisco; vice-president, W. F. Taber, Poughkeepsie; secretary and treasurer, E. Van Alstyne, Kinderhook.

Western New York Horticultural Society, 1898-99.—President, W. C. Barry, Rochester; vice-president, S. D. Willard, Geneva; secretary and treasurer, John Hall, Rochester.

North Carolina State Horticultural Society, 1898-99.—President, J. Van Lindley, Pomona; secretary and treasurer, Thomas L. Brown, Greensboro.

Ohio State Horticultural Society, 1898-99.—President, E. H. Cushman, Euclid; vice-president, W. N. Scarff, New Carlisle; secretary, W. W. Farnsworth, Waterville; treasurer, N. Ohmer, Dayton.

Oklahoma Agricultural, Horticultural, and Irrigation Association.—President, C. A. McNabb, Oklahoma City; vice-president, H. C. St. Clair, Kingfisher; secretary-treasurer, W. T. Little, Norman.

Oregon State Horticultural Society, 1899.—President, H. B. Miller, Eugene; vice-president, L. T. Reynolds, Salem; secretary and treasurer, E. R. Lake, Corvallis.

Pennsylvania State Horticultural Association, 1898-99.—President, S. B. Heiges, York; secretary, Cyrus T. Fox, Reading.

Pennsylvania Horticultural Society, 1899.—President, James M. Rhodes, Philadelphia; vice-president, Robert Craig, Philadelphia; secretary, David Rust, Horticultural Hall, Philadelphia; treasurer, William F. Dreer, Philadelphia.

Rhode Island Horticultural Society, 1898.—President, Levi W. Russell, Providence; vice-president, R. H. I. Goddard, Providence; secretary and treasurer, Charles W. Smith, 61 Westminster street, Providence.

South Dakota State Horticultural Society, 1899.—President, H. C. Warner, Forestburg; vice-president, C. W. Gurney, Yankton; secretary, N. E. Hansen, Brookings; treasurer, G. H. Whiting, Yankton.

East Tennessee Horticultural Society, 1899.—President, J. R. Stradley, Hiwassee College; vice-president, H. Lightfoot, Jersey; secretary and treasurer, Paul F. Kefauver, Madisonville.

West Tennessee Horticultural Society, 1898.—President, J. W. Rosamon, Gadsden; secretary and treasurer, L. C. James, Gibson.

Texas State Horticultural Society, 1898-99.—President, C. Falkner, Waco; vice-president, F. W. Malley, Hulen; secretary, E. L. Huffman, Fort Worth; treasurer, D. O. Lively, Fort Worth.

Vermont Horticultural Society, 1898.—President, T. L. Kinney, South Hero; secretary and treasurer, F. A. Waugh, Burlington.

Virginia State Horticultural Society, 1898-99.—President, Samuel B. Woods, Charlottesville; vice-president, W. H. Boaz, Covesville; secretary-treasurer, George E. Murrell, Colemans Falls.

West Virginia State Horticultural Society, 1898-99.—President, R. C. Burkhart, Martinsburg; vice-president, J. H. Crawford, Organ Cave; secretary, L. C. Corbett, Morgantown.

Wisconsin State Horticultural Society, 1898.—President, L. G. Kellogg, Ripon; vice-president, Franklin Johnson, Baraboo; secretary, A. J. Philips, West Salem; treasurer, R. J. Coe, Fort Atkinson.

Wisconsin State Cranberry Growers' Association, 1899.—President, Charles Briers, Grand Rapids; vice-president, S. M. Whittlesey, Cranmoor; treasurer, Melvin Potter, Centralia.

PATRONS OF HUSBANDRY.

NATIONAL OFFICERS.

Master, Aaron Jones, South Bend, Ind.; overseer, O. H. Hale, North Stockholm, N. Y.; lecturer, Alpha Messer, Rochester, Vt.; treasurer, Mrs. E. S. McDowell, Columbus, Ohio; secretary, John Trimble, No. 514 F street NW., Washington, D. C.; executive committee, N. J. Batchelder, Concord, N. H.; J. J. Woodman, Paw Paw, Mich.; S. H. Messick, Bridgeville, Del.; ex officio, Aaron Jones, South Bend, Ind.

OFFICERS OF STATE GRANGES.

List of masters and other officers for 1899, so far as elected on March 1.

State.	Master.	Post-office.	Lecturer.	Post-office.	Treasurer.	Post-office.	Secretary.	Post-office.	Date of meeting.
Alabama	H. Hawkins	Hawkinsville	Rev. A. Daugherty.	Dothen	W. J. Roundtree.	Valegrande	F. Shackelford, jr.	Colquit	Wednesday after second Monday in July.
California	W. W. Greer	Sacramento	John L. Beecher.	Stockton	A. D. Logan	300 California street, San Francisco.	Miss Mattie Maholm.	Sheldon	First Tuesday in October.
Colorado	J. A. Newcomb	Golden	Wm. B. Roberts.	2506 Fifteenth street, Denver.	Elwood Easley.	Golden	Will T. Wilson.	1638 Fifteenth street, Denver.	Second Tuesday in January.
Connecticut	S. O. Bowen	Eastford	Mrs. Estella H. Barnes.	Southington	Norman S. Platt.	New Haven	H. E. Loomis.	Glastonbury	Do.
Dakota *a*									
Delaware	Arnold Naudain.	Stanton	A. T. Neale	Newark	Thos. H. Riggin.	Laurel	W. W. Seeders	Farmington	Second Tuesday in December.
Georgia	T. H. Kimbrough	Cataula	J. D. Gennels.	Banksville	S. H. Roberts.	Dawson	E. Taylor	Popes Ferry.	Do.
Illinois	Oliver Wilson	Magnolia	Geo. F. Bell	Lostant	D. Q. Trotter.	Piasa	Thos. Keady.	Dunlap	Do.
Indiana	Aaron Jones	South Bend	W. W. Stevens.	Salem	J. W. Holmes.	Cortland	Taylor B. Frazier.	Frankfort	Do.
Iowa	A. B. Judson	Silver City	Geo. Van Houden.	Lenox	W. H. Hollister	Manchester	John Turner	Lenox	Second Tuesday in October.
Kansas, including Oklahoma.	Henry Rhoades	Gardner	Mrs. Bina A. Otis.	Topeka	Wm. Henry	Olathe	Geo. Black	Olathe	Second Tuesday in December.
Kentucky	J. D. Clardy	Newstead	W. G. Myers.	Wingo	J. M. Clark	Hopkinsville.	J. A. Browning.	Church Hill	Do.
Maine	Obadiah Gardner	Rockland	Elijah Cook	Vassalboro	M. B. Hunt	Center Belmont.	E. H. Libby	Dirigo	Third Tuesday in December.
Maryland	Joseph B. Ager	Hyattsville	J. Enos Ray, sr.	Chillum	Geo. H. Merrymor.	Bosley	Wm. B. Sands	Lake Roland.	Second Tuesday in December.
Massachusetts	W. C. Jewett	Worcester	Geo. W. Ladd.	Sturbridge	F. A. Harrington.	Worcester	Wm. N. Howard.	South Easton	Do.
Michigan	Geo. B. Horton	Fruitridge	Jason Woodman.	Paw Paw	E. A. Strong.	Vicksburg	Miss Jennie Buell.	Ann Arbor	Do.
Minnesota	Mrs. S. G. Baird	Edina Mills	J. S. MacDonald.	Rush City	Mrs. Corolin Schofield.	Bloomington	Mrs. A. J. Adams.	Box 447, Minneapolis.	Second Tuesday after Dec. 4.
Mississippi	S. L. Wilson	Okolona	H. F. Simrall	Glass	Mrs. Joe Bailey.	Conehatta	T. J. Aby	Fayette	Second Tuesday in December.
Missouri	C. O. Raine	Benjamin	E. H. Long	Deerridge	W. E. Harbaugh.	Liberty	R. L. Harbaugh.	Liberty	Second Tuesday in October.
Nebraska	J. M. Williams	Culbertson	A. M. Bovee	Vacoma	B. S. Gitchel	Butler	J. R. Cantlin.	Webster	Second Tuesday in December.
New Hampshire	N. J. Bachelder	Concord	Henry H. Metcalf.	Concord	J. D. Roberts	Salmon Falls.	E. C. Hutchinson.	Milford	Third Tuesday in December.

a Annexed to Minnesota; also Idaho is included by Oregon and Oklahoma by Kansas.

OFFICERS OF STATE GRANGES—continued.

List of masters and other officers for 1899, so far as elected on March 1—Continued.

State.	Master.	Post-office.	Lecturer.	Post-office.	Treasurer.	Post-office.	Secretary.	Post-office.	Date of meeting.
New Jersey	Edmund Braddock.	Medford	George L. Gillingham.	Moorestown	C. Collins	Moorestown	M. D. Dickinson.	Woodstown	First Tuesday in December.
New York	Elliot B. Norris	Sodus	F. P. Cole	Ovid	P. A. Welling.	Hannibal	H. H. Goff	Spencerport	First Tuesday in February.
North Carolina	W. R. Williams	Falkland	M. B. Pitt	Old Sparta	W. H. Powell	Battleboro	H. T. J. Ludwig.	Mount Pleasant.	Second Tuesday in December.
Ohio	S. H. Ellis	Waynesville	C. E. Strode	Westland	W. W. Miller	Columbus	Frank A. Akins.	Sandusky	Do.
Oregon, including Idaho.	W. M. Hilleary	Turner	S. H. Hatch	Turner	J. C. White	Crowley	Mrs. Mary S. Howard.	Mulino	Fourth Tuesday in May.
Pennsylvania	W. F. Hill	Westford	Wm. Packard	Windfall	S. E. Niven	Laudenburg	J. T. Ailman	Thompsontown.	Second Tuesday in December.
Rhode Island	Joseph A. Tillinghast.	Kingston	P. H. Wilbur	Little Compton.	B. Martin	E. Providence.	N. T. Reynolds.	E. Greenwich.	Do.
South Carolina	W. K. Thompson	Liberty Hill	C. J. Rollins	Bishopville	J. J. Shaw	Wisacky	W. A. James, jr.	Bishopville	First Tuesday in February.
Tennessee	W. L. Richardson.	Brownsville	J. M. McCorkle.	White Haven	D. A. Stewart	Brownsville	E. L. Allen	Brownsville	Third Tuesday in August.
Texas, including Indian Territory.	J. L. Ray	Mineola	C. F. Kiker	Dublin	J. L. Howell	Dublin	J. J. Ray	Dublin	Second Tuesday in August.
Vermont	C. J. Bell	E. Hardwick	R. B. Galusha	Jericho	F. B. Pier	Rawsonville	A. A. Priest	Randolph	Second Wednesday in December.
Virginia	A. J. Wedderburn.	Washington, D. C.	Thos. F. Rives.	Gunnshill	E. C. Powell	San Marino	T. S. Staddon	Wadesville	Second Tuesday in January.
Washington	Augustus High	Vancouver	Wm. Olson	Troutlake	Wm. Smiley	Vancouver	Mrs. M. Wright.	Washougal	First Tuesday in June.
West Virginia	Prof. T. C. Atkeson.	Morgantown	E. D. Smoot	Meadowbluff.	J. M. Rine	Wells	M. V. Brown	Buffalo	Second Wednesday in January.
Wisconsin	H. E. Huxley	Neenah	S. C. Carr	Milton Junction.	Thos. Dickson.	Waneka	A. C. Powers.	Beloit	Second Tuesday in December.

NATIONAL FARMERS' ALLIANCE.

President, Edward Furnas, Nevada, Iowa; vice-presidents, E. J. Bye, West Branch, Iowa; F. E. Fitch, Bellevue, Ohio; William Toole, Baraboo, Wis.; T. J. Meighen, Forestville, Minn.; A. S. Brewer, Tampico, Ill.; W. A. Kelsey, Dunfee, Ind.; J. W. Arrasmith, Colfax, Wash.; T. Bedard, Frenchtown, Mont.; J. Barrows, Lincoln, Nebr.; secretary and treasurer, August Post, Moulton, Iowa; lecturer, George E. Lawrence, Marion, Ohio.

FARMERS' NATIONAL CONGRESS.

President, Hon. W. D. Hoard, Fort Atkinson, Wis.; secretary, John Stahl, No. 4328 Langley avenue, Chicago, Ill.

REVIEW OF WEATHER AND CROP CONDITIONS, SEASON OF 1898.

January averaged mild in all districts east of the Rocky Mountains with the exception of northern New England, where it was somewhat colder than usual. In the Ohio, Mississippi, and Missouri valleys the month was exceptionally mild, the average temperature excess amounting to 15° in the Dakotas and western Minnesota. It was colder than usual over the central and southern Rocky Mountain districts and in California. This month was characterized by exceptionally light precipitation in the Pacific coast districts and in the South Atlantic and East Gulf States, while over the Lower Mississippi and Ohio valleys and New England the precipitation was much greater than usual.

February was mild throughout the country except southward of the Ohio River and eastward of the Mississippi River, where it was much colder than usual, the month being decidedly mild over the eastern Rocky Mountain slope and in the Missouri and Red River of the North valleys. There was somewhat more precipitation than occurred in January in the Pacific coast districts, but in Oregon and California there was a marked deficiency as compared with the February average, which intensified the drought conditions prevailing over the greater part of California. February was also exceptionally dry in the central Mississippi and Ohio valleys, and generally throughout the Middle and South Atlantic and East Gulf States, with more than the usual amount of rain over the greater part of the Lake region, on the central Gulf coast, and in portions of the North Pacific coast region.

East of the Rocky Mountains March averaged mild, with temperatures ranging from 3° to 12° per day above normal, the greatest excess occurring in the lower Lake region, while to the westward of the Rocky Mountains the month was unusually cold, the average daily deficiency in temperature ranging from 3° to 9°. Throughout the Pacific coast region this month was exceptionally dry, and at its close the seasonal deficiency in portions of California was unprecedented. There was also a marked deficiency in the monthly precipitation in the East Gulf States and generally throughout the Atlantic coast districts, but in the lower Lake region, Ohio, central Mississippi, and Lower Missouri valleys the precipitation was unusually heavy.

Upon the whole, the weather conditions during March were favorable to agricultural interests. At the close of the month farm work was exceptionally well advanced for the season in the Atlantic coast and Gulf States, though retarded by excessive rains in the Ohio and central Mississippi valleys and Lake region. Winter wheat made rapid growth and generally was reported in excellent condition. Spring-wheat seeding was well advanced in Nebraska and Iowa and some had been sown in the southern portions of Wisconsin, Minnesota, and South Dakota. In California the outlook for wheat was very unpromising, except in irrigated districts. No corn had been planted northward of Tennessee, but a large part of the crop had been planted in the Gulf States, where early planted was up, with good stands. In Texas corn sustained some injury as a result of low temperatures during the latter part of March. Some cotton had been planted over the southern portion of the cotton belt, and preparations for planting were well advanced over the central and northern portions.

SUMMARY OF THE SEASON, BY WEEKS.

By weeks ending with Monday, from April 11 to September 26, the crop conditions may be summarized as follows:

April 11.—The weather conditions of this week were very unfavorable for farming operations, germination of seed, and growth of vegetation. Freezing temperatures occurred as far south as the northern portions of the Gulf States and the North Carolina coast, with damaging frosts generally throughout the Gulf States and light frosts as far south as central Florida. The conditions were especially unfavorable for early planted corn in the Southern States, and in North

Carolina, Georgia, and Arkansas some was killed by frost. In Alabama and Mississippi nearly the whole corn crop was planted, but growth of the early planted was checked by low temperatures. In Nebraska, Kansas, Iowa, Illinois, Indiana, and Ohio, plowing for corn progressed favorably, but in Missouri little progress was made. Winter wheat in the Atlantic coast and East Gulf States, Tennessee, Missouri, and Kansas was generally in excellent condition, and, while but slight growth was made in Illinois, the crop in that State was in thrifty condition. Cold weather affected the wheat crop unfavorably in West Virginia, Ohio, Michigan, Nebraska, and Washington. In Oregon the outlook for wheat was excellent, but in California drought injured the crop beyond recovery in many sections, but where irrigated it did well. Spring-wheat seeding was nearly completed in Nebraska, Iowa, and in the southern portion of South Dakota, and was well advanced in central South Dakota and southern Minnesota. Seeding had begun in the northern portion of South Dakota. In North Dakota frost was still in the ground and no seeding had been done. Oats were in excellent condition in the Atlantic coast and East Gulf States, seeding nearly completed in Iowa, well advanced in Nebraska, and in progress in Illinois and Michigan. The oat crop was damaged to some extent by freezing weather and frosts in Kansas, Missouri, and Tennessee. The reports indicated that great damage had been done to fruit in the Middle Atlantic States as far north as southern New Jersey, and generally from the Ohio River southward to the northern portion of the Gulf States. Much damage was also done in Oklahoma, Missouri, and Arkansas, and while the effects of the cold were less serious in the States north of the Ohio River, fruit sustained more or less injury in Illinois, Ohio, and Pennsylvania. But little damage was done, however, in Indiana and New York; and in Michigan and New England fruit buds had not been injured. Early-planted cotton was injured by frost in portions of Alabama, Mississippi, and Louisiana. In Texas planting progressed favorably over the southern and central portions, where, however, the early-planted came up to poor stands, requiring some replanting. Preparations for planting were well advanced over northern Texas, where some planting was done. Some planting also was done in southern Arkansas. Tobacco plants were seriously injured by frost in Kentucky, and sustained some damage in Virginia.

April 18.—The general weather conditions were more favorable than in the preceding week, and over the Northern, Central, and Western States were, upon the whole, very favorable. In Southern States the week was too cool and in some sections too dry, while over portions of the Ohio, central Mississippi, and Lower Missouri valleys it was too wet. In California drought conditions were further intensified. As a result of the cold weather of the previous week much replanting of corn was necessary in the Southern States. Corn planting was in progress as far north as the southern portions of Missouri and Illinois, and preparations for planting were well advanced in the more northerly States. In Kansas planting was nearly completed in the southern part of the State and in progress in the central counties. In Iowa a large area was prepared for corn, and conditions were favorable for early planting. The reports concerning winter wheat were generally favorable, and a decided improvement, as compared with the conditions in the preceding week, was reported from Indiana and Ohio, while the crop was recovering from the effects of cold weather in Kentucky and Tennessee. In Michigan wheat was much in need of rain, while in California the crop was expected to prove a failure except in the northern coast counties and in limited areas in the interior valleys. Considerable wheat had been sown in the northern portion of the spring-wheat region and seeding nearly completed in the southern portions of Minnesota and South Dakota. In Oregon the wheat crop made good growth and was in promising condition. Oat seeding progressed satisfactorily in the more northerly States. The bulk of the crop was now sown in the States of the central valleys, and in Iowa and Nebraska early-sown fields were coming up nicely, and in Kentucky and Tennessee were recovering from the effects of freezing temperatures of the previous week. The outlook for fruit in the Northern and Western States was generally very favorable, the reports indicating that the effects of cold in the Middle Atlantic and Southern States would prove less serious than was expected. Tobacco plants were plentiful in the Carolinas, Kentucky, and Virginia, and the condition of the beds in Maryland fair. In Indiana and North Carolina tobacco plants were injured lightly by frost. Some transplanting was done in South Carolina. Cool weather prevailed in the cotton region and was unfavorable for the germination of seed planted, especially in the central and eastern portions, where the crop came up slowly and in some sections to bad stands. In central and southern Texas the recently planted cotton came up well, and planting was well under way over the northern part of the State. Some cotton was planted in Arkansas, North Carolina, and Tennessee.

April 25.—This week was too cool for the best results in New England, the cen-

tral valleys and East Gulf States, while excessive moisture retarded farm work generally in the States northward of the Ohio River and in the East Gulf States. In the Middle and South Atlantic States, Texas, the Dakotas, generally throughout the Rocky Mountain region, and on the North Pacific coast the weather conditions were more favorable. No rain fell in California; consequently the severe drought continued unbroken. Drought also continued in Florida, though partially relieved in localities in the northern portion of the State. The bulk of the corn crop was planted southward of the northern boundaries of Arkansas, Tennessee, and the Carolinas; but northward of this line, except in Kansas, slow progress was made, owing to excessive rains and cool weather. No corn had yet been planted in Indiana, but planting had begun in portions of Ohio, Virginia, Maryland, and Pennsylvania. A little planting had also been done in Nebraska. Poor stands were reported from the South Atlantic States, and but slight growth made generally in the Southern States. In southern and central Texas, however, the corn crop was growing well and was receiving its second cultivation; over northern Texas it was late and irregular. The winter-wheat crop continued in promising condition in the principal wheat States of the central valleys. Further improvement in wheat was reported from Ohio, and in Michigan it was benefited by rain. In the Southern States wheat was heading. As a result of the severe drought in California, the grain crop was reported to be injured beyond recovery, except in the northern coast counties and in some foothill regions. Spring-wheat seeding was nearing completion in Minnesota, South Dakota, and over the southern portion of North Dakota, and seeding well advanced over the northern portion of North Dakota and in Montana. Slow progress was made with oat seeding where unfinished in the more northerly States. In the central and southern portions of the country the crop made favorable progress; the early sown was nearing maturity in some sections. Cotton planting was about completed over the southern section of the cotton region and well advanced over the northern portion. The early planted was making but slow growth over the central and eastern portion of the cotton belt, while poor stands were reported from Georgia, Florida, and Mississippi. There was an abundant supply of tobacco plants, and transplanting continued in South Carolina and commenced in North Carolina. Tobacco suffered from drought in Florida. The general outlook for fruit in the Northern States continued promising, and prospects in the middle and southern sections appeared more favorable.

May 2.—In the Atlantic Coast and East Gulf States this week was not favorable, being much too cool, with excessive moisture along the immediate coast from the Carolinas northward to southern New England; while high winds with freezing temperatures in the States of the Upper Missouri Valley were very unfavorable. In the Upper Mississippi, Lower Missouri, and Ohio valleys, Lake Region, and West Gulf States the conditions were more favorable, although excessive rains retarded farm work in Missouri and portions of Kansas, Illinois, and Arkansas. On the Pacific coast the week was especially favorable in Washington and Oregon, and beneficial showers fell over portions of southern California. Frosts occurred as far south as the Carolinas and northern Florida, and snow fell over a considerable portion of the Middle Atlantic States. Slow progress was made with corn planting in the central valleys and Middle Atlantic States, and in the Southern States growth of corn was retarded, although its condition was improved somewhat by the end of the week. In Texas the conditions were more favorable, and the crop generally did well. Planting began in Iowa, Illinois, and Indiana, but was not general. Except in California the reports concerning winter wheat continued favorable and indicated that the general condition of this crop was most promising. Further improvement was reported from Ohio and Michigan, but in Virginia excessive rains and low temperatures caused it to turn yellow to some extent. High winds caused damage to spring wheat in the Dakotas and Nebraska, but elsewhere in the spring-wheat region the reports indicated that the crop was doing well. In the central valleys and in the Southern States the outlook for oats was generally favorable, but slow growth was reported over portions of the Ohio Valley and Central Gulf States. Seeding was delayed in Pennsylvania, but practically completed in Michigan and Wisconsin. Except in Texas, the reports concerning cotton indicated that it had come up to poor stands and that it had made slow growth, while in the Carolinas the crop suffered injury from frost. Considerable planting remained to be done in Mississippi, but in general the bulk of the crop was planted. In Texas cotton made rapid growth over the central and southern portions of the State and was coming up to good stands in the central and northern portions. Tobacco beds escaped injury from frost in North Carolina, and the outlook for a plentiful supply of plants continued favorable. Some transplanting was done in Tennessee.

May 9.—This week was much too cool for best results over nearly the whole country. There was deficient sunshine with excessive moisture from the middle Rocky Mountain slope eastward over the central portions of the country to the

middle Atlantic and southern New England coasts, while very heavy rainfall caused destructive freshets in Oklahoma and portions of Arkansas and retarded farm work in southern Missouri, Kentucky, the Middle Atlantic States, and New England. In the Southern States the first half of the week was very favorable, but the latter part was much too cool, while in the States of the Upper Mississippi, Red River of the North, and Upper Missouri valleys the latter part of the week was more favorable than the first. In Texas and on the North Pacific coast the week was favorable throughout, but in California severe and protracted drought continued. As in the preceding week, slow progress was made with corn planting in the Central and Northern sections; but little had been planted in Nebraska, Iowa, Illinois, Indiana, and Michigan, while planting was much delayed over the northern portion of the Middle Atlantic States. Although somewhat improved in the Southern States, growth of corn was checked by cool weather of the latter part of the week, while complaints of rotting were received from portions of Kansas and southern Missouri. Considerable replanting was necessary in Arkansas and Oklahoma as a result of freshets. In Texas the crop was well cultivated and in a promising condition, except in some localities in the central portion where it was damaged by chinch bugs. The condition of winter wheat continued most promising, except in California, where the crop promised to be a failure in all but irrigated and foothill sections. Further improvement in wheat was reported from Ohio and Michigan, while in portions of Missouri and Virginia the crop deteriorated to some extent as the result of excessive rains. In Washington and Oregon the outlook for wheat was most flattering. The general condition of spring wheat was also very promising, the reports indicating that it had largely recovered in those sections where damaged by high winds during the preceding week. Seeding was finished except over the northern portion of North Dakota. The condition of oats in the Ohio Valley and Middle Atlantic States was generally favorable, but was less promising than previously reported in portions of the South Atlantic and East Gulf States, while in Nebraska the crop made but slow growth. Cotton was in need of warm sunshine throughout the cotton belt, and rain was needed over the eastern portions. Planting was now practically completed. Good stands were reported from Tennessee and Mississippi, variable from South Carolina and Louisiana, and poor from Georgia and Florida. In Texas cotton was generally well cultivated over the southern portion and came up to good stands in the northern sections, but the weather was too cool for growth, and the crop had been washed out in places by heavy rains.

May 16.—Under the favorable weather conditions which prevailed throughout nearly the whole country during this week farm work and growth of crops made exceptional progress. Farming operations, however, were interrupted by rains in portions of the Lower Missouri, Central Mississippi, and Upper Ohio valleys, and in the Middle Atlantic States, while frosts occurred in portions of the Lake Region, New England, and the Middle Atlantic States. Generous rains, ranging from 0.50 to 1.25 inches, fell over the greater part of California, where marked shortage in seasonal precipitation existed. These rains were the heaviest since February in California, and in some sections the heaviest of the season, and were beneficial to grass and that portion of the grain crop not permanently injured. Hay, however, sustained damage. Corn planting in the principal corn States of the central valleys made rapid progress, notwithstanding the wet soil, resulting from excessive rains of this and the preceding week. Corn planting was nearing completion in Indiana, over the greater part of Iowa, and in central and western Kansas; in Illinois about one-half of the crop was planted, and planting was well advanced in South Dakota, Minnesota, and Michigan, while but little had been done in Wisconsin, and considerable remained to be planted in the Middle Atlantic States. As a result of the excessive moisture and cool weather of the preceding week in the central valleys, germination was slow, and in portions of Missouri some rotting was reported. The general condition of the corn crop in the Southern States was improved. The previously reported favorable condition of the winter-wheat crop continued. Some lowland wheat in Missouri, however, was unfavorably affected by heavy rains, and in Michigan the crop, although showing improvement, needed rain. Wheat was now heading as far north as southern Kansas, the Ohio Valley, and the southern portion of the Middle Atlantic States and was ripening in Texas. In Oregon a full crop was practically assured. This week marked the completion of spring-wheat seeding. The early sown had made good growth, and its condition was reported as generally promising in the States of the Upper Missouri, Red River of the North, and Upper Mississippi valleys, but in Oregon and Washington it needed rain. Oat seeding continued in North Dakota, while the crop was nearing maturity in the Southern States, and harvesting had begun in Texas. The condition of the crop was promising. Cotton made slow growth in the central and eastern portions of the cotton belt, although generally some improvement was

reported from these sections. In southern Texas the crop did well, except in the extreme eastern portion, where rain was needed, while over the central and northern portions of the State the weather was too cool. Tobacco planting was in general progress in Tennessee and had begun in Maryland and Virginia, plants being ready to set in Ohio. In the Carolinas and Florida tobacco did well. The supply of plants was generally abundant.

May 23.—The weather conditions of this week were most favorable for crop growth throughout the central valleys, Lake Region, Middle Atlantic States, New England, and on the north Pacific coast. The high average temperatures throughout all districts east of the Rocky Mountains proved especially beneficial, but excessive rains in the central valleys and in portions of the lower Lake Region and Middle Atlantic States retarded farm work and caused rapid growth of weeds, while portions of the South Atlantic and East Gulf States suffered from drought. It was too cool for rapid growth of vegetation in the States of the Rocky Mountain region. Cloudy and wet weather in the central valleys and on the Middle Atlantic coast greatly delayed corn planting, but was very favorable for germination and growth of the early planted. In the Southern States corn was in silk and tassel and generally doing well in the West Gulf States, but in the East Gulf States suffered from drought. Winter wheat made rapid growth and was generally in excellent condition. It continued to improve in Ohio and Michigan, but was injured by excessive rains on lowlands in Missouri. The crop was now heading as far north as the central portion of Kansas, Missouri, Illinois, and Indiana, and harvesting had begun in Georgia and Texas. In Oregon and Washington the outlook was excellent, and rains of the two previous weeks in California improved the grain outlook in that State. Spring wheat was mostly in fine condition in the Dakotas and Minnesota, and greatly improved in Wisconsin and eastern Washington. The general condition of the oat crop was very good, although damaged to some extent by rains in lowlands in Missouri and by drought in the Carolinas and Alabama. Under favorable conditions cotton showed improvement, especially over the eastern portions of the cotton belt, excepting Florida, where its condition was poor. In Louisiana late planted cotton was not up and the ground was too dry for germination. In Texas the crop was late and in localities weedy, but improved generally, though needing sunshine. The greater part of the tobacco crop was planted as far north as Tennessee and North Carolina, and planting was well advanced in Kentucky, but north of the Ohio River and in the Middle Atlantic States little planting had been done. Plants were generally abundant.

May 30.—As in the preceding week, the weather conditions were especially favorable for crops in the principal agricultural States, the high average temperatures throughout the central valleys and Southern States having been decidedly beneficial. Rain, however, was needed in the Gulf States, while excessive moisture retarded farm work in New England and portions of the Middle Atlantic States, particularly in New England. Corn planting was vigorously pushed and was nearing completion in the more northerly sections, except in New York and New England. In the principal corn States of the central valleys corn was coming up well and cultivation of the early planted had begun. Excessive rains retarded cultivation in Missouri and western Kansas, while in portions of Nebraska the crop was badly washed. In the Southern States corn, especially the early planted, which was being laid by, needed rain. Winter wheat was heading in the more northerly States and maturing rapidly in the central-southern sections, while harvesting was general in the Gulf States. The outlook in Oregon and Washington never was better, the rains in Washington having greatly improved the prospects for an abundant crop in that State. All reports from the spring-wheat region indicated a rapid and healthy growth of spring wheat and showed this crop to be in a most promising condition. Oat harvest continued in the Southern States, the general condition of the crop being satisfactory, although the growth was too rank in Iowa, and it suffered on lowlands in Missouri from excessive rains. There was a general improvement in the condition of cotton, except in Florida. The crop was clean and well cultivated, and the early planted forming "squares," [American name for very young bolls.] In southern Louisiana cotton needed rain, and in localities of Texas insects were causing damage. In Kentucky about one-half of the tobacco crop had been planted, and much planting had been done in Virginia. Farther north but little planting had been done. Plants were abundant generally, but were backward in Wisconsin and New England.

June 6.—Favorable weather conditions of the previous week continued in the States of the central valleys and on the Middle Atlantic coast, while in the east Gulf and South Atlantic States and southwest Texas drought became more pronounced. The temperature conditions to the eastward of the Rocky Mountains were highly favorable, but in the Rocky Mountain region and over the greater part of the Pacific coast it was too cool, freezing weather and frosts occurring in

portions of Idaho, Nevada, and eastern Oregon. Corn planting was now practically completed in the more northerly sections, and the crop had received its last cultivation in the Southern States, where it was suffering from drought. In the principal corn States of the central valleys this week was especially favorable for growth and cultivation, and generally the crop was clean and in good condition. In Nebraska and portions of northern Missouri, however, cultivation was delayed by rains, and in North Dakota corn was backward and needed sunshine. The winter-wheat harvest had been completed in the South Atlantic and Gulf States, except in Texas, where it continued, and had begun in North Carolina and Tennessee. Winter wheat matured rapidly and in excellent condition in the central and northern sections, although some complaints of rust were reported from portions of New Jersey, Maryland, Tennessee, Missouri, and Kansas. Thrashing was in progress, with satisfactory results, in the South Atlantic and East Gulf States. The condition of the crop in Washington and Oregon continued most favorable, and in California a better yield than expected was promised. Spring wheat made rapid growth, and its condition was most promising generally throughout the spring-wheat region. The reports concerning oats were favorable, although some complaints of rust were received from New Jersey and Missouri, while growth was too rank in portions of Iowa and Nebraska. The absence of rain over the central and eastern portions of the cotton belt was favorable for the cultivation of cotton, and the crop was clean, except in portions of Arkansas and central Texas, where heavy rains favored the rapid growth of grass. The plant generally was small, but healthy and making steady growth. Tobacco did well in the Carolinas, and planting progressed under favorable conditions in Virginia, Pennsylvania, and New England. Rain was needed for transplanting in the Ohio Valley, where but slow progress had yet been made, except in Kentucky, where it was nearly completed. Cutting had begun in Florida.

June 13.—Upon the whole, the weather conditions of this week were less favorable to agricultural interests than in the preceding week, injury having resulted from excessive rains in portions of the Upper Mississippi Valley, in the Lower Missouri Valley, and in Oklahoma and Texas, while the absence of rain intensified the drought conditions in the Carolinas. In the principal corn-producing States of the central valleys corn generally made good growth, but owing to excessive rains cultivation was interrupted and the crop was generally weedy, especially in the Lower Missouri Valley, the weather conditions being exceptionally beneficial in the Lake region, Ohio Valley, Middle Atlantic States, and Texas. The general condition of winter wheat was less promising than at the close of the previous week, as a result of heavy rains in the Missouri and Upper Mississippi valleys, which tended to increase rust and caused some lodging in the Lower Missouri Valley. Some complaints of rust were also reported from Tennessee and the Middle Atlantic States. Wheat ripened rapidly in the Ohio Valley, and harvesting was in progress in Virginia, Kentucky, and in the southern portions of Illinois, Missouri, and Kansas. Harvesting was delayed by rains in Oklahoma and Texas. The outlook in Oregon and Washington continued excellent, and in the first-named State the crop promised to be the largest ever produced. The condition of spring wheat in the Dakotas continued most promising. In Minnesota the crop made vigorous growth, but rust made its appearance, and some complaints of lodging were reported, while unfavorable reports were received from Iowa, where the crop was in imminent danger from rust and lodging, a considerable area already being down. Oats suffered from the same conditions that injured wheat, namely, rust and lodging, in the Upper Mississippi and Lower Missouri valleys, but the general condition of the crop was favorable. Oat harvest was in progress in some of the Southern States. Over the eastern portion of the cotton belt cotton generally was small, but healthy and well cultivated. In the central portion more rapid growth was reported, but in Arkansas it was grassy in some localities. In Texas cotton made good growth in all sections, but continuous rains prevented cultivation. Tobacco planting progressed favorably in the more northerly sections, but in Maryland, Ohio, Kentucky, and Tennessee transplanting was slow, on account of lack of "seasons." In Carolina tobacco suffered for rain.

June 20.—With generally favorable temperature conditions and abundant rains over the greater part of the country east of the Rocky Mountains, more particularly the central and southern sections, crops made substantial progress. Cultivation, however, was retarded in portions of the central valleys and in Texas, where continuous rains favored rank growth of grass and weeds. Except over southern Georgia, where rain was still needed, the previous drought conditions in the South Atlantic and East Gulf States were wholly relieved. Corn continued to make good growth and the general condition of the crop was promising, although suffering from lack of cultivation in some of the principal corn States of the central valleys and in northern Texas. Owing to continuous rains slow prog-

ress was made with winter-wheat harvest in the central Mississippi and Lower Missouri valleys, in Virginia and North Carolina. Harvesting was in progress in southern portions of Illinois, Indiana, and Ohio, where the conditions were more favorable. In Kansas, Missouri, southern Illinois, Arkansas, and Tennessee more or less damage was reported from rust, and in Arkansas and Tennessee grain in shock was damaged. The outlook in Washington and Oregon continued most promising. Spring wheat continued in excellent condition in the Dakotas, but in Iowa and portions of Minnesota there were complaints of rank growth and lodging, particularly in Iowa. Oat harvest was in progress as far north as southern Missouri. Although complaints of lodging and rust were received from portions of the central valleys, the condition of the crop was promising. The week was exceptionally favorable for cotton, and the reports indicated a decided improvement in the condition of this crop throughout the cotton belt. In portions of Mississippi, Louisiana, and Texas, however, it was grassy and in need of cultivation, while some complaints of lice were received from North Carolina. Tobacco planting was completed in Virginia and Kentucky, and well advanced in more northerly sections. Except in Maryland and southern New England, where planting was delayed and plants scarce, the general outlook was favorable. Cutting continued in Florida and had begun in South Carolina.

June 27.—Upon the whole, the general weather conditions of this week were favorable to agricultural interests, the light rainfall with abundant sunshine in the Southern States being especially beneficial to cotton. Local storms, in places accompanied by hail, however, proved destructive in portions of New Jersey and over local areas in the Ohio and Upper Mississippi valleys, while heavy rains retarded cultivation of crops and caused some injury to grain in Missouri. Reports from the principal corn-producing States indicated that corn had made rapid growth and that generally the crop was in excellent condition. Notwithstanding the heavy rains in portions of the Lower Missouri and Upper Mississippi valleys, where the crop at the close of the previous week was grassy, cultivation was vigorously pushed and, except in Missouri, where much was still weedy, the fields were generally clean. The cultivation of a large part of the crop as far north as Kansas, Missouri, and central Illinois was finished. Winter-wheat harvest was nearing completion in southern Kansas, and was practically completed to the south of the Ohio River. Harvesting was now general in northern Kansas, Missouri, Illinois, Indiana, and Ohio, and had begun in Nebraska. Considerable damage from rust was reported from Kansas, Nebraska, and Ohio, and similar complaints, in addition to injury from chinch bugs, were received from Missouri, central Illinois, and Virginia. The condition of wheat in Oregon and Washington continued very promising. Thrashing continued in the Southern States generally with satisfactory yields. In Texas some injury was caused to grain in shock by rains of the previous week. The condition of spring wheat was less favorable than reported in the previous week. Rust began to appear in North Dakota, while hot and dry southerly winds proved injurious in portions of South Dakota and Nebraska. In Minnesota reports of lodging were less numerous, and favorable weather conditions checked rust, but reports of damage by rust and lodging in Iowa continued. Oat harvesting generally was completed in the Southern States, and was in progress in the central valleys and Middle Atlantic States with satisfactory results. The crop was maturing rapidly in the more northerly sections, where its general condition was promising, except in the Dakotas, Iowa, and Missouri. In Iowa and North Dakota rust was reported; in Missouri damage was caused by excessive rains in places, while hot winds proved injurious in South Dakota. Except in the Carolinas cotton grew rapidly throughout the cotton belt, and in portions of the central section its growth was somewhat too rapid. The crop generally was well cultivated, except in limited areas in Texas, Louisiana, Tennessee, and South Carolina, where some fields were grassy. Complaints of lice also were received from the Carolinas. Conditions were unfavorable for transplanting tobacco in southern New England, Maryland, and Indiana. Planting in New York and Ohio practically was completed, but much replanting was necessary in the last-named State. In the Carolinas and Virginia the crop improved, and while the early planted in Kentucky made good growth, the late planted made slow progress. In Tennessee tobacco made good growth, but cut worms caused uneven stands.

July 4.—In the Atlantic coast and East Gulf districts this week was hot, excessively so during the latter portion, and for the most part dry. In the Lake region, central valleys, and west Gulf States the weather conditions were generally favorable, although heavy rains retarded cultivation in portions of the central Gulf States. The absence of rain over a large portion of Illinois and Missouri, where crops were previously reported as very grassy, was particularly favorable for cultivation. In the central and northern Rocky Mountain regions the week was

cool, with light to heavy frosts in Montana, Wyoming, and eastern Washington, causing little or no damage, however, except in Washington, where corn and vegetables were injured to a slight extent. A destructive "norther" occurred on June 30 and July 1 in northern California, during which much fruit was blown from trees and a large part of unharvested grain was shelled. Favorable reports as to the condition of corn continued from nearly all sections, and in the principal corn-producing States of the central valleys the crop made splendid progress, the early planted being in silk and tassel as far north as the southern portions of Missouri, Kansas, and the Ohio Valley. In the Gulf States, especially in Texas, corn matured under favorable conditions. In portions of Maryland, South Carolina, and northern Georgia the condition of corn was not promising, owing to drought. Wheat harvest progressed under favorable weather conditions in the more northerly winter-wheat States, and was practically completed as far north as Missouri and the central portions of Illinois and Indiana. Harvesting commenced in Oregon, and grain was nearly ready for harvest in Washington. In the last-named State high winds proved unfavorable to wheat. The condition of spring wheat generally was better than at the close of the previous week, rains and cool weather having proved especially beneficial in the Dakotas. Cotton improved over the greater part of the cotton belt, but owing to continuous rains was badly in need of cultivation in Mississippi, Louisiana, and portions of northeastern Texas and Alabama. Too rapid growth and rust were reported from Louisiana, while boll weevil and rust were reported from portions of Texas, where, however, the general condition of the crop was very promising. Reports concerning tobacco were favorable, except in Pennsylvania, Maryland, and North Carolina. In Maryland only about one-half the usual acreage at this date had been planted.

July 11.—The dry weather over the northern districts, from the Missouri Valley to New England, proved exceptionally favorable for harvesting and cultivation of crops, but was not wholly favorable for crop growth, and in the Lake Region, Middle Atlantic States, and New England rain was much needed; rain also was needed, particularly for spring wheat, in western South Dakota, Montana, and Washington. Some damage resulted from excessive rains in portions of Arkansas, Missouri, and Mississippi, and from local storms in Minnesota and Illinois, while high winds proved injurious to wheat in Washington. In the Southern States the week generally was favorable, except in portions of Mississippi, where damage resulted from heavy rains. With the exception of damage by chinch bugs in portions of Missouri and Illinois, and the need of rain in southern Wisconsin, upper Ohio Valley, and Middle Atlantic States, corn continued to make favorable progress and the outlook was promising. Cultivation largely was finished, except in the more northerly sections, and the crop was in tassel as far north as Michigan and Wisconsin. Winter-wheat harvest was well advanced in the extreme northern districts, and considerable thrashing done in the central valleys, Middle Atlantic and Southern States. Thrashing, however, was delayed by rains in portions of Missouri, where grain in shock was damaged. Harvesting, with excellent results, continued in Oregon, and was begun in Washington. In the last-named State the crop had ripened rapidly, in some sections prematurely, and was damaged to some extent by high winds. In California harvesting was nearing completion—the summer fallow giving fair yields in some sections. In South Dakota spring wheat was injured permanently by hot winds of the week ending June 27, and the previous excellent prospects were materially impaired. In Minnesota, however, lodged grain improved. Spring wheat was heading in the extreme northern portion of the spring-wheat region, and on the North Pacific coast the crop was ripening rapidly, and an excellent yield promised, especially in Oregon. With the exception of a few complaints of rust and shedding, the reports indicated an improvement in cotton over the eastern portion of the cotton belt. The crop was also doing well in Missouri and Arkansas, and generally in Texas, where, however, rust and boll weevil were reported in some sections. In Louisiana and Mississippi dry weather was needed, the first-named State reporting too rapid growth and crop grassy. Tobacco generally was doing well, except in Maryland, Pennsylvania, and southern New England, where, owing to lack of planting "seasons," less than the usual area had been planted. Light frosts occurred in northern New England on the 6th, causing but slight damage.

July 18.—At the close of this week rain generally was needed in the Missouri, Upper Mississippi, and Ohio valleys, the Lake Region, and over the greater part of New England and the Middle Atlantic States, especially in Missouri, Ohio, northern New England, and portions of the Middle Atlantic States, the drought in Maryland and adjacent portions of Virginia being especially severe. Too much rain fell over a large part of the South Atlantic and East Gulf States, causing injury to and preventing the cultivation of crops. Along the immediate coast from southern New England to North Carolina, in West Virginia, Kentucky,

Tennessee, the Central and West Gulf States, and generally throughout the Rocky Mountain and North Pacific coast regions the weather conditions were favorable to crops. While rains would have proved beneficial to corn in the principal corn States of the central valleys, that crop was generally doing well, except in southern Missouri and Michigan, where rain was greatly needed. Although needing rain, the condition in Kansas was improved greatly, and rapid growth was made in Nebraska and South Dakota. Corn was injured materially by frost on the 11th and 12th in the northern portion of the lower Michigan peninsula, northwestern Ohio, and in portions of New York, New Jersey, and New England. In the Southern States corn was generally in excellent condition and a large part of the crop made. Winter-wheat harvest continued where unfinished in a few of the more northerly States, but the bulk of the crop was harvested east of the Rocky Mountains and in California. Harvesting was in full progress in Oregon and well advanced in eastern Washington. A large yield, of excellent quality, was being harvested in Oregon, but while wheat turned out well in Washington, it had been somewhat injured by recent hot weather. Spring wheat ripened rapidly. As previously reported, it had been injured by hot winds in portions of South Dakota. Cotton made rapid growth generally throughout the cotton region, North Carolina reporting too rapid growth of stalk, but reports of rust and shedding greatly increased, especially over the central and eastern districts. In South Carolina, Florida, Alabama, and Mississippi the crop needed cultivation and sunshine. In Texas it was very promising, except in a few localities, where boll weevil, rust, and shedding were reported, and growth was slightly checked by cool nights. Some early cotton was maturing in southwest Texas. Over the north central portion of the cotton belt the crop was well cultivated and generally in promising condition. Tobacco on lowlands in Florida and in portions of northern Tennessee was injured by rains, while in Maryland drought greatly reduced the acreage, damaged the crop, and rendered further planting useless. In Pennsylvania and Ohio tobacco made slow growth, but in the Carolinas, Virginia, Kentucky, Missouri, Wisconsin, and New England it was in promising condition. Cutting and curing were in progress in Texas and the Carolinas, and topping in Virginia.

July 25.—The drought conditions of the previous week in the States of the central valleys and Lake Region were relieved in sections only, and at the close of the week rain was needed over the greater part of the Lake Region, Ohio, Mississippi, and Missouri valleys, in portions of New England and the Middle Atlantic States, and the greater part of Texas, while portions of the East Gulf and South Atlantic States suffered from excessive rains. Comparatively few local storms of sufficient severity to damage crops were reported. Light frosts occurred on the 20th in North Dakota and extreme northern Minnesota, but caused no serious injury. The weather conditions on the Pacific coast generally were favorable, but in Washington the high temperatures of the previous week shrunk grain to a somewhat greater extent than previously reported. In the great corn States of the central valleys, Nebraska, Kansas, Iowa, Missouri, Illinois, Indiana, and Ohio, which produce considerably more than half the entire product of the United States, corn was generally in need of rain, while in Iowa and portions of Missouri the crop was threatened with serious injury. In the Southern States continued favorable reports concerning corn were received. Winter-wheat harvest continued on the North Pacific coast, having been practically completed during the previous week in all districts east of the Rocky Mountains. In Oregon wheat yielded better than expected. In portions of Washington, however, hot winds of the previous week caused the grain to shrink materially. Spring-wheat harvest was well advanced in the central portion of the spring-wheat region, and the crop matured rapidly and well in the northern portion. In Oregon spring wheat was reported nearly as good as winter, which was an unprecedentedly good crop. As to cotton, reports of rust and shedding, although probably somewhat less numerous than in the previous week, continued from the central and eastern portions of the cotton belt, where excessive rains in some sections caused too rapid growth of stalk. The crop was in need of cultivation in portions of South Carolina, Mississippi, and Louisiana, some fields on lowlands of Mississippi having been abandoned. In Texas the crop generally was promising, but boll weevil were increasing, and rain was needed in localities. Picking was in progress in southern Texas, and cotton beginning to open in southern Alabama. Reports concerning tobacco generally were favorable, except in Maryland, Pennsylvania, and portions of Ohio and Kentucky. Recent rains improved the condition of the crop in Maryland, where a comparatively small area was planted. In Kentucky tobacco was of poor color, slender stalk, and "frenching." In Virginia the outlook was exceptionally favorable. Cutting and curing progressed in the Carolinas, Florida, and Texas. Some plowing for fall seeding was done in Tennessee, Michigan, Missouri, Kansas, and Oklahoma.

August 1.—Abundant rains during this week relieved the drought conditions

which threatened the States of the central valleys at the close of the previous week. Drought, however, continued in Minnesota, over the northern portions of the Lake Region and New England, in the western portions of Nebraska and Kansas, and in eastern Oklahoma. The week was hot and dry generally throughout the Rocky Mountain and Pacific coast regions, while excessive rains proved injurious, more particularly to cotton, in the central and East Gulf and South Atlantic States. Upon the whole, the week was decidedly favorable for corn. In the great corn States of the central valleys, with but few exceptions, the crop made excellent progress and was also greatly improved in the Atlantic coast States. In the northern portions of Illinois and Wisconsin, in Minnesota, over the western portions of Nebraska and Kansas and eastern Oklahoma corn suffered from drought, and was injured by hot winds in Kansas and Oklahoma. In Iowa, where at the close of the previous week corn was threatened with serious injury, it was much improved and gave promise of an average yield. In Missouri corn did finely, and much of the early planted in the southern sections was safe. A good corn crop also was assured in southern Illinois, but much was permanently injured in the central portions of the State and the crop suffered for rain in the northern counties. In Indiana, Ohio, Kentucky, and Tennessee, and generally throughout the Middle and South Atlantic States, the outlook for corn improved decidedly. Spring-wheat harvest continued under generally favorable conditions in the central and southern portions of the spring-wheat region. In the Red River Valley the crop was in promising condition. Harvesting began in Washington and Oregon, and in the first-named State, while the grain was considerably shriveled in dry localities, it yielded a fair average crop. Cotton suffered from excessive rains and insufficient sunshine throughout the central and eastern portions of the cotton belt. Rust, shedding, and too rank growth of stalk were general in the sections named. Some cotton was picked in southwest Georgia, and picking continued in southern Texas. In the last-named State the crop was in a good state of cultivation, and generally looked well, but needed rain in some localities. Tobacco greatly improved in the principal tobacco States. In Tennessee, however, the crop sustained injury as a result of wet weather, and while the crop in Indiana was still small it promised well. The outlook for a fine crop in Virginia was very promising. The abundant rains of this week put the soil in excellent condition for plowing for fall seeding generally throughout the central valleys and Atlantic coast districts.

August 8.—The favorable weather conditions of the previous week continued in the central valleys, Middle Atlantic States and New England, where the rainfall was ample, and in some sections excessive. In the Southern States the week was unfavorable for cotton, owing to insufficient sunshine and excessive rains. On the North Pacific coast the week was also unfavorable, being dry and exceptionally hot. In Washington wheat harvest was interrupted by intense heat, which caused the late grain to shrivel. Numerous complaints of damage to grain in shock by wet weather, which also interrupted thrashing, were received from portions of the Ohio, Upper Mississippi, and Missouri valleys. Corn continued to make excellent progress, and, except in portions of central Kansas, southern Nebraska, and central Illinois, the outlook materially improved. Some damage, however, from local storms was reported from portions of the Middle Atlantic States and New England, and in Ohio the crop needed cultivation. In Nebraska corn suffered considerable permanent injury from the drought which prevailed in July. The early crop in Kansas was made and the late was promising, except in central counties, where much was cut for fodder. A marked improvement in the condition of corn was reported in Illinois, where a good crop seemed assured, except in central counties. In Minnesota and South Dakota the weather conditions were less favorable than in the previous week for spring-wheat harvest, which was in progress as far north as Norman County, in northern Minnesota. In Oregon and Washington excessive heat caused wheat to ripen rapidly—too rapidly for harvesters in the latter State, where much grain was injured. Frequent heavy rains over the greater part of the cotton belt were unfavorable to cotton, causing too rapid growth of stalk, rust, and shedding to continue. Bollworms also were reported as numerous in the central and western portions. In Texas cotton was in a good state of cultivation, and as a rule the plant looked well. Cotton opened slowly throughout the central and eastern portions of the cotton region. Reports concerning tobacco indicated that it was in a very promising condition generally. In Ohio, however, it needed cultivation, and complaints of "frenching" continued from Kentucky. The outlook in Virginia was exceptionally promising. Cutting was about finished in North Carolina, and some of the early planted in Ohio and Pennsylvania was housed. Owing to abundant rains, the condition of the soil was most favorable for plowing for fall seeding, which work was unusually well advanced for the season.

August 15.—Although rather cool, the general weather conditions in the States of the central valleys were favorable for the growth and maturing of crops and for farm work. In the Atlantic Coast States south of New England and in the Central and East Gulf States, including Kentucky and Tennessee, there was too much rain except over limited areas, principally in the Southern States. In the Pacific Coast States the week was phenomenally hot, the temperatures in the interior of California and in the eastern portions of Oregon and Washington ranging from 100° to 112°, causing injury to grain in the last-named States. The week generally was favorable to corn, although somewhat too cool in the northern portion of the Upper Mississippi Valley and too dry in portions of South Dakota and Kansas, while excessive rains caused injury on the lowlands in southern Ohio. Harvesting of spring wheat in the Dakotas and Minnesota was nearly finished, except in the northern portions. Cotton suffered injury from continuous excessive rains and lack of sunshine over the greater part of the central and eastern districts of the cotton belt, in which sections too rank growth, rust, and injury from insects were extensively reported. In Missouri, Arkansas, and Oklahoma the crop did well, and some favorable reports were received from North Carolina and Mississippi. In northern and western Texas cotton deteriorated as a result of dry weather, and, while insects proved injurious over many parts of the State, the crop did well in some sections. Plowing for fall seeding made favorable progress in the Missouri and Upper Mississippi valleys, but this work was interrupted by excessive rains in the Ohio Valley and Middle Atlantic States.

August 22.—In the central valleys, New England, Middle Atlantic, and Central Gulf States the week generally was favorable, especially for corn in the great corn States. There was too much rain over the greater part of New York and generally throughout the South Atlantic States, while the central and northern Rocky Mountain regions, including a portion of the Upper Missouri Valley, suffered from intense heat and dryness. Local storms proved destructive in portions of North Dakota, Minnesota, Iowa, Illinois, Ohio, and Pennsylvania. The excessive heat of the previous week on the Pacific coast was followed by cooler weather, with light scattered showers in Oregon and Washington, the conditions in California being especially favorable for fruit drying. Corn suffered to some extent from excessive heat and drought in portions of Nebraska, Kansas, and Missouri, and from heavy rains in the Carolinas, but elsewhere the week was very favorable to this crop, which was maturing rapidly in the principal corn States. Some cutting was done in southern Missouri. The spring wheat harvest continued under generally favorable conditions in Washington and Oregon, where, owing to excessive heat for several weeks, the crop yielded less than was promised, especially in Washington. In the Carolinas, Georgia, and Florida cotton continued to suffer injury from excessive rains and lack of sunshine, and complaints of shedding and rust were general in these States, premature opening being reported from Georgia. There was a decided improvement in the condition of cotton in the Central Gulf States as a result of fair weather and favorable temperature conditions. In Texas cotton suffered from drought except in the southeast portion, the crop being irregular, generally late, and in many localities was shedding and suffering from the ravages of insects, while in other sections it was very promising. Picking was general over the southern portion of the cotton region. Reports respecting tobacco showed a general and decided improvement in this crop, except in North Carolina, where too much rain caused second growth. Cutting and housing were in progress generally. The condition of soil continued very favorable for plowing for fall seeding.

August 29.—Continued heavy rains proved unfavorable in the South Atlantic and East Gulf States, while drought prevailed in portions of Texas, Arkansas, and Missouri, and generally in the States of the eastern Rocky Mountain slope. The week proved very favorable in the New England and Middle Atlantic States, the lake region, and throughout the central valleys, the high temperatures favoring the rapid maturing of crops. With the exception of portions of Kansas, Nebraska, Missouri, and South Dakota, where the late crop was injured by drought and excessive heat, the week was very favorable for corn, which was maturing rapidly throughout the central and northern portions of the country. In the southern counties of Nebraska corn ripened too rapidly under the high temperatures of this and the preceding week. Some cutting was done in nearly all the principal corn States. Harvesting and thrashing of spring wheat continued in Oregon and Washington. In Washington thrashing showed good yields, which, however, were somewhat lessened by poor crops of late wheat in some sections as a result of the excessive heat of the first half of August, which also injured the crop in Oregon. The week was very unfavorable for cotton, especially over the most of the eastern portion of the cotton belt, where it suffered from heavy rains, causing rust, shedding, and too rapid growth of stalk. In portions of North Carolina and over the central part of the cotton region the conditions were somewhat more

favorable, and the crop improved in Tennessee, Missouri, and portions of Mississippi and Arkansas. Cotton also improved in central and northern Texas, but insects caused damage in many localities, and premature opening and shedding were reported from the central and southern portions of the State. Picking was now general in the northern portion. Except in New England, where warm dry weather was needed, the week was favorable for tobacco, a general improvement being reported from all tobacco-producing States. Cutting was general in Kentucky, Virginia, and Maryland, a large part of the early crop being housed.

September 5.—The abnormally high temperatures during this week were favorable for maturing crops, more particularly over the central and northern portions of the country from the Mississippi Valley eastward, while in Kansas, Nebraska, South Dakota, and portions of Missouri hot winds proved injurious. In the Central and West Gulf States the week also was generally favorable, but in the South Atlantic and portions of the East Gulf States excessively heavy rains caused much damage. On the Pacific coast the conditions were favorable. Corn made rapid progress toward maturity under the abnormally high temperature conditions, a large part of the crop in States where usually exposed to danger from frost being safe, and the remainder promising to mature earlier than usual. Late corn was seriously injured by hot winds in South Dakota, Nebraska, Kansas, and Missouri, while heavy rains caused rotting and sprouting in the South Atlantic and East Gulf States. Cotton suffered seriously from rust, shedding, and insects over the eastern portion of the cotton belt, from which section numerous reports of rotting and sprouting also were received, especially in Georgia and the Carolinas, where the rainfall was exceptionally heavy. In Louisiana and Texas reports of shedding and damage by insects were less numerous than in the preceding week. In Texas rain was needed for late cotton and the top crop. Cotton opened rapidly in all districts, and picking progressed favorably over the central and western portions, but was retarded by rains in parts of the eastern section. Most of the early tobacco was cut and housed under favorable conditions, the late crop being generally promising. The soil over the central and northern districts of the country east of the Mississippi River continued favorable for plowing, but in Missouri, Kansas, and Nebraska it was too dry.

September 12.—The weather conditions of this week were favorable for farm work and the maturing of crops in the lower lake region, Middle Atlantic States, the Carolinas, Lower Mississippi Valley, Texas, and the Pacific Coast States, but were generally unfavorable in New England and the East Gulf States, including Georgia, while to the east of the Rocky Mountains and west of the Upper Mississippi Valley the week was marked by unseasonably low temperatures, heavy frosts, and in some instances snow, proving injurious to crops that were not fully matured. Light frosts occurred in Iowa, Illinois, Indiana, and as far south as Kentucky, but with little or no damage to crops in these States. Reports from the principal corn-producing States indicated that the larger part of the early crop was practically safe, with much in shock. Late corn did well in the eastern portions of Nebraska and Kansas and in Iowa and Missouri. Considerable late corn was injured by frosts in North Dakota and the extreme western portions of Kansas and Nebraska. In portions of Missouri the crop sustained great damage by hail and wind storms, and suffered injury from excessive rains in the South Atlantic States. There was apparently no material improvement in the condition of cotton in the eastern section of the cotton belt, where it was opening rapidly and picking was progressing. In the central section of the cotton belt the condition of cotton was somewhat more favorable, except in Mississippi, where it was seriously injured. In Texas the bulk of the crop was open, and picking progressed under favorable conditions, the staple being clean. The soil conditions continued favorable for fall seeding in most sections, and the reports generally indicated this work to be well advanced except in Maine, New Jersey, Virginia, and Texas, where plowing had been delayed owing to lack of rain. Considerable fall wheat was sown in the States of the central valleys.

September 19.—This week on the whole was favorable, except in portions of New England, Pennsylvania, New Jersey, and Maryland, where the drought conditions previously reported continued, while in Mississippi, southwestern Texas, and some sections of Kansas and Missouri heavy rains retarded farm work. Killing frosts occurred in northern New England, Michigan, and Wisconsin, but with slight damage and light frosts occurred in New York, Pennsylvania, Ohio, and Indiana, doing little or no damage. The absence of rain in Washington and Oregon was highly favorable for harvested and threshed grain and for gathering hops. The weather was favorable for late corn, which was maturing rapidly, except in portions of Missouri and Illinois, where it needed sunshine and warmth. A slight improvement was noted in cotton in the eastern portion of the cotton region, where rotting and shedding were on the decrease. In the central portion of the cotton region, where about the same conditions prevailed as in the previous week, picking

progressed as the weather permitted. Some damage resulted from heavy rains in Arkansas. In Texas picking was well advanced. The reports indicated short top crop in South Carolina, Georgia, Oklahoma, and Texas. Plowing and seeding fall grain progressed rapidly in all sections except New England, Pennsylvania, New Jersey, Maryland, and Tennessee, where the work was delayed owing to dry-soil conditions. Wheat seeding also was delayed in portions of Missouri on account of heavy rains. Early-sown grain was coming up and growing nicely in Indiana, Illinois, Missouri, Nebraska, Kansas, and Oklahoma.

September 26.—This week was one of exceptionally favorable temperature conditions for the maturing of crops generally throughout the country. No frosts were reported from the States of the central valleys, but light frosts, causing no serious damage, occurred in portions of New York, New Jersey, and Pennsylvania on the 21st. Heavy rains delayed farm work in portions of the Lower Missouri and Lower Ohio valleys, and proved injurious in the central Gulf States, while drought continued unbroken in portions of Minnesota. On the Pacific coast the weather generally was favorable in Washington and Oregon, while rains ranging from one-fourth to more than one inch fell over the greater part of northern and central California, causing injury to raisins and unthrashed grain. Except in northern Missouri, where considerable late corn needed favorable weather to mature, the corn crop was now practically safe from frost and much had been cut. Heavy rains in the Lower Mississippi valley damaged open cotton and interfered with picking. Over the eastern portion of the cotton region the weather was more favorable and picking progressed rapidly. Picking also progressed rapidly in Texas, where the crop was reported as irregular, being good in places and poor in others. Reports throughout the cotton belt generally indicated that the top crop would be very inferior and in some places a total failure. The soil conditions throughout the country east of the Rocky Mountains were highly favorable for plowing and seeding, Minnesota being the only State in which the ground was too dry for this work. The reports generally indicated that fall-sown grain germinated quickly and was coming up to good stands.

October, 1898.—The month of October averaged warmer than usual in the lake region, Upper Ohio valley, in the Atlantic coast districts, from western Texas to Arizona, and along the immediate Pacific coast; colder than usual in the Gulf States, and from the Upper Mississippi valley westward over the Rocky Mountain region, including the eastern portion of Washington and Oregon. The month was unusually wet throughout the central valleys and in the Atlantic coast and east Gulf States, while the greater part of Texas, and limited areas in the central Gulf and south Atlantic States, California, Oregon, southern Washington, and the southern Rocky Mountain region received less than the usual amount. The month was generally very favorable for germination and growth of fall-sown grain throughout the country east of the Rocky Mountains, but excessive moisture in the central valleys, east Gulf, and south Atlantic States interfered with farm work and caused much damage to crops remaining in the field. On the Pacific coast, in New England, and the middle Atlantic States the weather conditions were favorable for farming interests. Generally throughout the central valleys and Southern States corn, both the uncut and that in shock, suffered great damage from excessive rains, which caused sprouting and rotting to a great extent and delayed husking and cribbing. Except in Texas and portions of the Carolinas, where cotton picking had progressed satisfactorily, the month was very unfavorable for gathering the late cotton, much of which in the central portion of the cotton belt was greatly damaged by heavy rains. The reports generally indicated that early-sown grain germinated quickly, made vigorous growth, and was in excellent condition at the close of the month. In Kentucky, tobacco in barns sustained injury from the effects of excessive moisture. The month was comparatively free from destructive frosts, although frosts occurred as far south as northern Florida.

EXPLANATIONS OF DIAGRAMS AND TABLES.

The diagrams (figs. 129 and 130) illustrate the conditions of temperature and precipitation from January 1 to April 4, and subsequently for each seven-day period, ending at 8 a. m. Monday, to October 10. The heavy horizontal line indicates normal, and the solid and broken irregular lines show, respectively, the average departures from normal temperature (degrees per day) and precipitation (tenths of inches) for the several districts, as determined from the records of Weather Bureau stations. The number of records used in determining the average departures for each district can be ascertained from the tables which supply data from which similar diagrams for individual stations may be constructed.

The tables contain in detail the data upon which the diagrams are based, and it is believed that the explanation of the latter, together with the column heading of the former, render further explanation unnecessary. It should be borne in mind.

however, that the temperature departure is the average daily for the periods indicated in headings of both diagrams and tables, and that the precipitation departure is the excess or deficiency determined by a comparison of the total amount for each week with the normal for the corresponding period.

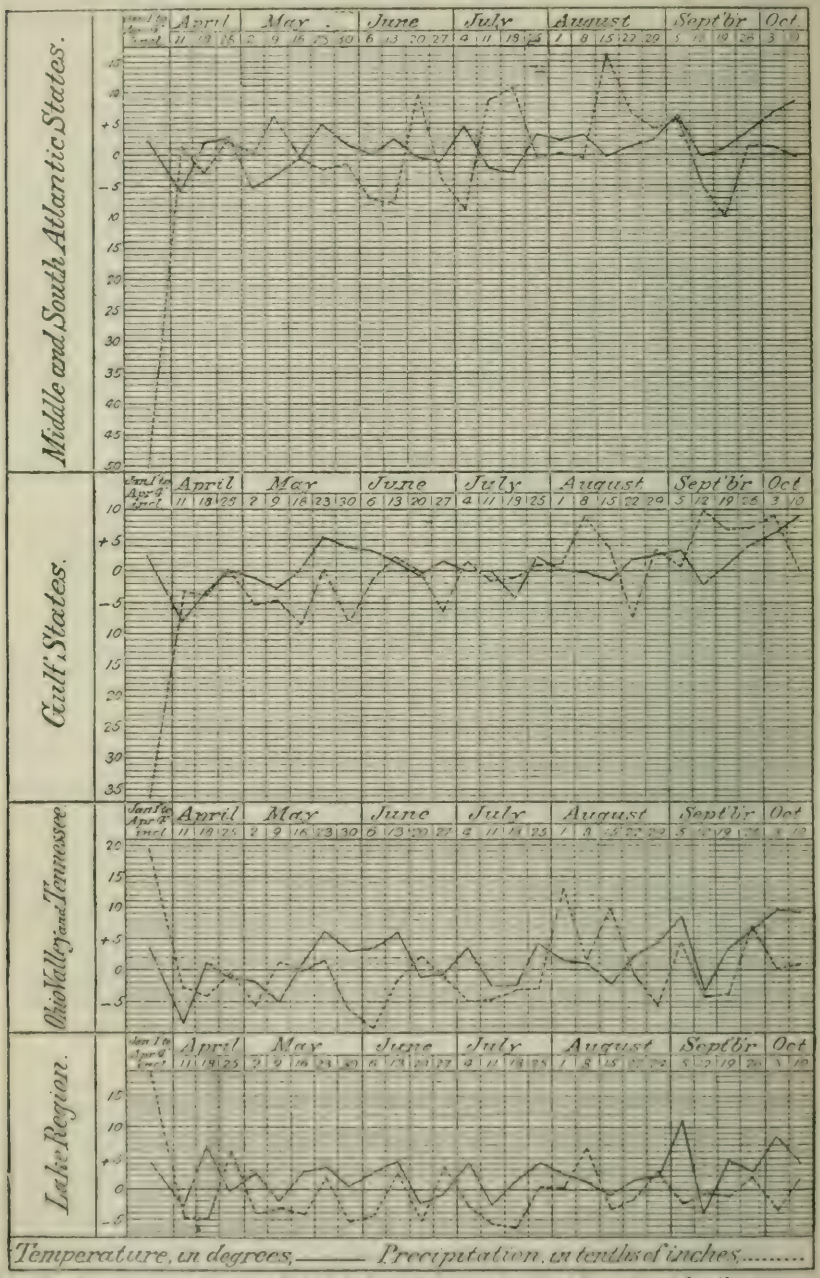

FIG. 129.—Temperature (degrees Fahr.) and precipitation (inches) departures for the season of 1898 from the normal of many years, for the Middle and South Atlantic States, the Gulf States, the Ohio Valley and Tennessee, and the Lake region.

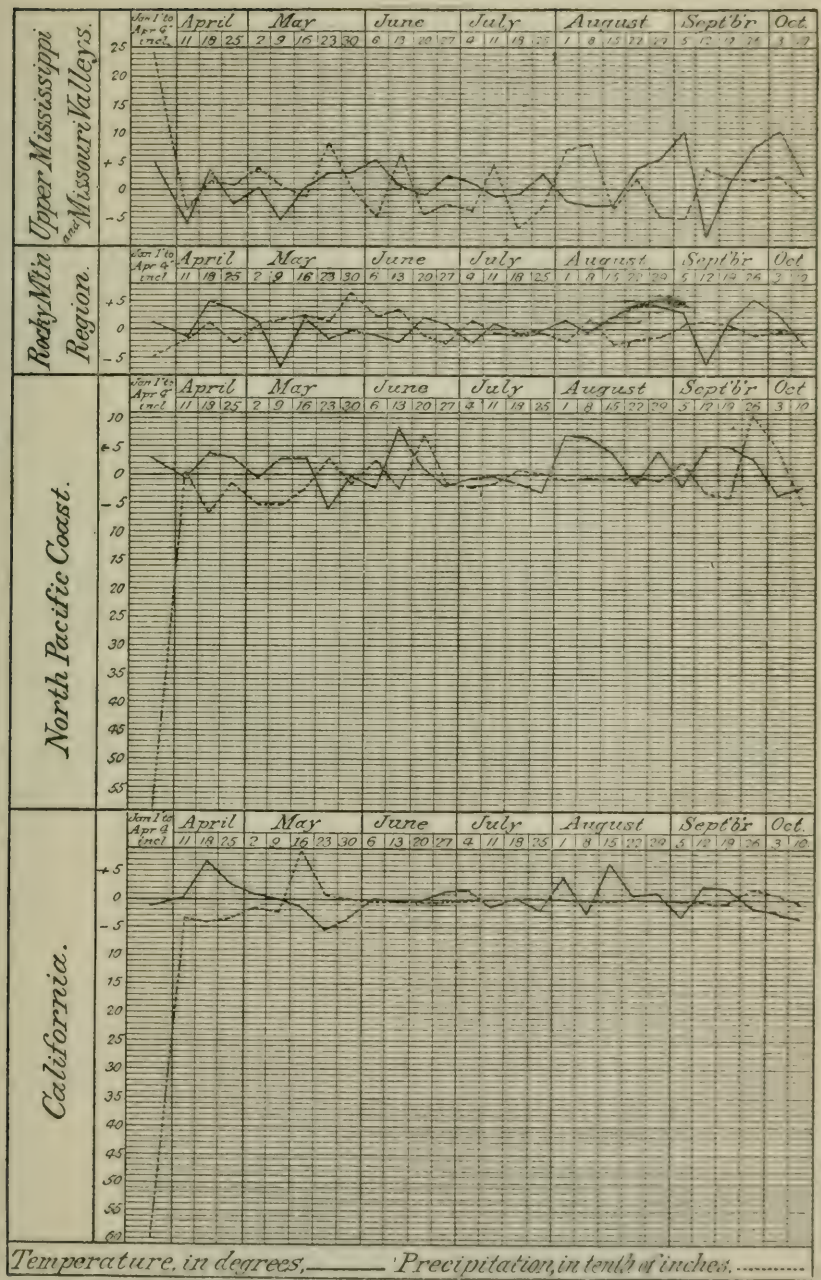

FIG. 130.—Temperature (degrees Fahr.) and precipitation (inches) departures for the season of 1898 from the normal of many years, for the Upper Mississippi and Missouri valleys, the Rocky Mountain region, the North Pacific coast, and California.

Average daily temperature departures (in degrees Fahrenheit) for the season of 1898 from the normal based upon observations for many years.

Sections.	From Jan. 1 to Apr. 4, inclusive.	For weeks ending—											
		April—			May—					June—			
		11.	18.	25.	2.	9.	16.	23.	30.	6.	13.	20.	27.
Middle and South Atlantic States	+2.5	−5.8	+2.0	+2.9	−5.2	−3.2	−0.6	+5.0	+1.6	0	+2.7	−0.3	+1.1
Gulf States	+2.7	−8.0	−3.3	0	−1.1	−2.6	0	+5.5	+3.8	+3.5	+1.5	+0.6	+1.6
Ohio Valley and Tennessee	+3.5	−8.6	+1.1	−1.4	−1.9	−5.1	+1.2	+6.2	+3.0	+3.5	+6.1	+1.1	+0.6
Lake Region	+4.3	−3.0	+7.0	−0.3	+2.6	−2.0	+2.6	+3.6	−0.3	+2.8	+4.8	−2.2	+3.7
Upper Mississippi and Missouri valleys	+5.1	−6.0	+3.5	−2.4	+0.4	−5.5	+0.3	+3.0	+3.0	+5.4	+0.5	+1.0	+2.3
Rocky Mountain Region	+1.2	−1.5	+5.0	+3.2	+1.2	−0.6	+1.8	−1.8	−0.4	−1.4	−2.1	−2.0	+0.8
North Pacific coast	+3.0	−0.7	+3.7	+2.7	−0.7	+2.7	+2.7	−6.0	−0.3	2.3	+8.3	+1.0	−2.0
California	−1.2	+0.4	+7.0	+2.8	+1.0	0	1.4	−5.6	−3.6	0	−0.4	−0.2	−1.6

Sections.	For weeks ending—														
	July—				August—					September—				October—	
	4.	11.	18.	25.	1.	8.	15.	22.	29.	5.	12.	19.	26.	3.	10
Middle and South Atlantic States	+4.4	−2.1	−3.0	+3.1	+2.3	+3.2	0.1	+1.2	+2.2	+6.2	−0.3	+0.8	+3.7	+6.6	+8.5
Gulf States	0	0	4.3	+2.2	0	−0.3	−1.4	+2.0	+2.5	+3.5	−2.1	+1.0	+4.1	6.1	+7.6
Ohio Valley and Tennessee	+3.5	−2.5	−2.4	+4.2	+1.6	+1.0	+2.2	2.2	+4.1	+8.6	3.4	+3.3	+6.7	9.5	+9.3
Lake Region	+4.4	−2.7	+1.1	+4.4	+2.3	+1.1	0.9	+1.4	+1.9	+10.9	−3.9	+4.7	+2.7	8.3	+4.3
Upper Mississippi and Missouri valleys	+1.2	−1.2	0.9	+2.8	2.1	−2.8	2.6	+3.8	+5.6	+10.5	−8.2	+1.2	+7.5	10.5	+2.5
Rocky Mountain Region	−2.6	1.0	0.9	0.2	+1.6	0.7	+2.0	+4.6	+4.0	+2.8	6.1	+1.3	+6.2	2.5	−2.8
North Pacific coast	0.7	0.3	1.7	3.3	+7.0	+6.3	+3.7	1.7	+4.0	+2.3	+5.0	+5.0	+2.7	3.7	+3.3
California	+1.6	1.4	+0.2	−2.0	+4.0	2.6	+6.4	+0.8	+1.4	3.0	+2.4	+2.0	−1.6	−2.4	−3.4

Precipitation departures (in inches and hundredths) for the season of 1898 from the normal based upon observations for many years.

Sections.	From Jan. 1 to Apr. 4, inclusive.	For weeks ending											
		April—			May—					June—			
		11.	18.	25.	2.	9.	16.	23.	30.	6.	13.	20.	27.
Middle and South Atlantic States	−5.03	+0.14	−0.29	+0.23	+0.04	+0.61	−0.67	−0.24	−0.14	−0.72	−0.78	+0.97	−0.40
Gulf States	−3.64	−.31	−.38	+.01	−.54	−.45	−.85	+.03	−.81	−.14	+.25	.00	.03
Ohio Valley and Tennessee	+1.95	−.26	−.42	−.04	−.59	+.13	−.01	+.17	.62	−.94	−.18	+.21	−.10
Lake Region	+1.88	−.48	−.49	+.59	−.40	−.32	−.42	+.18	.54	.42	+.25	−.52	+.37
Upper Mississippi and Missouri Valleys	+2.41	−.33	+.13	+.07	+.38	+.05	−.14	+.81	+.01	−.49	−.64	−.46	−.26
Rocky Mountain Region	−.49	−.14	+.10	−.24	+.10	+.17	+.22	+.11	+.04	+.23	+.36	−.12	+.26
North Pacific coast	−5.88	+.03	+.70	−.17	−.53	+.54	−.28	+.28	.18	+.24	−.27	+.70	−.19
California	−5.97	−.31	−.41	−.35	−.14	−.24	+.85	+.10	.00	−.03	−.04	−.05	−.02

Sections.	For weeks ending—														
	July—				August—					September—				October—	
	4.	11.	18.	25.	1.	8.	15.	22.	29.	5.	12.	19.	26.	3.	10.
Middle and South Atlantic States	−0.89	+0.88	+1.07	−0.08	+0.01	−0.09	+1.61	+0.66	+0.41	+0.58	−0.50	−1.02	+0.11	+0.11	−0.06
Gulf States	+.16	−.17	−.11	+.08	+.10	+.88	+.38	.75	+.35	+.05	+1.00	+.06	+.09	−.89	−.01
Ohio Valley and Tennessee	−.50	−.46	−.31	−.30	+1.31	+.17	+1.00	−.07	−.58	+.42	−.41	−.36	.71	+.02	+.08
Lake Region	−.28	.57	−.64	+.03	+.01	+.66	−.31	.17	+.26	−.23	−.05	.11	.17	−.36	+.15
Upper Mississippi and Missouri Valleys	−.19	+.41	−.69	−.31	+.71	+.80	−.33	+.18	−.48	−.51	+.35	+.20	.13	+.23	−.14
Rocky Mountain Region	+.15	−.06	−.12	−.10	−.21	+.18	−.27	−.18	−.13	+.08	+.12	+.06	−.12	−.05	−.10
North Pacific coast	.25	−.17	+.07	+.01	−.11	−.07	−.09	−.04	.12	+.21	−.34	.41	+1.07	+.43	+.53
California	−.02	+.01	.00	.00	.00	−.01	−.01	.00	.00	.00	−.04	−.06	+.20	−.09	−.07

Average daily temperature departures (in degrees Fahrenheit) for the season of 1898 from the normal based upon observations for many years.

Stations.	From Jan. 1 to Apr. 4, inclusive.	For weeks ending— April— 11.	18.	25.	May— 2.	9.	16.	23.	30.	June— 6.	13.	20.	27.
New England:													
Eastport, Me	+ 2.9	0	+ 4	+ 1	− 5	− 1	0	+ 3	− 1	− 1	− 1	− 1	+ 1
Portland, Me	+ 1.9	− 1	+ 5	− 2	− 5	− 2	− 1	+ 3	− 6	− 2	− 2	− 6	+ 3
Boston, Mass	+ 4.6	− 1	+ 5	− 1	− 5	− 4	+ 1	0	− 6	− 5	+ 4	− 2	+ 2
Middle Atlantic States:													
Albany, N. Y	+ 4.6	− 3	+ 8	− 1	− 1	− 5	− 2	+ 1	− 1	+ 1	+ 6	− 3	− 1
New York, N. Y	+ 2.8	− 4	+ 7	+ 2	− 4	− 8	− 3	+ 2	− 5	− 2	+ 3	− 1	− 1
Philadelphia, Pa	+ 4.3	− 4	+ 7	+ 3	− 4	− 8	+ 1	+ 3	− 2	− 1	+ 4	− 1	− 1
Washington, D. C	+ 3.0	− 6	+ 5	+ 3	− 6	− 7	+ 1	+ 5	+ 2	− 1	+ 5	− 1	− 3
Lynchburg, Va	+ 1.6	− 8	+ 1	+ 4	− 6	− 4	+ 1	+ 6	+ 2	0	+ 5	− 5	− 2
Norfolk, Va	+ 2.3	− 7	+ 2	+ 8	− 7	− 6	0	+ 3	+ 2	5	+ 1	− 2	− 2
South Atlantic States:													
Charlotte, N. C	+ 1.6	− 9	− 1	+ 3	− 5	+ 1	0	+10	+ 4	+ 2	+ 5	− 1	− 1
Wilmington, N. C	+ 1.4	− 7	− 1	+ 5	− 6	− 2	− 1	+ 6	+ 2	− 1	+ 2	+ 2	− 2
Charleston, S. C	+ 2.3	− 4	+ 1	+ 3	− 5	0	0	+ 5	+ 4	+ 1	0	+ 2	− 1
Augusta, Ga	+ 2.0	− 8	− 5	0	− 7	− 2	0	+ 8	+ 4	+ 4	+ 3	0	0
Savannah, Ga	+ 2.2	− 5	0	+ 3	− 6	+ 1	− 1	+ 6	+ 4	+ 2	0	+ 2	0
Jacksonville, Fla	+ 1.9	− 5	− 1	+ 2	− 5	+ 1	− 3	+ 5	+ 3	+ 1	− 2	+ 4	+ 1
Gulf States:													
Atlanta, Ga	+ 1.7	− 9	− 3	− 2	− 4	− 2	+ 3	+ 9	+ 4	+ 7	+ 5	0	+ 2
Mobile, Ala	+ 1.9	− 9	− 3	− 1	− 4	− 3	0	+ 3	+ 2	+ 3	+ 1	− 1	0
Montgomery, Ala	+ 1.9	− 9	− 4	− 1	− 4	− 1	+ 2	+ 7	+ 4	+ 6	+ 4	0	+ 1
Vicksburg, Miss	+ 2.9	− 9	− 4	− 2	− 2	− 4	0	+ 6	+ 4	+ 3	+ 2	− 2	+ 2
New Orleans, La	+ 2.0	− 9	− 3	0	− 3	− 3	− 1	+ 2	+ 3	+ 2	+ 2	0	+ 1
Shreveport, La	+ 3.3	− 7	− 5	+ 1	− 1	− 3	− 2	+ 5	+ 4	+ 2	+ 1	− 2	+ 1
Fort Smith, Ark	+ 5.0	− 7	− 2	− 1	0	− 3	+ 4	+ 5	+ 8	+ 6	+ 3	0	+ 4
Little Rock, Ark	+ 2.8	− 8	− 3	+ 1	− 2	− 2	+ 3	+ 7	+ 7	+ 5	+ 3	− 1	+ 3
Palestine, Tex	+ 3.5	− 6	− 5	+ 2	+ 2	− 3	0	+ 9	+ 3	+ 2	0	− 1	+ 2
Galveston, Tex	+ 2.0	− 6	− 3	+ 2	+ 1	− 3	− 4	+ 1	0	− 1	− 1	0	+ 1
San Antonio, Tex	+ 2.4	− 7	− 2	+ 2	+ 5	− 2	− 4	+ 6	+ 3	+ 4	− 4	0	+ 1
Ohio Valley and Tennessee:													
Memphis, Tenn	+ 4.1	− 9	0	0	− 3	− 2	+ 4	+ 5	+ 5	+ 5	+ 3	− 2	+ 1
Nashville, Tenn	+ 3.6	− 9	− 2	− 3	− 4	− 2	+ 2	+ 7	+ 4	+ 4	+ 6	0	0
Chattanooga, Tenn	+ 2.1	− 9	− 4	− 3	− 5	− 1	+ 1	+10	+ 5	+ 7	+ 5	0	+ 2
Louisville, Ky	+ 3.9	−10	+ 1	− 1	0	− 6	+ 1	+ 6	+ 2	+ 3	+ 7	0	− 2
Indianapolis, Ind	+ 3.8	− 8	+ 3	− 2	0	− 7	+ 1	+ 4	+ 1	+ 2	+ 5	− 2	− 1
Cincinnati, Ohio	+ 3.1	− 9	+ 1	− 1	− 1	− 7	0	+ 6	+ 1	+ 2	+ 7	− 1	− 2
Columbus, Ohio	+ 3.8	− 6	+ 4	− 2	− 1	− 9	0	+ 7	+ 3	+ 2	+ 8	− 2	− 1
Pittsburg, Pa	+ 3.7	− 9	+ 6	+ 1	− 1	− 7	+ 1	+ 5	+ 3	+ 3	+ 8	− 2	− 2
Lake Region:													
Oswego, N. Y	+ 4.0	− 2	+ 6	− 2	− 1	− 5	+ 2	+ 3	+ 2	0	+ 6	− 2	− 1
Buffalo, N. Y	+ 5.3	− 2	+ 9	+ 3	+ 3	− 2	+ 4	+ 6	+ 2	+ 1	+ 7	− 2	− 2

Cleveland, Ohio	+ 4.6	− 6	+ 6	− 1	+ 3	− 7	0	+ 6	− 1	0	+ 8	− 5	− 1
Detroit, Mich	+ 2.4	− 5	+ 8	− 1	+ 2	− 4	+ 2	+ 4	+ 2	+ 2	+ 8	− 5	0
Alpena, Mich	+ 5.1	− 1	+ 9	+ 2	+ 3	0	+ 4	+ 6	+ 1	+ 3	+ 3	− 4	+ 3
Grand Haven, Mich	+ 4.1	− 3	+ 7	− 1	+ 3	− 3	+ 1	+ 4	− 1	+ 4	+ 6	− 2	− 3
Milwaukee, Wis	+ 4.1	− 2	+ 7	− 1	+ 3	0	+ 4	+ 3	0	+ 6	+ 3	0	+ 2
Chicago, Ill	+ 3.8	− 5	+ 3	− 3	+ 3	− 5	+ 2	+ 2	− 2	+ 5	+ 5	− 3	0
Duluth, Minn	+ 5.7	0	+ 7	+ 1	+ 4	+ 8	+ 4	− 2	0	+ 1	− 3	+ 3	− 4
Upper Mississippi Valley:													
St. Paul, Minn	+ 7.6	− 1	+ 5	− 3	+ 3	+ 1	0	0	0	+ 5	− 1	0	+ 1
La Crosse, Wis	+ 4.7	− 3	+ 4	− 4	+ 2	− 1	− 1	0	0	+ 6	+ 1	− 2	+ 1
Davenport, Iowa	+ 4.2	− 4	+ 5	− 3	+ 3	− 4	− 2	+ 3	+ 3	+ 7	+ 4	− 2	− 2
Des Moines, Iowa	+ 5.2	− 3	+ 5	− 3	0	− 6	− 4	+ 5	+ 5	+ 7	0	− 2	+ 3
Springfield, Ill	+ 4.1	− 7	+ 2	− 4	0	− 9	+ 1	+ 4	+ 4	+ 6	+ 4	− 3	+ 1
Cairo, Ill	+ 3.7	− 9	+ 1	− 1	0	− 4	+ 2	+ 5	+ 4	+ 4	+ 5	0	+ 1
St. Louis, Mo	+ 4.4	− 8	+ 4	− 2	+ 2	− 7	+ 2	+ 5	+ 4	+ 5	+ 4	− 1	+ 1
Missouri Valley:													
Springfield, Mo	+ 3.2	−11	− 1	− 3	− 3	− 7	+ 5	+ 8	+ 7	+ 6	+ 1	− 1	+ 1
Kansas City, Mo	+ 4.8	− 5	+ 4	− 2	0	− 8	0	+ 4	+ 5	+ 6	+ 2	− 1	+ 3
Concordia, Kans	+ 4.9	− 8	+ 2	− 1	− 2	− 9	+ 2	+ 5	+ 2	+ 6	− 4	6	+ 7
Omaha, Nebr	+ 5.5	− 4	+ 5	− 1	− 1	− 7	− 2	+ 2	+ 3	+ 4	− 1	− 1	+ 4
Valentine, Nebr	+ 4.3	− 8	+ 6	− 2	+ 1	− 7	0	3	+ 1	+ 4	− 6	+ 1	+ 5
Huron, S. Dak	+ 9.1	− 6	+ 4	− 2	0	− 4	+ 1	+ 1	+ 2	+ 4	− 2	0	+ 4
Extreme Northwest:													
Moorhead, Minn	+10.0	+ 2	+ 6	− 2	+ 1	− 1	− 1	0	+ 2	+ 3	− 5	− 3	+ 3
Bismarck, N. Dak	+ 6.6	+ 1	+ 6	− 2	0	− 3	0	− 2	− 1	+ 2	− 2	+ 4	+ 2
Williston, N. Dak	+ 3.9	− 2	+ 3	− 1	0	− 1	+ 2	+ 1	0	− 4	− 2	+ 3	+ 1
Rocky Mountain slope:													
Havre, Mont	+ 2.7	− 4	+ 4	− 1	0	− 2	+ 4	− 1	− 4	− 6	+ 2	+ 4	− 1
Helena, Mont	+ 2.3	0	+ 9	+ 2	− 1	− 3	+ 4	− 3	− 4	−10	+ 4	+ 6	− 1
Spokane, Wash	+ 2.4	+ 1	+ 6	0	+ 1	− 1	+ 3	− 3	− 5	− 5	+ 9	+ 3	− 2
Salt Lake City, Utah	− 3.5	+ 3	+10	+ 5	+ 2	− 7	+ 4	− 6	− 4	− 9	+ 1	+ 7	+ 1
Cheyenne, Wyo	0	− 2	+ 7	+ 3	+ 3	−12	+ 1	− 3	+ 1	+ 1	− 4	+ 3	+ 2
North Platte, Nebr	+ 4.6	− 5	+ 5	+ 1	− 3	−10	0	− 1	+ 1	+ 3	− 6	0	+ 3
Denver, Colo	+ 0.7	− 2	+ 7	+ 5	+ 1	−14	+ 1	− 2	+ 1	0	− 4	+ 1	+ 4
Dodge, Kans	+ 2.9	− 3	+ 4	+ 3	+ 1	−10	+ 1	+ 2	+ 1	+ 4	− 6	+ 1	+ 3
Abilene, Tex	+ 3.5	− 6	− 2	+ 3	+ 4	− 8	0	+ 4	+ 6	+ 6	− 4	− 3	+ 1
Santa Fe, N. Mex	− 0.4	+ 1	+ 4	+ 5	+ 1	− 5	+ 1	− 3	+ 2	+ 1	− 9	+ 1	0
El Paso, Tex	− 0.6	− 3	− 1	+ 7	+ 1	− 4	− 1	− 2	+ 3	0	− 8	− 2	− 3
Phenix, Ariz	0.6	+ 2	+ 6	+ 6	+ 5	− 3	+ 1	− 4	− 2	− 2	0	+ 3	+ 3
Pacific coast:													
Seattle, Wash	+ 1.2	0	+ 1	+ 2	0	+ 5	+ 1	− 4	+ 5	0	+ 8	+ 1	− 1
Portland, Oreg	+ 0.2	2	+ 4	+ 2	0	+ 2	+ 3	− 7	− 2	− 3	+ 8	+ 1	− 3
Roseburg, Oreg	− 0.5	0	+ 6	+ 4	− 2	+ 1	+ 1	− 7	− 4	− 4	+ 9	+ 1	− 2
Red Bluff, Cal	− 1.0	+ 1	+11	+ 5	+ 4	+ 5	+ 1	−10	− 7	− 5	+ 3	− 2	+ 3
Sacramento, Cal	− 1.6	+ 1	+ 9	+ 3	+ 1	+ 1	− 2	− 7	− 5	− 2	− 1	− 1	+ 4
San Francisco, Cal	− 1.8	− 2	+ 5	0	− 2	− 4	− 5	− 4	− 3	+ 3	− 4	+ 1	+ 2
Los Angeles, Cal	0	+ 2	+ 8	+ 4	+ 3	− 2	− 1	− 4	− 1	+ 3	+ 1	+ 2	0
San Diego, Cal	− 1.4	0	+ 2	+ 2	− 1	0	0	− 3	− 2	+ 1	− 1	− 1	− 1

Average daily temperature departures (in degrees Fahrenheit) for the season of 1898 from the normal based upon observations for many years—Continued.

Stations.	For weeks ending—														
	July—				August—					September—				October—	
	4.	11.	18.	25.	1.	8.	15.	22.	29.	5.	12.	19.	26.	3.	10.
New England:															
Eastport, Me	+2	0	0	−3	−1	+1	0	0	+1	+2	+3	+1	−3	+2	+1
Portland, Me	+2	−3	−4	−1	+1	+3	+1	+3	+4	+6	+4	+1	−3	+4	+2
Boston, Mass	+3	−2	−3	+1	+3	+4	0	+4	+6	+10	+5	+3	−1	+6	+6
Middle Atlantic States:															
Albany, N. Y	+4	−2	−1	+7	+6	+4	0	+2	+3	+12	+1	+3	0	+8	+7
New York, N. Y	+5	−2	−2	+1	+4	+3	−1	+2	+3	+11	+2	+3	−1	+8	+6
Philadelphia, Pa	+7	−2	−1	+4	+6	+4	−1	+3	+5	+11	+3	+3	+1	+7	+9
Washington, D. C	+7	−3	−2	+4	+6	+4	−1	+2	+3	+10	−1	+3	+4	+5	+10
Lynchburg, Va	+5	−4	−5	+3	+2	+3	0	+2	+4	+5	−2	+1	+4	+7	+11
Norfolk, Va	+5	−1	−3	+1	+2	+4	+2	+2	+4	+7	0	0	+4	+6	+9
South Atlantic States:															
Charlotte, N. C	+6	−2	−5	+3	+2	+8	0	0	+2	+3	−2	−1	+5	+7	+9
Wilmington, N. C	+3	−3	−3	+2	0	+2	0	0	+1	+4	−2	0	+6	+6	+8
Charleston, S. C	+3	−2	−3	+3	0	+2	0	0	0	+3	0	−1	+5	+6	+8
Augusta, Ga	+4	−1	−5	+3	0	+1	−1	+1	0	+2	−3	−1	+6	+8	+9
Savannah, Ga	+2	−2	−4	+3	0	+1	0	0	+1	+2	0	−1	+6	+6	+9
Jacksonville, Fla	+2	−1	−2	+3	0	+1	+1	0	+1	+4	0	0	+4	+5	+7
Gulf States:															
Atlanta, Ga	+4	0	−4	+1	−1	+1	−1	+1	+3	+2	−2	0	+6	+7	+8
Mobile, Ala	0	−1	−4	+3	+1	−1	−3	0	+1	+2	−1	0	+3	+4	+9
Montgomery, Ala	+3	−1	−6	+2	0	−1	−2	0	0	+2	−3	−1	+4	+6	+9
Vicksburg, Miss	−1	−1	−6	+1	−2	−1	−1	+3	+2	+3	−2	+3	+2	+6	+10
New Orleans, La	0	−1	−3	+1	0	−2	−2	+2	+1	+1	+2	+1	+4	+3	+8
Shreveport, La	−2	+1	−5	+2	0	−1	−2	+2	+2	+3	−3	+2	+3	+6	+10
Fort Smith, Ark	+1	+4	−4	+4	+2	0	−2	+4	+7	+9	−5	+2	+1	+12	+9
Little Rock, Ark	+1	+1	−5	+3	−1	0	−1	+4	+5	+8	−3	0	+5	+7	+9
Palestine, Tex	−2	0	−4	+3	−1	0	−1	+2	+4	+5	−4	+2	+5	+7	+10
Galveston, Tex	−3	−2	−2	0	0	0	−1	+1	+1	+1	−2	0	+2	+3	+6
San Antonio, Tex	−2	0	−4	+4	+1	+2	+1	+2	+2	+3	−2	+2	+4	+6	+9
Ohio Valley and Tennessee:															
Memphis, Tenn	+1	−2	−7	+2	−1	0	−3	+3	+4	+7	−2	+1	+7	+9	+12
Nashville, Tenn	+2	−2	−3	+3	0	0	−4	+2	+4	+6	−2	+3	+7	+10	+11
Chattanooga, Tenn	+4	−2	−3	+2	+1	+2	−1	+2	+5	+4	0	1	+6	+8	+10
Louisville, Ky	+3	−3	−2	+5	+2	+1	−3	+3	+4	+9	−5	+3	+7	+11	+9
Indianapolis, Ind	+2	−4	−1	+6	0	+1	−3	−1	+4	+11	−6	+3	+8	+10	8
Cincinnati, Ohio	+3	−3	−2	+5	+2	+1	−2	+3	+4	+10	−5	+4	+7	+10	+8
Columbus, Ohio	+7	−1	0	+6	+3	+2	−1	+3	+5	+11	−4	+4	+5	+10	+8
Pittsburg, Pa	+6	−3	−1	+5	+4	+1	−1	+3	+3	+11	−3	+4	+3	+8	+8

Lake Regions:															
Oswego, N. Y	+5	−2	−2	+8	+6	+3	0	+2	+2	+11	−2	+4	−1	+9	+6
Buffalo, N. Y	−4	−2	+1	+8	+5	+4	+1	+3	+2	+10	−2	+7	+2	+13	+7
Cleveland, Ohio	+6	−3	−1	+6	+2	+2	−1	+1	+3	+11	−4	+5	+2	+9	+6
Detroit, Mich	+4	−4	+1	+5	+1	+3	−1	+2	+3	+14	−2	+4	+2	+11	+6
Alpena, Mich	+6	−5	+3	+6	+2	+1	−1	+2	−1	+14	−4	+6	+3	+11	+4
Grand Haven, Mich	+3	−4	+1	+3	+3	−1	−1	0	+3	+10	−5	+4	+3	+10	+3
Milwaukee, Wis	+7	−1	+2	+2	+2	0	−1	+1	+4	+12	−5	+5	+4	+9	+4
Chicago, Ill	+6	−2	+1	+2	+1	−1	−2	−1	+3	+11	−5	+3	+4	+9	+4
Duluth, Minn	−1	−1	+4	0	−1	−1	−2	+3	−2	+5	−6	+4	+5	+10	−2
Upper Mississippi Valley:															
St. Paul, Minn	−2	0	+5	+3	−3	−2	−3	+3	+1	+12	−8	+2	+9	+11	0
La Crosse, Wis	−2	−1	+2	+2	−2	−3	−4	+1	+2	+11	−8	+2	+5	+9	+2
Davenport, Iowa	+2	−1	0	+4	−1	−3	−3	+1	+4	+10	−8	+4	+7	+10	+4
Des Moines, Iowa	+2	−1	−1	+3	−3	−3	−2	+6	+5	+11	−7	+1	+8	+11	0
Springfield, Ill	+3	−4	−1	+3	−1	−2	−4	+3	+6	+10	−7	+3	+6	+10	+5
Cairo, Ill	+3	−2	−4	+3	−1	−1	−3	+2	+5	+8	−3	+3	+7	+10	+11
St. Louis, Mo	+4	−4	−3	+4	−2	−3	−3	+3	+7	+12	−7	+3	+8	+11	+7
Missouri Valley:															
Springfield, Mo	+1	+1	−5	+2	−2	−4	−4	+3	+8	+8	−7	0	+6	+13	+10
Kansas City, Mo	+3	−2	−3	+3	0	−4	−2	+4	+7	+10	−9	+2	+10	+13	+3
Concordia, Kans	+4	+1	−4	+4	−2	−2	0	+8	+12	+13	−10	−2	+5	+14	+2
Omaha, Nebr	+2	−3	−2	+3	−4	−4	−3	+7	+5	+11	−10	0	+10	+11	−2
Valentine, Nebr	2	−2	+2	+2	−2	−5	−2	+3	+7	+9	−12	−2	+7	+7	−4
Huron, S. Dak	3	+2	+3	+1	−4	−1	−1	+6	+4	+11	−10	0	+10	+6	−5
Extreme Northwest:															
Moorhead, Minn	−6	0	+8	−3	−2	0	−3	+3	−1	+7	−9	+3	+8	+8	−5
Bismarck, N. Dak	−7	+1	+9	−2	−3	0	−1	+7	+2	+1	−10	+1	+9	+5	−6
Williston, N. Dak	−8	0	+9	−6	−5	−1	−2	+8	+3	0	−9	+2	+7	+1	−12
Rocky Mountain Slope:															
Havre, Mont	−7	+5	+9	−7	−2	+1	+6	+9	+5	−1	−4	+6	+9	3	−20
Helena, Mont	−10	+1	+2	−7	+1	−1	+8	+4	+4	−6	−3	+7	+6	−9	−8
Spokane, Wash	−3	+2	+1	−5	+2	+6	+9	+2	+5	−3	+5	+8	+3	−6	−9
Salt Lake City, Utah	−6	+5	+1	−1	+2	−2	+2	+5	+5	0	1	+2	+7	−6	−7
Cheyenne, Wyo	−3	+1	0	+1	0	−4	+1	+6	+6	+6	−2	+1	+9	+5	−4
North Platte, Nebr	+1	−2	−2	+2	−2	−3	−1	+5	+6	+9	12	−4	+8	+7	−4
Denver, Colo	−1	+2	0	+3	+1	−3	+2	+5	+4	+5	−13	−2	+8	+7	−4
Dodge, Kans	0	−1	−6	+4	+1	−2	0	+7	+5	+8	−13	−3	+7	+10	−1
Abilene, Tex	3	+1	−8	+2	+1	0	−4	+4	+4	+6	−9	+1	+3	+10	−10
Santa Fe, N. Mex	+1	−2	−5	+2	+5	0	0	+3	+3	+4	−7	−1	+1	+6	−5
El Paso, Tex	−5	−1	−6	0	+2	0	−5	+1	+1	+5	−4	−2	+3	+6	−5
Phenix, Ariz	−5	1	+3	+3	+7	0	+6	+4	0	0	+3	+3	+5	+7	0
Pacific Coast:															
Seattle, Wash	+1	1	0	0	+6	+7	+4	−1	+4	1	+8	+6	+3	1	1
Portland, Oreg	−1	0	−2	−5	+7	+6	+3	−2	+4	−3	+5	+4	+3	−5	2
Roseburg, Oreg	−2	0	−3	−5	+8	+6	+4	−2	+4	−3	+2	+5	+2	−5	4
Red Bluff, Cal	+3	0	−1	−3	+10	−4	+10	−1	0	−9	2	+4	+3	−3	7
Sacramento, Cal	+4	−2	0	−2	+8	−6	+12	+1	+1	−4	0	+3	−2	−4	−6
San Francisco, Cal	+2	−4	−2	−2	−2	−2	+1	−3	−2	−1	1	−4	0	−2	2
Los Angeles, Cal	0	0	+4	−1	+3	0	+7	+4	+4	0	+6	+4	−1	−1	1
San Diego, Cal	−1	−1	0	−2	+1	1	+2	+3	+4	−1	+5	+3	−2	0	2

Precipitation departures (in inches and hundredths) for the season of 1898 from the normal based upon observations for many years.

Stations.	From Jan. 1 to Apr. 4, inclusive.	For weeks ending— April 11.	April 18.	April 25.	May 2.	May 9.	May 16.	May 23.	May 30.	June 6.	June 13.	June 20.	June 27.
New England:													
Eastport, Me	+ 2.83	−0.49	−0.09	+0.62	+0.04	−0.73	−0.73	−0.38	+0.45	0.11	+0.37	+0.23	−0.51
Portland, Me	+ 4.58	− .05	− .17	+1.74	− .04	− .46	− .74	− .65	+1.18	− .13	+ .83	+ .85	− .72
Boston, Mass	− 1.88	− .34	+ .30	+2.59	+ .47	− .38	− .41	− .68	+2.54	− .15	− .69	+ .03	− .51
Middle Atlantic States:													
Albany, N. Y	− .91	− .31	+ .02	+ .89	− .29	+ .37	− .06	− .34	+1.17	− .83	+1.30	+2.03	− .41
New York, N. Y	− 1.38	− .44	− .40	+1.05	− .10	+1.29	+ .82	− .25	+ .83	− .70	− .46	− .35	− .31
Philadelphia, Pa	− .28	− .34	− .33	+ .37	+ .42	+1.06	+ .83	+ .49	− .45	− .71	− .51	− .40	− .33
Washington, D. C	− 3.80	− .25	− .11	− .03	− .34	+1.24	− .57	− .05	− .65	− .91	− .80	− .84	− .63
Lynchburg, Va	− 5.25	+ .62	+ .08	− .19	− .73	+4.24	+ .42	+1.29	− .42	− .74	− .50	+1.37	− .54
Norfolk, Va	− 6.40	+ .46	+ .22	.00	+2.24	+ .71	− .23	+ .15	+ .44	− .64	− .98	+1.30	− .98
South Atlantic States:													
Charlotte, N. C	− 6.19	+ .34	− .56	+ .24	− .59	− .92	− .54	− .44	− .21	− .79	−1.05	+2.27	− .70
Wilmington, N. C	− 5.36	+ .76	− .45	− .52	− .16	− .85	+ .11	− .69	+ .01	− .70	−1.30	+ .64	+ .42
Charleston, S. C	− 9.34	+ .01	− .57	− .18	− .12	− .81	− .88	− .85	− .59	− .97	−1.26	+1.66	+ .22
Augusta, Ga	− 8.33	+1.73	− .45	+ .59	+ .06	− .47	− .77	− .58	− .79	− .84	−1.07	+1.08	+ .51
Savannah, Ga	− 7.69	− .60	− .68	+ .04	+ .48	− .37	− .42	− .69	− .93	− .44	−1.55	+2.82	+ 1.59
Jacksonville, Fla	− 5.38	− .35	− .23	+ .51	− .45	− .59	− .56	− .95	− .12	− .37	−1.22	− .38	− .50
Gulf States:													
Atlanta, Ga	− 9.17	+1.63	− .73	+1.33	− .56	− .59	− .77	− .51	− .15	− .74	− .64	− .48	−1.02
Mobile, Ala	− 8.05	− .72	−1.00	+ .50	− .84	− .91	− .88	−1.00	− .31	−1.25	+ .84	+ .40	− .57
Montgomery, Ala	−11.44	+1.57	−1.07	+ .33	−1.03	− .72	− .59	− .89	− .93	− .90	− .91	− .37	− .77
Vicksburg, Miss	− 2.22	− .76	−1.14	+ .57	−1.25	− .62	−1.12	− .72	− .72	− .73	− .81	+2.63	− .87
New Orleans, La	− 6.49	− .42	−1.05	+ .09	−1.17	−1.07	−1.05	−1.66	−1.19	− .96	−1.17	− .42	−1.57
Shreveport, La	− 3.57	−1.19	− .70	− .81	+ .14	− .86	− .93	− .69	− .66	+ .48	− .21	+1.90	− .84
Fort Smith, Ark	+ 4.68	− .81	− .38	− .14	− .15	+2.15	− .91	+2.25	−1.05	+ .25	+ .58	− .74	+1.46
Little Rock, Ark	− 3.71	− .42	−1.01	+ .46	+1.33	− .03	−1.33	+2.36	− .89	+ .56	− .39	− .68	− .61
Palestine, Tex	+ .26	−1.01	+ .06	−1.00	1.04	−1.02	−1.33	+1.56	−1.27	+ .57	+1.25	− .46	− .77
Galveston, Tex	+ 2.66	− .63	+2.14	− .50	− .79	− .74	− .46	− .91	−1.01	+ .82	−1.10	−1.20	− .86
San Antonio, Tex	− 2.98	− .63	+ .65	− .73	− .67	− .50	+ .01	− .68	− .70	+ .38	+5.26	− .62	− .52
Ohio Valley and Tennessee:													
Memphis, Tenn	+ .48	− .73	−1.17	− .18	+ .20	− .82	−1.01	+1.95	− .97	−1.05	− .76	+ .54	− .48
Nashville, Tenn	+ .27	+ .32	− .65	− .47	− .65	− .06	− .67	+ .16	− .80	− .93	+ .27	+2.07	−1.01
Chattanooga, Tenn	−9.77	+ .96	− .62	+ .72	− .43	− .82	− .50	− .88	−1.01	− .96	+ .74	− .29	+ .04
Louisville, Ky	+8.10	+ .05	− .22	− .30	− .96	+1.39	− .61	+ .61	− .50	− .97	− .69	+ .11	+1.56
Indianapolis, Ind	+5.68	− .82	− .26	− .20	− .85	− .26	− .25	+ .08	− .76	−1.04	+ .09	− .79	− .84
Cincinnati, Ohio	+5.84	− .57	− .32	− .21	− .77	+1.01	+ .30	− .72	− .64	− .89	− .52	−1.06	− .17
Columbus, Ohio	+3.58	− .68	+ .03	+ .19	− .54	+ .28	+1.87	− .41	+ .45	− .90	− .20	− .58	.00
Pittsburg, Pa	+1.41	− .37	− .13	+ .14	− .72	+ .30	+ .77	+ .58	− .74	− .78	− .38	+1.69	+ .06
Lake region:													
Oswego, N. Y	+1.64	− .47	− .35	+1.46	− .33	+ .59	+ .33	+ .49	+ .01	− .76	− .28	− .74	− .51
Buffalo, N. Y	+ .78	− .56	− .50	+ .65	− .55	− .54	− .17	− .06	− .75	− .84	− .49	− .29	+ .02

Cleveland, Ohio	+1.73	-.48	-.48	+1.06	-.60	-.17	-.17	-.01	-.90	-.91	+.04	-.63	+.34
Detroit, Mich	+2.97	-.49	-.33	+.54	-.48	-.56	-.45	+.09	-.70	-.90	+1.24	+.39	+.37
Alpena, Mich	+1.76	-.40	-.46	+.76	+.03	-.03	-.42	-.29	-.42	-.03	+.58	-.43	+1.42
Grand Haven, Mich	+3.69	-.55	-.53	+.81	-.20	-.69	-.59	+.92	-.81	-.82	+.55	-.95	-.25
Milwaukee, Wis	+3.52	-.59	-.61	+.86	-.52	-.52	-.41	+.03	-.81	-.88	+.31	+.98	+.15
Chicago, Ill	+3.56	-.27	-.67	-.56	-.65	-.26	-.72	+.14	-.26	-.90	+1.30	-.61	+1.91
Duluth, Minn	-2.10	-.52	-.53	-.27	-.33	-.71	-.79	+.22	-.10	+2.27	-1.04	-1.05	-.11
Upper Mississippi Valley:													
St. Paul, Minn	+.13	-.43	-.51	+.14	-.18	-.68	-.75	+1.31	-.03	-.13	-.12	-.81	-.46
La Crosse, Wis	.27	-.31	+.38	+1.24	-.47	-.52	-.72	-.02	-.65	-.84	+.34	-1.01	-.81
Davenport, Iowa	+4.67	-.35	+.65	+.38	-.19	-.53	-.13	+1.51	+1.77	-.85	+1.36	-1.02	-.14
Des Moines, Iowa	-.59	-.47	+.71	+.31	-.46	+.16	-.76	-.04	+.36	+.35	+2.59	-.61	-.58
Springfield, Ill	+9.89	-.53	-.20	+.38	+.39	-.46	+.27	+1.26	.63	-.82	+1.41	+.20	-.28
Cairo, Ill	+5.33	-.39	-.71	-.63	+.13	+1.27	-.83	+.78	+.48	-.99	-.68	-.82	-.17
St. Louis, Mo	+6.18	-.11	+.19	-.15	+1.41	+.14	+.15	+.81	+1.78	-1.20	-.43	+.19	+.47
Missouri Valley:													
Springfield, Mo	+5.17	-.19	-.26	+.44	+1.43	+2.10	-1.15	+.72	-1.31	-.78	+.74	-.32	+2.22
Kansas City, Mo	+5.19	-.50	-.03	+.43	+2.45	-.13	+2.14	-.20	-.70	-.31	+1.33	+.43	-.05
Concordia, Kans	1.04	-.42	+.70	-.06	-.52	-.04	+.69	-.28	-.44	+.70	+.32	-.67	-.71
Omaha, Nebr	.41	-.63	+.70	-.37	-.36	-.05	-.22	+1.06	-.63	+.28	+1.97	-.90	-1.35
Valentine, Nebr	1.68	-.63	+.24	-.60	-.24	+.05	+.57	+2.05	+.25	-.57	+.01	+.21	-.76
Huron, S. Dak	1.22	-.68	-.21	-.51	+1.50	-.64	-.65	+1.63	-.17	-.23	-.51	-.84	-.82
Extreme Northwest:													
Moorhead, Minn	.64	-.37	-.52	+.10	+1.30	-.54	-.56	+1.08	+.53	+.83	-.99	-1.16	-.78
Bismarck, N. Dak	.75	-.48	-.53	-.21	+.12	-.46	-.56	+1.59	-.25	-.48	-.94	-.84	+.22
Williston, N. Dak	+.41	-.25	-.12	+.08	-.03	-.42	-.42	-.13	+.17	+.55	-.61	-.07	+1.44
Rocky Mountain slope:													
Havre, Mont	-.68	-.19	+.66	-.19	+.28	-.28	-.34	+.44	-.37	+.73	-.46	-.72	-.34
Helena, Mont	+.31	-.19	-.14	-.24	+.10	-.07	+1.58	+.66	+1.18	+.93	-.48	-.03	-.30
Spokane, Wash	1.38	-.24	-.33	-.10	.31	-.21	.28	.10	+.96	-.25	-.46	-.26	-.27
Salt Lake City, Utah	1.84	.54	-.54	+.25	+.12	+.79	-.24	+.80	+.72	+.63	-.08	-.15	+.28
Cheyenne, Wyo	.58	.28	-.26	-.32	+.70	+.45	+.49	-.20	+.20	+.57	+.95	.31	-.32
North Platte, Nebr	-.23	-.44	+.18	-.56	+.60	-.06	.19	+1.61	-.20	+.08	-.11	+.07	-.67
Denver, Colo	-.47	-.24	-.13	-.54	+.50	+.95	-.38	-.35	+1.06	+.05	+.16	-.28	-.32
Dodge, Kans	-.53	-.29	+.11	-.15	+.24	+.44	+1.18	-.29	+5.38	+.88	+1.40	+.05	-.77
Abilene, Tex	.50	+.18	+.41	-.72	-.77	+.15	+.90	-.84	-.84	-.58	+1.89	+.41	-.65
Santa Fe, N. Mex	+.10	+.28	+.69	-.16	-.19	-.03	-.25	-.28	-.21	-.21	+1.28	.20	-.09
El Paso, Tex	.67	+.10	+.49	-.05	-.07	-.07	.09	-.14	-.14	-.08	+.14	-.06	+.14
Phenix, Ariz	-.52	-.07	+.11	-.07	-.06	-.07	-.07	.00	.00	.00	+.07	.00	-.03
Pacific coast:													
Seattle, Wash	-4.18	.12	-.70	-.32	.54	-.58	.48	+.16	.36	+.23	.32	+1.22	-.28
Portland, Oreg	-6.54	+.10	-.77	+.17	-.53	-.56	-.02	+.19	-.20	+.25	-.25	+.45	-.16
Roseburg, Oreg	-6.92	+.10	-.63	-.37	-.52	-.49	.34	+.48	+.01	+.23	-.35	+.44	-.12
Red Bluff, Cal	-5.53	-.31	-.50	-.45	-.42	+.36	+.78	+.63	.02	-.10	.00	.10	+.07
Sacramento, Cal	6.01	.32	-.56	-.50	-.41	-.31	+.87	-.04	+.09	-.07	-.07	-.04	.00
San Francisco, Cal	8.35	-.35	-.49	-.40	-.30	-.26	+1.10	-.05	.01	+.11	.06	.07	.04
Los Angeles, Cal	6.71	-.39	-.30	-.24	+.13	-.14	+1.33	-.07	-.07	-.07	-.04	.00	.00
San Diego, Cal	3.26	.12	-.19	-.14	+.29	-.14	+.16	+.01	-.01	.00	-.02	-.02	.00

Precipitation departures (in inches and hundredths) for the season of 1898 from the normal based upon observations for many years—C'f'd.

Stations.	For weeks ending—														
	July—				August—					September—				October—	
	4.	11.	18.	25.	1.	8.	15.	22.	29.	5.	12.	19.	26.	3.	10.
New England:															
Eastport, Me	−0.84	−0.88	−0.56	−0.66	−0.78	+0.09	−0.62	0.25	−0.21	+0.63	−0.67	−0.57	+0.22	−0.44	−0.48
Portland, Me	−.73	−.75	.00	−.17	−.57	+.16	−.38	−.36	+1.02	−.39	+.11	−.58	+1.38	−.65	−.36
Boston, Mass	−.71	+.05	+1.49	−.17	−.08	+.16	+1.38	+1.00	−.23	.49	.08	.59	.49	.53	+.59
Middle Atlantic States:															
Albany, N. Y	−.75	−.79	−.91	−.43	−.38	+.85	−.34	+.13	+2.25	−.62	−.12	−.55	−.38	−.70	+.77
New York, N. Y	.62	−.12	+1.00	.74	+.69	−.14	+.02	.30	−.73	−.90	−.70	−.39	+.10	−.79	+.38
Philadelphia, Pa	.02	+.19	−.51	.51	+.63	+5.73	+.65	−.50	−.77	−.81	−.54	−.46	+.31	−.52	−.55
Washington, D. C	−.20	−.69	−.90	+.66	+.22	+.17	+6.26	−.59	−.68	.89	−.85	−.72	−.15	−.65	−.54
Lynchburg, Va	−.67	−.20	+2.17	+1.33	+.32	.02	+.80	−.91	.69	.77	−.74	−.91	+2.35	+.27	+.82
Norfolk, Va	+.11	+1.90	−.25	+.89	+.89	−.97	+5.09	−1.17	−.88	.26	+.06	−.95	+.99	−.89	+.30
South Atlantic States:															
Charlotte, N. C	−1.10	−.03	−.48	−.29	+.58	−1.18	+.06	+5.13	−.46	+.77	−.01	−.71	+1.10	−.37	+.95
Wilmington, N. C	−.98	+1.82	−.05	−.12	−1.29	−1.09	+.49	−.50	−.42	−.86	−1.36	−1.41	−.51	−.96	−.67
Charleston, S. C	−1.51	+3.38	+2.26	+1.08	−.70	1.75	+1.38	+1.42	+1.93	+.32	−1.09	−1.53	−1.02	+.58	−.21
Augusta, Ga	−1.06	−.27	+3.09	−.90	−.07	−1.10	+.12	+1.07	+2.51	+2.65	−.44	−.94	−.27	+.68	−.23
Savannah, Ga	−1.23	+2.12	+3.16	−1.12	−1.07	−.13	.10	+4.24	+3.22	+9.81	−.02	−1.33	−1.21	+2.13	−.91
Jacksonville, Fla	−1.41	+2.00	+4.06	−.18	+.29	−1.41	+1.37	−.07	−.45	−1.49	−.22	−2.00	−1.03	+2.64	−.95
Gulf States:															
Atlanta, Ga	−1.01	−.54	+.26	+4.86	+1.60	+.27	+.89	−.91	+1.93	+4.46	−.75	−.91	−.04	+.19	+2.09
Mobile, Ala	−.75	−.48	+.25	−.04	−.76	+1.07	+3.95	1.51	+1.66	−.27	+1.45	−.81	+5.16	+8.17	.59
Montgomery, Ala	−.87	+1.63	+.35	−.10	−.86	+2.46	+.71	+.04	+.40	+.24	−.22	−.69	−.56	−.37	+.39
Vicksburg, Miss	+3.03	−.55	−.39	−.60	+1.30	+.18	+.11	−.62	−.05	−.76	−.82	+1.56	+3.57	+1.72	+1.23
New Orleans, La	+.36	−.02	+.36	−.64	−1.05	+2.25	−.32	−1.17	−.96	+.15	+5.37	+.61	+.69	+3.36	−.70
Shreveport, La	+1.61	−.80	−.01	−.78	−.15	+.31	+.48	−.35	+.55	−.67	+4.09	−.76	−.73	−.54	−.62
Fort Smith, Ark	−.82	+.05	−.86	−.96	−.05	+4.67	−.78	−.42	−.78	−.81	+2.82	−.36	+.04	−.74	.63
Little Rock, Ark	−.89	.79	−.90	−.80	+1.82	−.65	+.05	−.95	−.52	−.84	+1.64	+4.60	+1.39	+1.02	+.31
Palestine, Tex	+.80	−.34	−.58	+.62	−.40	+.40	−.31	−.60	+1.31	+.02	−.20	−.77	−.17	−.69	−.05
Galveston, Tex	+1.02	+.07	+.70	−.13	−.81	−.75	+.31	−1.08	−.87	−.30	−1.53	+4.73	−1.31	−.83	1.06
San Antonio, Tex	+.23	−.15	−.45	−.51	+.50	−.59	+.06	−.70	+1.21	−.65	−.86	+.01	−.49	−.69	−.45
Ohio Valley and Tennessee:															
Memphis, Tenn	−.79	+.80	−.70	−.72	+2.01	−.35	+.45	−.84	−.19	−.68	+.78	−.38	−.55	+2.39	−.12
Nashville, Tenn	−.12	−.53	.33	+.12	+1.07	+.08	+4.95	−.73	−.79	+.24	−.90	−.53	+1.15	+.34	+.15
Chattanooga, Tenn	.89	+.37	+.79	−.83	+2.53	−.63	−.52	−.92	−.91	+3.76	−.91	−.91	+.89	.71	1.34
Louisville, Ky	−.09	−.84	−.41	.84	+1.07	−.58	+2.87	+.03	−.60	−.25	−.51	+.09	+.76	.19	−.18
Indianapolis, Ind	+.21	.98	.87	−.49	+2.82	+.41	−.56	+.49	−.67	+.55	−.56	+.01	+1.42	−.10	+.14
Cincinnati, Ohio	−.76	−.77	+.04	+.19	+.74	−.64	+.15	+.36	−.64	−.56	−.38	−.23	+1.43	.47	−.17
Columbus, Ohio	−.77	−.75	−.33	+.81	−.98	+2.78	+.19	+.26	−.25	+.72	−.57	−.38	+.74	−.56	−.09
Pittsburg, Pa	−.77	−.94	−.65	−.65	+.50	+.29	+.48	+.77	−.33	−.42	−.21	−.55	−.18	.56	−.30
Lake region:															
Oswego, N. Y	+.05	−.63	+.70	+.61	+.61	+1.03	−.04	−.48	+.38	−.49	+1.47	−.10	+.57	+.32	−.22
Buffalo, N. Y	−.05	−.27	−.68	−.50	−.47	+.82	−.61	+.34	−.75	−.76	+.44	+.61	−.33	−.82	−.44

Cleveland, Ohio	−.19	−.79	−.20	−.12	−.04	−.26	−.52	−.23	.00	−.43	−.24	−.16	−.09	−.52	+1.53			
Detroit, Mich	−.47	−.77	−.63	−.50	+.59	−.15	−.47	+.46	−.46	+.49	+.43	.16	+.16	−.49	−.12			
Alpena, Mich	−.05	.67	−.61	+.07	−.36	+.58	−.70	−.12	+1.01	+.01	−.55	−.63	+.41	−.42	.81			
Grand Haven, Mich	−.41	−.50	−.63	+.12	−.53	+2.07	−.31	−.59	+.45	−.42	−.75	+.32	+1.65	−.07	.08			
Milwaukee, Wis	−.84	+.14	−.70	+1.74	+.07	+.37	+.22	−.59	+1.70	−.24	−.49	−.15	+.18	−.42	−.05			
Chicago, Ill	−.84	−.80	−.77	−.37	+.78	+.26	+.04	−.09	+.15	+.55	−.44	.00	+.36	−.22	−.47			
Duluth, Minn	+.21	−.87	−.76	−.74	−.55	+1.20	−.42	−.23	−.17	−.76	−.34	−.80	−.71	−.48	+.92			
Upper Mississippi Valley:																		
St. Paul, Minn	+1.03	−.56	−.58	−.70	−.70	+2.21	−.04	−.57	−.66	−.75	−.51	−.14	−.69	.45	+1.51			
La Crosse, Wis	+.04	−.66	−.91	−.55	−.31	+.76	+.89	−.70	−.80	−.71	−1.01	−.83	+.06	−.63	−.17			
Davenport, Iowa	−.84	−.62	−.84	−.28	+.29	+.19	−.14	+1.63	+.04	−.07	−.37	−.23	+.81	−.63	−.13			
Des Moines, Iowa	−.37	−.57	−.77	−.53	+.03	−.08	−.40	−.69	−.69	−.66	−.39	+.34	.54	−.54	−.37			
Springfield, Ill	−.80	−.54	−.56	−.49	+1.55	+1.98	+.05	+.60	−.34	−.36	+.24	+.14	+2.94	+2.46	−.65			
Cairo, Ill	−.66	−.65	−.21	−.63	+4.10	+.98	+.31	−.04	−.26	−.57	+.82	+.65	−.21	+5.24	−.51			
St. Louis, Mo	−.94	+4.27	−.44	−.83	+1.08	−.17	.72	−.71	−.69	−.76	−.07	+.34	+.76	+.65	.65			
Missouri Valley:																		
Springfield, Mo	−.62	+.38	−1.02	+.33	+2.86	+1.25	−.88	+2.05	−.40	−.91	+1.71	+1.60	+.49	.77	.69			
Kansas City, Mo	−1.08	−.14	−.92	+1.58	+.68	+.85	−.90	+1.95	−.42	−.19	+1.41	+.11	−.31	−.76	−.49			
Concordia, Kans	+.27	+.06	−.70	−.70	+.35	−.29	−.64	−.06	−.59	−.58	+2.46	−.18	−.55	−.46	+.40			
Omaha, Nebr	−1.26	+2.40	−.93	−1.00	−.45	+1.08	−.71	−.71	−.70	−.50	+1.05	+.39	−.65	.63	+.26			
Valentine, Nebr	−.65	+.52	−.56	−.39	+.46	+1.75	−.49	+.71	−.23	−.26	+.16	−.01	−.21	−.21	−.21			
Huron, S. Dak	+.87	+1.38	−.58	+.20	−.66	−.21	−.63	−.53	−.52	−.43	+.08	+.54	−.28	−.30	−.24			
Extreme Northwest:																		
Moorhead, Minn	+1.13	−.86	−.69	−.39	−.69	−.30	−.22	+.70	+.08	−.39	−.45	+.33	−.15	−.16	−.45			
Bismarck, N. Dak	−.13	−.07	−.55	+.12	−.49	−.47	−.37	+.58	−.42	+.24	−.16	−.24	−.23	+1.19	+.56			
Williston, N. Dak	+.22	.00	−.35	+.04	−.32	−.29	−.28	−.24	−.21	+.90	−.21	−.21	−.15	+.92	+.24			
Rocky Mountain slope:																		
Havre, Mont	−.54	−.57	−.34	+1.86	−.40	−.31	−.35	−.26	−.27	+.71	−.28	−.23	.23	+1.08	−.14			
Helena, Mont	+1.97	−.31	−.04	+.02	−.14	−.14	−.14	+.10	−.12	+.87	−.23	−.28	−.14	−.12	−.21			
Spokane, Wash	+.61	−.21	+.26	−.14	−.07	+.02	−.07	+.09	−.11	+.49	−.21	−.24	−.17	+.05	.27			
Salt Lake City, Utah	−.14	−.13	+.06	−.08	−.14	+.16	−.14	−.14	−.21	+.83	−.21	.21	−.21	+.60	.35			
Cheyenne, Wyo	−.25	+.10	+.55	−.40	−.17	+.40	−.35	−.31	−.32	+.07	+.02	−.21	−.21	.19	.21			
North Platte, Nebr	−.21	−.55	−.63	−.52	+.05	+.28	−.54	−.56	+.01	−.40	+1.51	+.48	.28	.28	.22			
Denver, Colo	−.07	−.24	−.35	−.42	−.15	+.43	−.35	−.34	−.14	−.17	−.12	−.02	.15	.21	−.20			
Dodge, Kans	−.13	+.75	−.70	−.42	+.10	+1.56	−.70	−.65	−.57	−.42	+1.52	+1.01	−.28	−.28	+1.01			
Abilene, Tex	+.01	+.72	−.24	−.28	−.11	+.89	−.62	−.55	−.49	−.62	−.40	+1.18	+.98	.56	.56			
Santa Fe, N. Mex	+.41	−.22	+.53	−.68	−.81	+.15	+.14	+.91	+.42	−.31	−.23	−.35	.35	.30	+.20			
El Paso, Tex	+.14	−.16	−.33	+.05	−.46	−.08	+.08	−.42	−.22	−.22	+.14	−.28	−.23	.21	.21			
Phenix, Ariz	−.07	+.08	−.17	−.24	−.27	−.17	−.28	−.05	+.44	+.14	−.09	.14	.14	.18	.14			
Pacific coast:																		
Seattle, Wash	−.28	−.21	−.05	−.18	−.20	−.14	−.14	.07	−.14	−.06	−.53	−.02	+1.29	+.31	.58			
Portland, Oreg	−.26	−.17	+.31	+.27	−.07	−.07	−.08	+.01	−.19	−.04	−.31	.39	1.24	.39	.62			
Roseburg, Oreg	−.20	−.14	−.05	−.07	−.06	.00	−.06	.07	−.02	+.52	.18	.22	.69	.59	.30			
Red Bluff, Cal	−.06	.00	.00	.00	.00	.00	.00	.00	.00	+.00	.12	.17	.02	.18	.25			
Sacramento, Cal	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.07	.07	.14	.30	.15			
San Francisco, Cal	−.02	.00	.00	.00	.00	.00	.00	.00	.00	.01	−.01	−.05	.55	.07	.24			
Los Angeles, Cal	−.02	+.07	.00	.00	.00	.00	.00	.00	−.01	−.02	.00	.00	.04	.02	.14			
San Diego, Cal	.00	.00	.00	.00	−.02	−.07	−.04	.00	.00	.00	.00	.04	.05	.0.	.15			

PLANT DISEASES IN THE UNITED STATES IN 1898.

The prevalence of plant diseases in the United States during 1898, as shown by reports to the Division of Vegetable Physiology and Pathology, has not differed much from former years.

NORTHERN FRUITS.

Peach yellows, by reason of the strict measures adopted in fighting it, has been practically eradicated in some districts and held in check in others. In some sections, however, it still acts as a barrier to successful peach growing.

Peach leaf curl has again been widely distributed and destructive. A method of winter spraying introduced by the Department promises to control this disease effectually. Fruit rot of peaches, plums, and cherries has also been widely distributed and destructive. No practical method of controlling it has yet been discovered. Two kinds of root rot of peach and plum were found to be doing serious damage in the South. A new disease, known as "little peach," has appeared in Michigan and has already caused a loss of nearly $300,000. The entire peach industry of Michigan, representing nearly $10,000,000, is threatened. Some work on the disease is under way, but so far no definite conclusion in regard to the cause or remedy has been reached.

Pear blight has been unusually destructive, especially in the South. The method of pruning out the winter stage, or what is called "hold-over blight," has not yet come into general use. It has been effective, however, where thoroughly tried.

VEGETABLES, COTTON, AND GRAIN.

The leaf blights of potato and the potato rot have been widely distributed and have caused much loss to growers who did not spray with Bordeaux mixture. The bacterial rot of potatoes and tomatoes has also done much damage in restricted regions. Rotation of crops and war against insects which carry the germs are the only means of combating the trouble.

The black rot of cabbage, described in Farmers' Bulletin No. 68, of the Department, appeared in many cabbage-growing regions during the year, often causing heavy losses. Rotation of crops, making of seed bed on uninfected soil, and destruction of leaf-eating insects, the carriers of the disease, are the principal means of prevention.

The watermelon wilt, caused by a fungus in the roots and stems, is still prevalent in the South. Growers who adopted the recommendations of the Department relative to rotation of crops were not much troubled, while others lost heavily.

A similar disease of cotton was quite generally distributed during the year and caused much loss.

The prevalence of rusts of grain has been about the same as in former years. The aggregate loss from this cause alone is estimated to be over $40,000,000 annually. The only method of controlling rusts appears to be in the direction of obtaining resistant varieties by crossing and breeding. The loss from smuts of grain is annually being reduced through the application of the hot water and other methods of treating the seed to kill the smut spores. The present average yield of grain will be largely increased when the smut diseases are conquered.

SOUTHERN FRUITS.

A bacterial disease of the olive known as tuberculosis did serious damage in a restricted area in California. No method of treatment except complete destruction of diseased parts of the tree is yet known.

Sooty mold of the orange, though prevalent, did much less damage, owing to the methods of treatment adopted in accordance with the recommendations of the Department. The greatest drawback to orange growing in Florida and California is the severe injury by frosts. Efforts are being made by this Division to obtain a hardier class of trees by hybridizing the common sweet orange with the hardy trifoliate variety.

Pineapple blight was severe in many localities during the year. It appears to be caused by a fungus, and can in many cases be cured by cutting off the base of the plant above the diseased portion and transplanting. Much more work needs to be done on this disease.

NOTES ON SOIL MOISTURE IN 1898.

The percentages of moisture for 1898 in the following table (p. 654) are based on water free soil and were ascertained for a depth of from 3 to 6 inches, except at Glenburnie and Belair, Md.; Fort Meade, Fla.; Stockton, Cal.; and Wichita Falls, Tex.

The results for each month are the means of daily determinations during the month. The work was done by the Division of Soils.

The per cent of clay is that determined in the subsoil, either in the field in which the moisture was determined or in similar soil in the vicinity.

The letters w, f, and d in the table indicate the condition of the soil as wet, favorable, and dry, respectively. Where two letters occur together, the first one indicates the condition for the first half of the month and the second for the last half.

The season as a whole was favorable for the majority of the places, and yet Lexington, Ky., Oakland, Md., and Wichita Falls, Tex., are the only places at which there was not at least a half month's drought. At Glenburnie, Md., Takoma Park, Md., Pullman, Wash., and Stockton, Cal., the season was dry. A wet half month at some time during the season occurs in half of the places reported.

The mean per cent of soil moisture for the season ranges from 3.6 under cantaloupes at Glenburnie, Md., to 36.7 under wheat at Fargo, N. Dak. The moisture in the latter soil was a little more than ten times as great as in the former.

All of the early truck crops appear in the upper part of the table on soils that have less than 5 per cent of clay and have less than 10.3 per cent of moisture as the mean content for the season. It will be seen from this table that no corn, wheat, oats, or grass occurs on soil having less than 18.6 per cent of clay; and excepting wheat at Pullman, Wash., and Stockton, Cal., both of which suffered from drought, all of these crops occur on soils that maintain a mean water content for the season of 12.8 per cent or more. In a general way the clay content of the subsoil and the water content at the depth indicated increase together. There are fluctuations in the soil moisture due to the character of the season and kind of crop grown.

Moisture content of soils, May to August, inclusive, 1898.

Locality.	Character of soil.	Crop grown in 1898.	Per cent clay in subsoil.	Per cent moisture in soil.					Rainfall in inches.			
				May.	June.	July.	August.	Average.	May.	June.	July.	August.
Glenburnie, Md	Light sandy truck	Cantaloupes	2.7		4.4 d.	3.3 d.	3.2 d.	3.6		1.82	4.65	4.60
Do	do	Potatoes	2.7		4.7 d.	4.0 d.	3.6 d.	4.1		1.82	4.65	4.60
Pullman, Wash	Basalt, loam soil	Wheat	18.6		5.7 d.	4.4 d.	3.8 d.	4.6		1.56	.51	None
Fort Meade, Fla	Hammock, sandy	Tobacco	3.4	4.9 d.	5.5 f.	5.9 w.	6.5 w.	5.7	1.31	4.42	9.93	10.19
Do[1]	do	do	3.4	7.3 d.	8.3 f.	8.8 w.	9.9 w.	8.6	1.31	4.42	9.93	10.19
Vineland, N. J.[1]	Sandy truck	Potatoes	4.5	8.7 f.	8.1 f. d.	9.1 f.	9.3 f.	8.8	5.74	1.59	7.99	3.04
Do[1]	do	Peas and squash	4.5	9.2 f.	8.1 f. d.	8.9 f.	9.1 f.	8.8	5.74	1.59	7.99	3.04
Stockton, Cal	Adobe	Wheat	22.7	9.9 d.	9.5 d.	9.4 d.	9.1 d.	9.5	1.00	None.	None.	None.
Vineland, N. J.[1]	Sandy truck	Cabbage	4.5	9.1 f.	9.8 f. d.	10.5 f.	9.0 f.	9.6	5.74	1.59	7.99	3.04
Ithaca, N. Y	Gravelly loam	Potatoes			15.4 f.	6.2 d.	9.0 f.	10.2		2.30	4.19	3.82
Oakland, Md	Catskill sandstone, red clay loam.	Oats	25.9		15.2 f.	7.8 f.	15.4 w.	12.8		2.64	3.75	7.66
Waxahia Falls, Tex		Wheat		13.8 f.	12.7 f.			13.2	2.53	5.35		
Hopkinsville, Ky	Clay, loam	do	27.2	14.3 f. w.	13.6 f.	12.9 f. d.	12.4 d.	13.3	5.92	4.02	3.16	.94
Belair, Md	Gabbro, red clay	Grass	28.1		10.8 f. d.	12.3 d.	17.9 w. f.	13.7		.93	4.25	10.81
Takoma Park, Md	Loam	Tomatoes	17.8		17.0 d.	12.4 d.	15.2 f.	14.9		.49	2.09	9.37
Geneseo, N. Y	Clay loam	Grass		24.9 f.	12.3 f.	8.8 f. d.	8.8 f.	15.3	2.68	3.32	1.26	4.10
Belair, Md	Gabbro, red clay	Wheat	28.1		14.0 f. d.	13.6 d.	18.3 w. f.	15.3		.93	4.25	10.81
Bozeman, Mont	Foothills, loam	Virgin			29.1 w. f.	11.4 f.	7.4 d.	16		1.71	.96	.52
Geneseo, N. Y	Clay loam	Wheat		22.2 f.	14.0 f.	14.6 f. d.	14.6 f.	16.9	2.68	3.32	1.26	4.10
Bozeman, Mont	Foothills, loam	do			29.6 w. f.	13.9 f.	8.2 d.	17.2		1.71	.96	.52
Do[1]	Valley, loam	Barley			18.8 w. f.	18.4 f.	14.9 d.	17.4		1.71	.96	.52
Takoma Park, Md	Loam	Potatoes	17.8		16.0 d.	16.6 d.	19.8 f.	17.5		.49	2.09	9.37
Lititz, Pa	Limestone, clay	Tobacco	36.3	27.7 w.	12.3 f.	14.2 d.	21.8 w.	19	6.45	2.10	3.48	6.51
Do	do	Corn	36.3	25.8 w.	19.7 f.	15.9 d.	18.2 w.	19.9	6.45	2.10	3.48	6.51
Oakland, Md	Catskill sandstone, red clay loam.	Grass	25.9		19.6 f.	16.8 f.	21.4 w.	20.2		2.64	3.75	7.66
Bird City, Kans	Loess	Wheat			25.1 f.	15.5 d.		20.3		2.65	3.50	
Hopkinsville, Ky	Clay, loam	Tobacco	27.1	23.5 f. w.	22.7 f.	19.9 f. d.	16.2 d.	20.6	5.92	4.02	3.16	.94
Lexington, Ky	Limestone, clay	Grass	27.7	21.4 f.	18.4 f.	21.9 f. w.		20.6	6.08	7.41	6.30	
Hopkinsville, Ky	Clay, loam	Corn	27.1	23.8 f. w.	23.1 f.	22.0 f. d.	20.7 d.	22.4	5.92	4.02	3.16	.94
Lititz, Pa	Limestone, clay	Wheat	36.3	29.8 w.	20.3 f.	19.5 d.	23.7 w.	23.2	6.45	2.10	3.48	6.51
Lexington, Ky	do	Corn	27.7	23.5 f.	28.1 f.	18.6 f. w.		23.4	6.08	7.41	6.30	
Lincoln, Nebr	Black, loam	do	32.8		36.2 f.	24.4 d.	12.0 d.	24.2		.94	6.50	2.32
Oakland, Md	Catskill sandstone, red clay loam.	Potatoes	25.9		23.8 f.	21.4 f.	27.4 w.	24.2		2.64	3.75	7.66
Lexington, Ky	Limestone, clay	Wheat	27.7	25.4 f.	22.1 f.	28.9 f. w.		25.5	6.08	7.41	6.30	
Do	do	Tobacco	27.7	27.4 f.	31.6 f.	19.6 f. w.		26.2	6.08	7.41	6.30	
Belair, Md	Gabbro, red clay	Corn	28.1		29.6 f. d.	21.0 d.	31.9 w. f.	27.5		.93	4.25	10.81
Hastings, Nebr	Loess	do	22.0		33.9 w. d.	30.1 d.	19.2 d.	27.7				
Fargo, N. Dak	Red River valley	Wheat		42.5 f.	35.4 f.	32.3 f. d.		36.7	2.41	2.29	2.5	

[1] Irrigated.

COMPOSITION OF MILLETS AND OTHER FORAGE PLANTS.

The millets are all very much alike in composition and digestibility, there being often more variation in the forage from a single variety, cut at different periods in the development of the plant, than between samples of different varieties, particularly when cut at about the same stage of growth. This shows the importance of cutting at the proper time in order to obtain the richest, most palatable, and most digestible forage.

The following tables, prepared in the Division of Agrostology, give the chemical composition and digestibility of the millets, as shown by various American analyses and digestion experiments. No data on the digestibility of broom-corn millet are at present obtainable. To facilitate comparison and to furnish easily accessible data for use in arranging suitable feeding rations, the composition and digestibility of a number of the most common grasses and leguminous forage crops are added.

Average chemical composition of millets and other grasses and forage plants.

Variety and kind of forage.	Fresh or air-dry substance.						Water-free substance.				
	Water.	Ash.	Crude cellulose.	Fat.	Crude protein.	Nitrogen-free extract.	Ash.	Crude cellulose.	Fat.	Crude protein.	Nitrogen-free extract.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Foxtail millets:											
Hungarian (hay)	7.7	6.0	27.7	2.1	7.5	49.0	6.5	30.0	2.3	8.1	53.1
Common (hay)	15.0	4.3	28.3	1.8	6.6	44.0	.....	33.3	2.1	7.8	51.8
Japanese foxtail (hay)	15.0	4.7	30.1	1.8	5.1	43.3	.....	35.4	2.1	6.0	50.9
"Golden" (hay)	14.0	.....	25.5	1.7	6.4	45.7	.....	.....	.....	.....	.....
Early harvest[1]	26.8	5.1	26.9	1.7	4.3	35.2	6.9	36.7	2.3	6.0	48.1
Millet straw	15.0	5.8	35.5	1.2	4.2	38.3	.....	41.8	1.4	4.9	45.1
Common (fresh)	65.0	1.7	11.0	1.0	2.6	18.7	.....	31.4	2.9	7.4	53.4
Japanese foxtail (fresh)	75.0	1.5	7.8	0.5	2.1	13.1	.....	31.2	2.0	8.2	52.5
Hungarian (fresh)	74.0	2.1	7.0	0.5	2.6	13.8	.....	26.9	1.9	10.0	53.1
Millet seed (variety unknown)	12.8	3.4	7.8	3.8	11.0	61.2	3.9	9.1	4.5	12.5	70.0
Millet seed (hulled, grown in India)	10.2	1.2	1.5	2.9	10.8	73.4	.....	.....	.....	.....	.....
Golden wonder millet seed	9.3	3.0	9.1	4.5	13.8	60.5	3.3	10.1	4.9	15.0	66.7
Barnyard millets:											
Freshly cut (for soiling)	73.1	2.0	8.1	0.8	2.0	14.0	.....	30.0	3.0	7.5	52.0
Hay	11.0	8.9	30.9	2.2	11.3	35.7	10.0	34.6	2.5	12.7	40.2
Straw	15.0	4.6	30.4	2.1	5.2	42.7	5.4	35.8	2.5	6.1	50.2
Silage	71.8	2.8	9.6	0.8	1.7	13.3	9.7	34.0	3.0	6.2	47.1
Seed	10.3	3.1	7.7	5.7	12.3	60.9	3.5	8.6	6.3	13.7	67.9
Broom-corn millets:											
Japanese broom-corn millet[1]	38.5	3.7	19.3	1.0	2.6	34.9	5.9	31.3	1.7	4.3	56.8
Silage	78.0	1.8	7.0	0.7	1.7	10.8	8.3	31.8	3.3	7.5	49.1
Hog millet seed	10.2	2.3	6.6	4.4	13.5	63.0	2.6	7.3	5.0	15.0	70.1
Some common hay and forage grasses:											
Timothy (hay)	13.2	4.4	29.0	2.5	5.9	45.0	5.1	33.5	2.9	6.8	51.7
Timothy (fresh)	61.6	2.1	11.8	1.2	3.1	20.2	5.4	30.7	3.1	8.0	52.8
Redtop (hay)	8.9	5.2	28.6	1.9	7.9	47.4	5.7	31.4	2.1	8.7	52.1
Redtop (fresh)	64.8	2.3	9.4	1.2	3.3	19.1	6.6	26.8	3.3	9.4	53.9
Orchard grass (hay)	9.9	6.0	32.4	2.6	8.1	48.6	6.7	36.0	2.9	9.0	45.4
Orchard grass (fresh)	73.0	2.0	8.2	0.9	2.6	13.3	7.4	30.4	3.3	9.6	49.3
Kentucky blue grass (hay)	11.9	7.1	30.4	2.2	7.6	40.8	8.2	34.4	2.5	8.6	46.3
Kentucky blue grass (fresh)	65.1	2.8	9.1	1.3	4.1	17.6	8.0	26.2	3.7	11.8	50.3
Western wheat grass (hay)	8.1	8.6	37.5	2.7	9.5	33.6	10.6	40.7	3.0	10.4	36.3
Western wheat grass (fresh)	63.2	1.7	12.9	1.3	4.5	16.4	4.7	35.0	3.4	12.2	44.7
Big blue stem (hay)	7.8	5.7	38.0	2.1	5.3	41.1	6.2	41.3	2.2	5.8	44.5
Crab grass (hay)	14.3	10.3	23.6	2.6	9.3	39.9	12.0	27.6	3.0	10.8	46.6
Corn fodder (cured)	42.2	2.7	14.3	1.6	4.5	34.7	4.7	24.7	2.8	7.8	60.1
Corn fodder (fresh)	79.3	1.2	5.0	0.5	1.8	12.2	5.6	24.1	2.6	8.8	58.9
Corn silage	79.1	1.4	6.0	0.8	1.7	11.0	6.6	28.7	3.8	8.2	52.7
Johnson grass (hay)	9.6	6.5	32.8	1.8	6.1	43.2	7.2	36.3	2.0	6.7	47.8
Johnson grass (fresh)	78.8	1.9	5.6	1.2	3.0	9.5	9.4	25.6	5.7	14.8	44.4
Sorghum (cured)	28.6	4.0	24.0	2.7	4.0	36.7	5.7	34.3	3.9	5.7	50.4
Sorghum (fresh)	71.4	1.7	8.2	1.4	1.6	15.7	6.0	28.7	4.9	5.6	54.8
Sorghum silage	75.6	1.6	7.6	1.0	1.4	12.8	6.5	31.1	4.1	5.8	52.5
Common leguminous forage crops:											
Red clover (hay)	15.3	6.2	24.8	3.3	12.3	38.1	7.3	29.1	3.9	14.5	45.2
Red clover (fresh)	70.8	2.1	8.1	1.1	4.4	13.5	7.2	27.8	3.9	15.3	45.8

[1] Partially cured. Analyses of these and of silage of both barnyard and broom-corn millets furnished by Dr. J. B. Lindsey of the Massachusetts (Hatch) Experiment Station.

Average chemical composition of millets and other grasses and forage plants—Continued.

Variety and kind of forage.	Fresh or air-dry substance.						Water-free substance.				
	Water.	Ash.	Crude cellulose.	Fat.	Crude protein.	Nitrogen-free extract.	Ash.	Crude cellulose.	Fat.	Crude protein.	Nitrogen-free extract.
Common leguminous forage crops—Continued.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Crimson clover (hay)	9.6	8.6	27.2	2.8	15.2	36.6	9.5	30.1	3.1	16.8	40.5
Crimson clover (fresh)	80.9	1.7	5.2	0.7	3.1	8.4	8.9	27.2	3.6	16.3	44.0
Alfalfa (hay)	8.4	7.4	25.0	2.2	14.3	42.7	8.1	27.3	2.4	15.6	46.6
Alfalfa (fresh)	71.8	2.7	7.4	1.0	4.8	12.3	9.4	26.2	3.4	17.1	43.9
Cowpea (hay)	10.7	7.5	26.1	2.9	16.6	42.2	8.5	22.5	3.2	18.6	47.2
Cowpea (fresh)	83.6	1.7	4.8	0.4	2.4	7.1	10.5	29.5	2.6	14.3	43.6
Soy bean (hay)	11.3	7.2	22.3	5.2	15.4	38.6	8.1	25.1	5.9	17.4	43.5
Soy bean (fresh)	75.1	2.6	6.7	1.0	4.0	10.6	10.5	26.9	4.1	16.1	42.4
Japan clover (hay)	12.8	12.8	25.5	3.5	13.8	30.6	14.7	30.3	4.0	15.9	35.1
Spring vetch (hay)	8.8	4.3	24.6	3.2	18.3	40.8	4.7	27.0	3.5	20.1	44.7
Spring vetch (fresh)	81.0	1.8	3.5	0.7	4.5	8.5	9.5	18.3	3.8	24.4	44.0

Digestibility of millets and other common grasses and forage plants.

Variety and kind of forage.	Dry matter.	Organic matter.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free extract.	Remarks.
Foxtail millets:	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
Hungarian (hay)	65	66	.....	68	64	60	67	Experiments made with ruminants in this and the next.
Hungarian (fresh)	63	68	.....	70	62	63	67	Early to late bloom.
"Golden" (hay)	.....	.....	.....	58	41	60	65	
Barnyard millets:								
Fresh fodder	.....	65	53	63	72	47	68	Bloom to early seed; average of three trials with sheep.
Fresh fodder [1]	.....	67	66	74	64	68	76	Experiment began when millet was just heading out.
Hay [1]	.....	59	63	62	46	64	52	Rather late bloom.
Some common hay and forage grasses:								
Timothy (hay)	57	58	.....	52	60	48	63	
Redtop (hay)	60	61	.....	61	51	61	62	
Orchard grass (hay)	56	56	.....	61	55	60	55	
Corn fodder (partially cured).	68	.....	.....	65	74	55	73	
Corn fodder (fresh)	66	.....	.....	52	76	53	74	
Johnson grass (hay)	55	.....	.....	58	39	45	54	
Sorghum (dry)	63	.....	.....	70	47	61	65	Leaves only.
Sorghum (fresh)	67	.....	.....	59	74	46	74	Whole plant.
Common leguminous forage crops:								
Red clover (hay)	54	55	.....	47	48	52	61	
Red clover (fresh)	66	61	.....	53	63	64	71	
Crimson clover (hay)	62	56	.....	45	44	69	62	
Crimson clover (fresh)	.....	69	.....	56	66	77	74	
Alfalfa (hay)	.....	.....	.....	47	52	75	67	
Cowpea (hay)	59	.....	.....	43	50	65	71	
Cowpea (fresh)	.....	76	.....	57	59	74	84	
Soy bean (hay)	62	.....	.....	61	29	71	69	
Soy bean (fresh)	64	.....	.....	45	54	71	73	

[1] Analyses furnished by Dr. J. B. Lindsey, Massachusetts (Hatch) Experiment Station.

METHODS OF CONTROLLING INJURIOUS INSECTS.

[The following remedies for important insects and directions for the preparation of insecticides are contributed by the Entomologist. The species marked with an asterisk (*) have gained entrance into America from foreign countries and represent twenty-eight out of the sixty-three species listed. The origin of those preceded with an interrogation point is in doubt.]

REMEDIES FOR IMPORTANT INSECTS.

*ANGOUMOIS GRAIN MOTH (*Sitotroga cerealella* Oliv.). Prompt thrashing of grain after harvesting; bisulphide of carbon in bins and granaries; storage in bulk.

?APPLE-ROOT PLANT-LOUSE (*Schizoneura lanigera* Hausm.). Kerosene emulsion under and above ground; scalding water poured freely about roots; bisulphide of carbon under ground about roots; powdered tobacco or ashes incorporated in the soil.

APPLE-TREE BORER, FLAT-HEADED (*Chrysobothris femorata* Fab.). Painting trunk and larger branches in June with strong soap solution, washing soda, or mixture of whitewash and Paris green.

?ARMY WORM (*Leucania unipuncta* Haw.). Burning over fields in winter; ditching; Paris green.

*ASPARAGUS BEETLE, COMMON (*Crioceris asparagi* Linn.). Prompt marketing of all canes; trap plants; dusting with lime or arsenical mixtures; jarring larvæ to ground on hot days, especially if soil be sandy.

*BEAN WEEVIL, COMMON (*Bruchus obtectus* Say). Treating with bisulphide of carbon in air-tight vessels.

*BLACK SCALE (*Lecanium oleæ* Barn.). Kerosene emulsion on young scale or treatment with hydrocyanic acid gas.

BLISTER BEETLES (*Epicauta vittata* Fab., *E. cinerea* Lec., *E. pennsylvanica* DeG., *Macrobasis unicolor* Kb.). Arsenicals, 1 pound to 100 gallons of water.

BOLL WORM. (*See* Corn ear worm.)

BUFFALO GNAT (*Simulium pecuarum* Riley). Smudges; oil, grease, etc., applied to stock.

*CABBAGE BUG, HARLEQUIN (*Murgantia histrionica* Hahn). Spring collecting from trap mustard; hand picking.

*CABBAGE WORMS (*Pieris rapæ* Sch., *Plutella cruciferarum* Zell., *Plusia brassicæ* Riley). Pyrethrum; kerosene emulsion; Paris green dry, with flour or lime—1 part of the poison in 50 to 100 of the diluent.

CANKERWORM, SPRING (*Paleacrita vernata* Peck). Arsenical mixtures in spray; trapping female moth in oil troughs or tar bands about trunks of trees.

*CARPET BEETLE, OR "BUFFALO MOTH" (*Anthrenus scrophulariæ* L.). Benzine; hot ironing of carpets over damp cloth; killing by steam.

CHINCH BUG (*Blissus leucopterus* Say). Burning wild grass land and all rubbish in early winter; kerosene emulsion; contagious disease; trap crops; ditching.

?CLOTHES MOTH, SOUTHERN (*Tinea biselliella* Hum.). Brushing and airing; benzine; naphthalene; packing in bags of paper or cotton cloth; cold storage.

*COCKROACH, GERMAN; CROTON BUG (*Phyllodromia germanica* L.). Pyrethrum or buhach; bisulphide of carbon in tight rooms or compartments away from fire.

*CODLING MOTH; APPLE WORM (*Carpocapsa pomonana* Linn.). Arsenicals; first application as soon as blossoms fall; second, one week later, before the calyx closes and the fruit turns down on the stem; trapping larvæ by applying bands to the tree; prompt destruction of infested fallen fruit.

*COTTON WORM (*Aletia xylina* Say). Paris green dusted on as dry powder.

CORN ROOT-WORM, WESTERN (*Diabrotica longicornis* Say). Rotation of corn with oats or other crop.

*CORN-STALK BORER, LARGER (*Diatræa saccharalis* F.). Plowing under or burning stubble.

?CORN EAR WORM; BOLL WORM (*Heliothis armiger* Hbn.). Late fall plowing; poisoned baits; for cotton, planting corn as trap crop.

*CURRANT WORM, IMPORTED (*Nematus ribesii* Scop.). Hellebore, 1 ounce to 2 gallons water, in spray.

CUCUMBER BEETLE, STRIPED (*Diabrotica vittata* Fab.). Protecting young plants with netting; arsenicals.

CUTWORMS (Agrotis, Leucania, Mamestra, Hadena, Nephelodes, etc.). Distribution of poisoned green bait; late fall plowing; burning waste tracts and rubbish.

*ELM LEAF-BEETLE, IMPORTED (*Galerucella luteola* Müll.). Arsenicals, 1 pound to 100 gallons water, as soon as beetles appear and later for larvæ.

FLEA-BEETLE, STRIPED (*Phyllotreta vittata* Fab.). Kerosene emulsion; arsenicals.

*FLUTED SCALE (*Icerya purchasi* Mask.). Introduction of its ladybird enemy, *Novius cardinalis;* hydrocyanic-acid gas treatment; soap, 1 pound to 2 gallons hot water.

* FRUIT-TREE BARK-BEETLE (*Scolytus rugulosus* Ratz.). Burning trap trees and infested trees at any time, but preferably in winter.
* GRAIN WEEVILS (*Calandra granaria* Linn., *C. oryza* Linn.). Bisulphide of carbon in bins and granaries; storage in large bulk.
GRAPE PHYLLOXERA (*Phylloxera vastatrix* Planch.). Submersion; bisulphide of carbon, kerosene emulsion, or resin compound about roots; use of resistant stocks.
GRAPEVINE LEAF-HOPPER (*Erythroneura vitis* Harr.). Spraying with kerosene emulsion in early morning; catching on tarred shield; cleaning up all leaves and rubbish in fall.
* GIPSY MOTH (*Ocneria dispar* L.). Spraying with arsenicals; hand collecting of cocoons and eggs; oiling egg masses; trapping larvæ.
* HESSIAN FLY (*Cecidomyia destructor* Say). Late planting; selection of wheat less subject to attack; rolling; pasturing to sheep; rotation of crops.
* HOP PLANT-LOUSE (*Phorodon humuli* Schr.). Destroying all wild plum trees in vicinity; spraying others in fall or spring with strong kerosene emulsion; spraying vines with kerosene emulsion or fish-oil soap; destroying vines after hops are picked.
* HORN FLY (*Hæmatobia serrata* R.-D.). Application of strong-smelling greases and oils to cattle, or of lime or plaster to dung.
LOCUST, CALIFORNIA DEVASTATING (*Melanoplus devastator* Scudd.). Poisoned bait of bran, sugar, and arsenic.
LOCUST, ROCKY MOUNTAIN (*Melanoplus spretus* Thos.). Catching with hopper-dozers; ditching; burning; rolling; plowing under of eggs.
OX BOT (*Hypoderma lineata* Vill.). Strong-smelling fats and oils applied to cattle.
* OYSTER-SHELL BARK-LOUSE (*Mytilaspis pomorum* Bouché). Kerosene emulsion; strong soap or alkali washes.
PEACH-TREE BORER (*Sannina exitiosa* Say). Cutting out the larvæ or scalding them with hot water in late autumn or early spring; painting trunk with arsenicals in thick whitewash; wrapping trunk with grass, paper, etc.
* PEAR-TREE PSYLLA (*Psylla pyricola* Först.). Kerosene emulsion: First, a winter application diluted seven times; second, in spring as soon as leaves are unfolded, diluted nine times.
PEAR-TREE SLUG (*Eriocampoides limacina* Klug.). Hellebore, 1 ounce to 2 gallons water in a spray; whale-oil soap, 12 pounds to 50 gallons water; arsenicals.
* PEA WEEVIL (*Bruchus pisorum* Linn.). Keeping seed over to second year; bisulphide of carbon in tight vessels.
PLUM CURCULIO (*Conotrachelus nenuphar* Herbst). Arsenical spray: First, after the bloom falls or as soon as foliage starts; second, a week or ten days after the last; collection of adults from trees by jarring.
POTATO BEETLE, COLORADO (*Doryphora decemlineata* Say). Arsenicals, 1 pound to 100 gallons of water.
* PURPLE SCALE OF THE ORANGE (*Mytilaspis citricola* Pack.). Kerosene emulsion, applied immediately after appearance of new brood.
ROSE-CHAFER (*Macrodactylus subspinosus* Fab.). Planting spiræas, etc., as trap plants, and collecting beetles in special pans; arsenicals; bagging grapes.
* SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.). Soap wash (2 pounds to the gallon) as soon as leaves fall in autumn; in warm, dry climate, winter resin wash; fumigation with hydrocyanic acid gas.
* SCREW WORM (*Compsomyia macellaria* Fab.). Prompt burning or burying of dead animals; smearing wounds with fish oil; washing with carbolic acid.
SQUASH-VINE BORER (*Melittia ceto* Westw.). Planting early summer squashes to be destroyed; late planting of main crop; destruction of all vines attacked as soon as crop can be gathered; collecting moths.
SQUASH BUG (*Anasa tristis* De G.). Early burning of vines and all rubbish in fall; biweekly collection of eggs; trapping under shingles.
STRAWBERRY WEEVIL (*Anthonomus signatus* Say). Trap crops; protecting beds with cloth covering; using staminate varieties as fertilizers only and as few plants of the former as necessary; spraying with Paris green and Bordeaux mixture.
* SUGAR-CANE BORER (*Diatræa saccharalis* Fab.). Burning trash and laying down seed cane under ground.
WEBWORM, FALL (*Hyphantria cunea* Dr.). Prompt removal and destruction of webs and larvæ; arsenical spraying.
WHEAT ISOSOMA (*Isosoma grande* Riley). Burning stubble; rotation of crops.
* WHEAT PLANT-LOUSE (*Siphonophora avenæ* Fab.). Rotation of crops.

WHITE GRUBS; JUNE BEETLES (*Lachnosterna* spp.). Luring the beetles by lights over tubs into water with skim of kerosene. Against larvæ: Kerosene emulsion; liberal use of potash fertilizers; collecting after the plow.

WIREWORMS (*Drasterius elegans* Fab., *Melanotus fissilis* Say, and *Agriotes* spp.). Fall plowing; poisoned baits; rotation of crops.

PREPARATION AND USE OF INSECTICIDES.

ARSENICALS: PARIS GREEN, SCHEELE'S GREEN, AND LONDON PURPLE.—These three arsenicals practically take the place of all other insecticides for biting and gnawing insects living or feeding on the exterior of plants.

Paris green is a very fine crystalline powder, composed of arsenic, copper, and acetic acid, and costs about 20 cents a pound.

Scheele's green is similar to Paris green in color, and differs from it only in lacking acetic acid. It is a finer powder, more easily kept in suspension, and costs only about one-half as much per pound.

London purple is a waste product, containing chiefly arsenic and lime. It is not as effective as the green poisons and more apt to scald foliage. It costs about 10 cents a pound.

These arsenicals may be used as follows:

The wet method.—Make into a thin paint in a small quantity of water, adding powdered or quicklime equal to the amount of poison used. Strain the mixture into the spray tank. Use the poison at the rate of a pound of dry powder in from 100 to 200 gallons of water. The stronger mixtures are for resistant foliage, such as that of the potato, and the weaker for sensitive foliage, such as that of the peach and plum.

The dry method.—It is ordinarily advisable to use the poison in the form of a spray, but in the case of cotton and some other low crops it may be dusted on the plants. Make the application preferably in early morning or late evening, when the dew is on, to enable the poison to better adhere to the plant. In cotton fields the powder is usually dusted over the plants from bags fastened to each end of a pole, which is carried on horse or mule back. The motion of the animal is sufficient to cause the distribution over the foliage. Garden vegetables may be dusted by hand from bags or powder bellows. For vegetables which are soon to be used as food, mix the poison with 100 times its weight of flour or lime, and apply merely enough to show evenly over the surface.

Fruit trees should never be sprayed when in bloom, on account of the liability of poisoning honeybees or other insects useful as cross fertilizers.

ARSENATE OF LEAD.—The advantages of this arsenical are that it shows plainly on the leaves, indicating at once which have been sprayed; remains much more easily suspended in water, and may be used in large proportions without danger to foliage. For sensitive foliage, or where no risk of scalding may be taken, it will prove useful.

It is prepared by combining, approximately, 3 parts arsenate of soda with 7 parts acetate of lead. From 1 to 10 pounds arsenate of lead are used with 150 gallons of water, 2 quarts of glucose being added to cause it to adhere better to the leaves. From 2 to 5 pounds will answer for most larvæ. The arsenate of lead costs 7 cents a pound wholesale, and glucose $16 a barrel.

ARSENIC BAIT.—It is not always practicable to apply poison directly to plants, and in such cases the use of poison bait is valuable, particularly for cutworms, wireworms, and grasshoppers or locusts.

Bran-arsenic bait.—This is made by combining 1 part by weight of white arsenic, 1 of sugar, and 6 of bran, to which enough water is added to make a wet mash. For grasshoppers or locusts, place a tablespoonful at the base of each tree or vine, or lay a line of it at the head of the advancing army, placing a tablespoonful every 6 to 8 feet, and following this up with another line in front of the first. For baiting cutworms, distribute the mash in small lots over the infested territory.

Green bait.—For the destruction of cutworms and wireworms, use preferably poisoned green succulent vegetation, such as freshly cut clover, distributing it in small bunches about the infested fields. The bunches of green vegetation should be dipped in a strong solution of arsenicals, and prevented from rapid drying by being covered with stones or boards. Renew as often as the bait becomes dry.

In the use of poisoned bait care must be exercised against its being eaten by domestic animals.

CARBON BISULPHIDE.—This substance, used in tight receptacles, is the cheapest and most effective remedy for all insects affecting stored food and seed material, natural-history specimens, etc., and is one of the best means against insects affect-

ing the roots of plants in loose soils. It is a colorless liquid, with an offensive odor, which soon passes off. It readily volatilizes, and is deadly to insect life. The vapor is highly inflammable and explosive, and should be carefully kept from fire, even a lighted cigar in its proximity being a source of danger. Wholesale, it costs 10 cents a pound; retail, of druggists, 25 to 30 cents a pound.

For root lice of grape, apple, etc., put one-half ounce of bisulphide into holes about plants 10 to 16 inches deep, 1½ feet apart, and not closer to trunk than 1 foot. Make the holes with iron rod and close with foot, or use hand injectors. For root maggots, put a teaspoonful into a hole 2 or 3 inches from the plant and close immediately. For ant nests, pour an ounce of the liquid into each of several holes in the nests; close the opening with the foot or cover with a wet blanket for ten minutes, and then explode the vapor at mouth of holes with torch.

For stored-grain insects, distribute in shallow dishes over the bins; with open bins, cover with oilcloth or blankets to retain the vapor. Keep bins or buildings closed for from twenty-four to thirty-six hours; then air them well. Disinfect infested grain in small bins before placing in large masses for long storage.

The bisulphide is applied at the rate of 1 pound to the ton of grain.

HYDROCYANIC ACID GAS.—This substance is chiefly used to destroy scale insects on fruit trees and nursery stock. The treatment consists in inclosing the tree or nursery stock with a tent and filling the latter with the poisonous gas.

The tents should be of blue or brown drilling, or 8-ounce duck, painted or oiled to make air-tight. The tent may be placed over small trees by hand and over large trees with a tripod or derrick. A tent and derrick for medium-sized trees cost from $15 to $25; for a tree 30 feet tall by 60 feet in circumference, about $60.

For nursery stock, in place of a tent it is often more economical to provide fumigating boxes or small fumigating houses.

Refined potassium cyanide (98 per cent pure), commercial sulphuric acid, and water are used in generating the gas, the proportions being from two-thirds to 1 ounce, by weight, of the cyanide, slightly more than 1 fluid ounce of acid, and 3 fluid ounces of water to every 150 cubic feet of space inclosed.

Place the generator (any glazed earthenware vessel of 1 or 2 gallons' capacity) on the ground within the tent, and add the water, acid, and cyanide (the latter in large lumps) in the order named. The treatment should continue forty minutes. Bright, hot sunlight is apt to cause injury to foliage, and with trees in leaf, fumigation should only be practiced on cloudy days or at night. One series of tents will answer for a county or large community of fruit growers.

KEROSENE.—Kerosene, or coal oil, is occasionally used directly against insects, although its important insecticide use is in combination with soap or milk emulsion. Under exceptional conditions it may be sprayed directly on living plants, and it has been so used in the growing season without injury. Ordinarily, however, when applied even in the dormant season on leafless plants, it is liable to do serious injury or to kill the plant outright. It is now being used to a certain extent mechanically combined with water in the act of spraying, and is less harmful in this way than when used pure, as it is broken up more finely and somewhat distributed. In this way it may be often safely applied to growing plants at a strength of 10 to 30 per cent of oil. But the danger from its use on tender plants is not altogether avoided by this method. Many insects which can not be destroyed by ordinary insecticides may be killed by jarring them from the plants into pans of water on which a little kerosene is floating, or they may be shaken from the plants upon cloth or screens saturated with kerosene.

For the mosquito, kerosene has proved a very efficient preventive. Applied, at the rate of an ounce to 15 square feet, to the surface of small ponds or stagnant water in which mosquitoes are breeding, it forms a uniform film over the water and destroys all forms of aquatic insects, including the larvæ of the mosquito and the adult females which come to the surface of the water to deposit their eggs. The application retains its efficiency for several weeks.

KEROSENE EMULSIONS.—The kerosene emulsions apply to all such sucking insects as plant bugs, plant lice, scale insects, thrips, and plant mites, and to such biting insects as can not be safely poisoned.

Soap formula.—Kerosene, 2 gallons; whale-oil soap (or 1 quart soft soap), 1 to 2 pounds; water, 1 gallon.

Dissolve the soap in water by boiling, and add boiling hot, away from the fire, to the kerosene. Agitate violently for five minutes by pumping the liquid back upon itself with a force pump and direct-discharge nozzle throwing a strong stream, preferably one-eighth inch in diameter. The mixture will have increased about one third in bulk, and assumed the consistency of cream. Well made, the emulsion should keep indefinitely, and should be diluted only as wanted for use.

In limestone or hard-water regions "break" the water with lye before using to

make or dilute the emulsion, or use rainwater. Better than either, use the milk emulsion, with which the character of the water does not affect the result.

Milk formula.—Kerosene, 2 gallons; milk (sour), 1 gallon.

Heating is unnecessary; churn as in the former case for three to five minutes, or until a thick, buttery consistency results. Prepare the milk emulsion from time to time for immediate use, unless it can be stored in air-tight jars; otherwise it will soon ferment and spoil.

How to use the emulsions.—For summer applications for most plant lice and other soft-bodied insects, dilute with 15 to 20 parts of water; for the red spider and other plant mites, the same, with the addition of 1 ounce of powdered sulphur to the gallon; for scale insects, the larger plant bugs, larvæ and beetles, dilute with 7 to 9 parts water.

For subterranean insects, such as root lice, root maggots, "white grubs," etc., use either kerosene emulsion or resin wash, wetting the soil to the depth of 2 to 3 inches, and follow with copious waterings, unless in rainy season.

OILS: FISH OIL, TRAIN OIL, AND COTTON-SEED OIL.—These are sometimes used on domestic animals to rid them of vermin, and fish oil is one of the best-known repellents for the horn fly, buffalo gnat, and ox bot fly. Any of these oils or any grease, the more strong smelling the better, thinly smeared on animals at the points of attack by flies, will afford great protection. They are also valuable against lice affecting live stock, but must be used carefully, or they may cause the hair to fall off.

PYRETHRUM, OR INSECT POWDER.—This insecticide is sold under the names of buhach and Persian insect powder.

It acts on insects externally, through their breathing pores, and is fatal to many forms. It is not poisonous to man or the higher animals, and hence may be used where poisons would be objectionable. Its chief value is against household pests, such as roaches, flies, and ants, and in greenhouses, conservatories, and small gardens, where the use of poisons would be inadvisable.

It is used as a dry powder, pure or diluted with flour, when it may be puffed about rooms or wherever insects may occur. When used on plants, it is preferably applied in the evening. As a preventive, and also as a remedy for the mosquito burning the powder in a tent or room will give satisfactory results. It may also be used as a spray, at the rate of 1 ounce to 3 gallons of water, but in this case should be mixed up some twenty-four hours before being applied. For immediate use a decoction may be prepared by boiling in water from five to ten minutes.

RESIN WASH.—This is valuable for scale insects wherever the occurrence of comparatively rainless seasons insures the continuance of the wash on the trees for a considerable period, and as winter washes in very mild climates, as southern California, or wherever the multiplication of the insect continues almost without interruption throughout the year.

Formula for resin wash.

Resin	pounds	20
Caustic soda (70 per cent)	do	5
Fish oil	pints	2½
Water to make	gallons	100

Ordinary commercial resin is used, and the soda is that put up for soap establishments in large 200-pound drums. Smaller quantities may be obtained at soap factories, or the granulated caustic soda (98 per cent) used, 3½ pounds of the latter being the equivalent of 5 pounds of the former. Place these substances with the oil in the kettle, with water to cover them to a depth of 3 or 4 inches. Boil from one to two hours, occasionally adding water, until the compound resembles very strong black coffee. Dilute to one-third the final bulk with hot water or with cold water added slowly over the fire, making a stock mixture, to be diluted to the full amount as used. When sprayed, the mixture should be perfectly fluid and without sediment, and should any appear in the stock mixture reheating should be resorted to. For a winter wash dilute one-third or one-half less.

SOAPS AS INSECTICIDES.—Any good soap is effective in destroying soft-bodied insects, such as plant lice and young or soft-bodied larvæ. The soaps made of fish oil, and sold under the name of whale-oil soaps, are especially valuable. For plant lice and delicate larvæ, such as the pear slug and others, a strength obtained by dissolving half a pound of soap in a gallon of water is sufficient. Soft soap will answer as well as hard, but at least double quantity should be taken.

As winter washes, the fish-oil soaps have proved the most effective means of destroying certain scale insects, and have been of especial service against the very resistant San Jose scale.

For winter applications, use the soap at the rate of 2 pounds to a gallon of water, making the application with a spray pump as soon as the leaves fall in the autumn, repeating, if necessary, in spring before the buds unfold.

Sulphur.—Flowers of sulphur is one of the best remedies for plant mites, such as the "red spider," six-spotted orange mite, rust mite of the orange fruit, etc. Applied at the rate of 1 ounce to a gallon of water, or mixed with some other insecticide, such as kerosene emulsion, it is a very effective remedy. For the rust mite, sprinkling the powdered sulphur about under the trees is sometimes sufficient to keep the fruit bright. Sulphur is often used to rid poultry houses of vermin, and when fed to cattle is said to be a good means of ridding them of lice; or it may be mixed with grease, oil, etc., and rubbed into the skin.

Bisulphide of lime.—This chemical is even better than sulphur as a remedy for mites; as it is a liquid, it can be diluted easily to any extent. It can be made very cheaply by boiling together in a small quantity of water equal parts of lime and flowers of sulphur. For mites, take 5 pounds of sulphur and 5 of lime, and boil in a small quantity of water until both are dissolved and a brownish liquid results. Dilute to 100 gallons.

MEASUREMENT OF STANDING TREES.

There are several methods of determining the height of a standing tree. The simplest is to measure the shadow of the tree and the shadow of a straight pole of known length set perpendicular to the earth. Multiply the length of the shadow

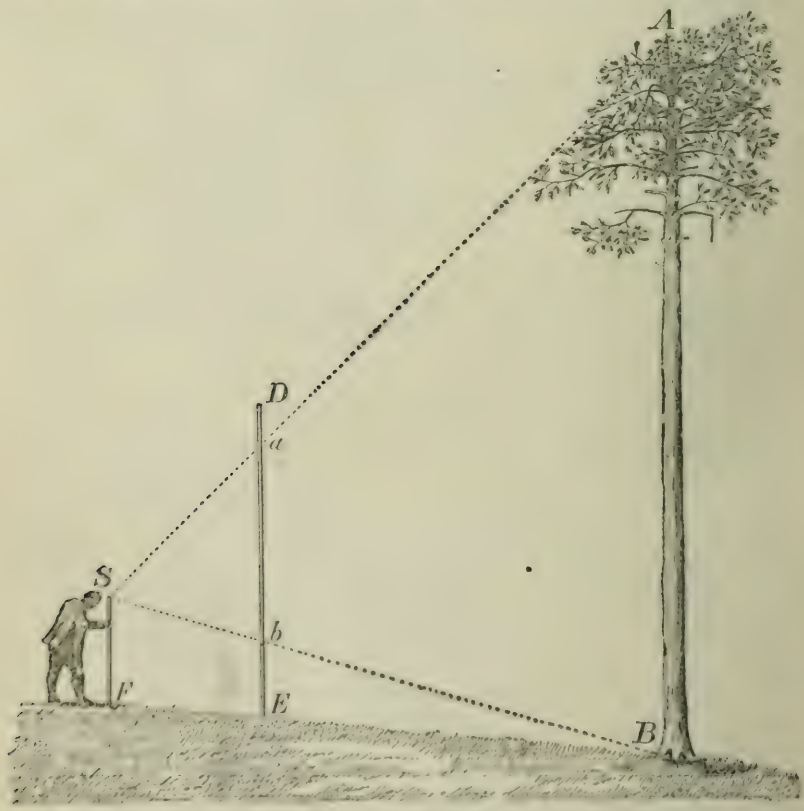

FIG. 131.—Measuring the height of a tree by means of two poles.

of the tree by the length of the pole and divide the product by the length of the shadow of the pole. The quotient will be the height of the tree. A method to be used when the sun is not shining is to set two poles in a line with the tree (fig. 131).

From a point on one pole sight across the other pole to points at the base and the top of the tree. Let an assistant note the points where the lines of vision cross the other pole and measure the distance between them. Also measure the dis-

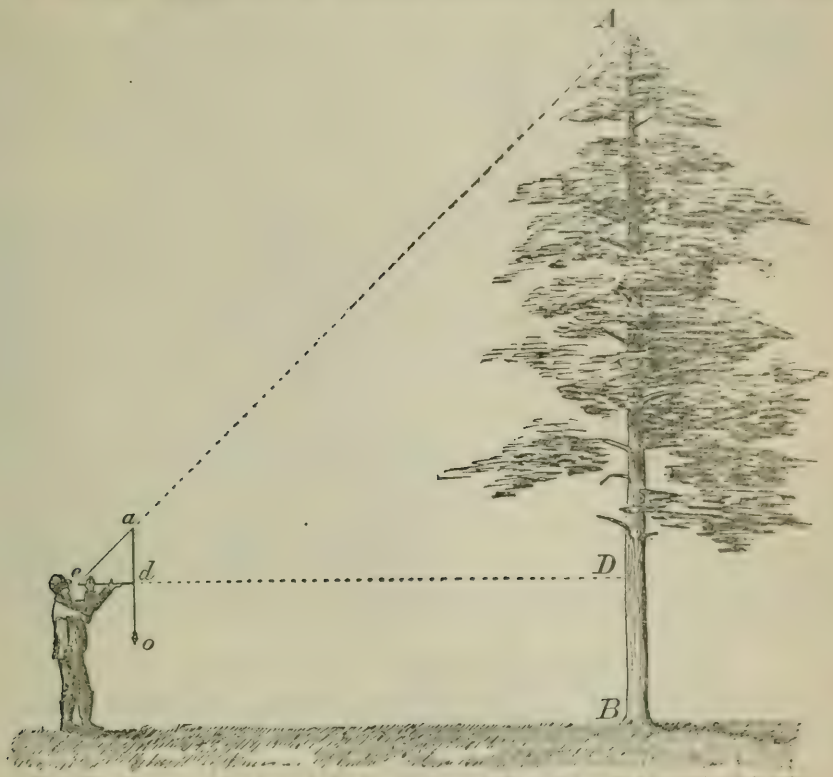

FIG. 132.—Measuring the height of a tree by means of a right angled isosceles triangle.

tances from the point of sighting to the point at the base of the tree and to the lowest point on the other pole. Multiply the first distance by the longer of the other two and divide by the shorter, the quotient will be the height of the tree.

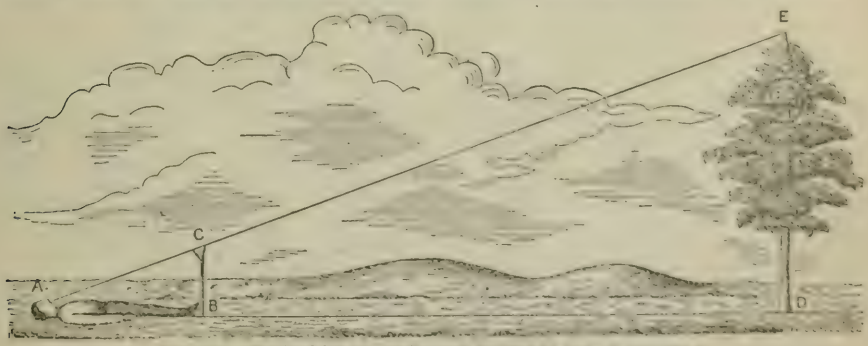

FIG. 133.—Method by use of known height to eye of observer.

Example: Let $ab=6$; $Sb=4$; and $SB=30$; then $\frac{6\times30}{4}=45$, height of tree.

A quicker way is with an isosceles right triangle made of pasteboard. The observer stands on the same level with the tree, places the triangle as shown in

fig. 132, taking care that the plumb line touches the edge of the triangle evenly. Move backward or forward so that the line of sight along the longer side of the triangle just touches the "tiptop" of the tree. Measure the distance from the observer's standpoint to the base of the tree and add the distance from his eye to the ground, the sum will be the height of the tree.

Another way much used is as follows: Walk on level ground to a distance from the foot of the tree or object about equal to its presumed height. Lie on your back on the ground, stretched at full length (fig. 133). Let an assistant note on a perpendicular staff at your feet the exact point where your line of vision to the top of the object crosses the staff. Measure the height of this from the ground BC, and your own height to your eyes AB. Then as AB : BC : : AD : DE.

Example: Let AB=6; BC=5; AD=60; then $\frac{5\times60}{6}=50$, height of tree.

The measurement of the diameter of a tree necessary to reckon approximately its volume is made with a pair of calipers. The form of these is shown in fig. 134. The two arms AC and ED should be accurately parallel at the moment of measuring. The diameter is usually measured above the swelling of the base. The calipers are usually placed breast-high, so that the graduated rule BA and the immovable arm AC touch the trunk of the tree, the rule being at right angles with the axis of the tree at the point of measurement. The arm ED is then moved along the rule until it touches the trunk and the diameter can be read on the rule. The diameter can also be obtained by measuring the circumference of the tree with a tapeline and dividing the number thus obtained by 3.14. With the diameter known, the volume in cubic feet may be roughly reckoned by multiplying the square of half the diameter by 3.14 and multiplying the product thus obtained by half the height of the tree.

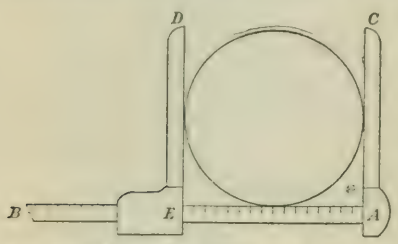

FIG. 134.—Calipers for measuring the diameter of trees.

RATE OF GROWTH OF TREES.

The following tables furnish some interesting data regarding the rate of growth in height and diameter of several important commercial trees:

Rate of growth in height.

Age.	White Pine (Pennsylvania and New York).[1]	Longleaf Pine (Southern States).[2]	Shortleaf Pine (New Jersey).[1]	Shortleaf Pine (Southern States).[2]	Cuban Pine (Southern States).[2]	Loblolly Pine (Southern States).[2]	Douglas Spruce (Oregon).[1]	White Cedar (New Jersey).[1]
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
10 years	.....	9	.....	11	20	18	10	.....
20 years	.....	23	.....	27	45	37	33	11
30 years	25.8	37	24	41	66	50	57	21
40 years	36.5	48	33	51	75	61	76	32
50 years	46	56	41	60	83	70	92	40.5
60 years	55.8	62	47.5	67	89	78	103	48
70 years	60.3	67	53	71	93	85	120	54.5
80 years	65.5	72	57.5	75	96	90	132	60
90 years	70.5	76	61.5	78	99	95	.....	.....
100 years	74.5	80	64.5	81	101	98	.....	.....
110 years	78.5	87	67	.....	103	100	.....	.....
120 years	82	93	69	.....	105	102	.....	.....

[1] Figures obtained by Gifford Pinchot and Henry S. Graves.
[2] Figures obtained by Dr. Charles Mohr.

Rate of growth in diameter.

Age.	White Pine (Pennsylvania and New York).[1]	Longleaf Pine (Southern States).[2]	Shortleaf Pine (New Jersey).[1]	Shortleaf Pine (Southern States).[2]	Cuban Pine (Southern States).[2]	Loblolly Pine (Southern States).[2]	Spruce Pine (Southern States).[2]	Yellow Poplar (North Carolina).[3]	Douglas Spruce (Oregon).[1]	White Cedar (New Jersey).[1]
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
10 years	.....	2.0	.....	3.0	2.9	3.4	5.0	.....	1.9	.....
20 years	.....	3.8	.....	5.2	5.9	5.6	8.5	.....	4.2	2.2
30 years	4.0	5.5	3.4	7.4	9.3	7.8	12.0	.....	6.6	3.7
40 years	5.6	7.0	4.8	9.3	12.3	10.0	.....	4.0	9.0	5.4
50 years	7.1	8.1	5.8	11.0	14.8	11.8	.....	.....	11.4	7.1
60 years	8.5	9.6	7.1	12.7	16.0	13.3	.....	7.1	13.4	8.6
70 years	9.9	11.5	8.2	14.5	17.6	15.5	.....	.....	15.0	9.8
80 years	11.1	13.0	9.2	16.0	18.8	17.1	.....	10.2	16.3	10.9
90 years	12.2	14.5	10.2	16.5	20.0	18.7	.....	.....	.....	.....
100 years	13.3	16.0	11.0	17.0	21.4	19.5	.....	13.3	.....	.....
110 years	14.3	.....	11.7	.....	22.4	20.2	.....	.....	.....	.....
120 years	15.2	18.0	12.4	.....	23.4	20.7	.....	15.9	.....	.....

[1] Figures obtained by Gifford Pinchot and Henry S. Graves.
[2] Figures obtained by Dr. Charles Mohr.
[3] Figures obtained by Dr. C. A. Schenck.

Rate of growth in diameter of Red Spruce before and after lumbering.[1]

[Average of 1,593 trees on cut-over land at Santa Clara, N. Y. Number of trees showing increased growth, 294, or 18 per cent.]

Diameter.	Number of trees.	Current annual growth in diameter.			Number of years required to grow 1 inch in diameter.	Number of trees showing increased growth.	Current annual growth in diameter since first cutting.
		Just before first cutting.	Since first cutting.	Since first cutting, values made regular by a curve.			
Inches.		*Inch.*	*Inch.*	*Inch.*			*Inch.*
5	8	0.095	0.095	0.09	11	1	0.100
6	158	.080	.100	.10	10	16	.180
7	329	.090	.110	.109	9	63	.185
8	350	.105	.125	.125	8	77	.205
9	277	.120	.140	.140	7	59	.205
10	226	.135	.150	.150	7	50	.215
11	135	.130	.145	.160	7	18	.210
12	64	.165	.175	.170	6	7	.240
13	39	.165	.170	.178	6	2	.170
14	11	.150	.150	.185	6	1	.200
15	1	.080	.080	.192	6	.....	.....
16	4	.200	.200	.200	5	.....	.....
Average	.....	.112	.137	.....	.....	.....	.20
Number of years to grow 1 inch	.....	9	.....	.....	7	.....	5

[1] From The Adirondack Spruce, by Gifford Pinchot.

LEGAL STANDARDS FOR DAIRY PRODUCTS, 1898.

The following table shows the requirements for articles sold under the names specified. States not named have no laws prescribing standards for dairy products.

[Prepared by Dairy Division, B. A. I.]

States.	Milk.			Skim milk.	Cream.	Butter.	Cheese.
	Total solids.	Solids not fat.	Fat.	Total solids.	Fat.	Fat.	Fat.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
California							Full cream, 30 p. c. fat. Half skim, 15 p. c. fat. Skim, from skim milk.
Colorado							35 p. c. total solids to be fat.
District of Columbia		9	3.5	9.3	20	83 Not over 12 p. c. water or 5 p. c. salt.	
Georgia		8.5	3.5				
Illinois	12		3				
Iowa	12.5		3		15		
Maine	12		3				
Massachusetts	13	9.3	3.7	9.3			
April-August	12	9	3				
Michigan	12.5		3				
	Sp. grav. 1.029-33			Sp. grav 1.032-37			
Minnesota	13		3.5		20		45 p. c. total solids to be fat.
Missouri							From milk testing at least 3 p. c. fat.
New Hampshire	13						
New Jersey	12						
New York [1]	12		3				
Ohio [1]	12		3			80	20 p. c. fat.
May and June	11.5						
Oregon	12		3 12 p. c. cream by vol.	Sp. grav 1.035		Not over 14 p. c. water.	
Pennsylvania (Milk and skim milk standards refer to cities of second and third class.)	12.5 Sp. grav. 1.029-33		3	2.5 p. c. fat. 6 p. c. cream by vol. Sp. grav 1.032-37			Full cream, 32 p. c. fat. Three-fourths cream. 24 p. c. fat. One-half cream, 16 p. c. fat. One-fourth cream, 8 p. c. fat. Skimmed, below 8 p. c. fat.
Rhode Island	12		2.5				
South Carolina		8.5	3				
Utah				9 p. c. solids not fat.			
Vermont	12.5	9.25					
May and June	12						
Washington		8	3				Full cream, 30 p. c. fat. Half skimmed, 15 p. c. fat. Skimmed, from skim milk.
Wisconsin			3				

[1] In New York and Ohio the milk solids of condensed milk shall be in quantity the equivalent of 12 per cent of milk solids in crude milk, of which solids 25 per cent shall be fat.

DETERMINATION OF AGE BY TEETH IN DOMESTIC ANIMALS.[1]

Horse.—The horse has 24 temporary teeth. The male has 40 permanent teeth; the female 36 or 40. The smaller number is more usual in females, due to the lack of the tusks. The temporary teeth consist of 12 incisors and 12 molars; the 4 center front teeth, 2 above and 2 below, are called pinchers; the next 4 are called intermediate or lateral, and the next 4 corner teeth. The permanent teeth consist of 12 incisors, 4 tusks, and 24 molars. The dental star is a yellowish ring appearing next the enamel on the table or crown of the tooth. The following table shows approximately the changes of the teeth with age:

3 to 10 days: Temporary pinchers and 3 molars cut.
40 to 60 days: Temporary intermediates or laterals cut.
6 to 9 months: Temporary corner teeth cut.
19 to 25 months: Leveling of temporary corner teeth.
2½ to 3 years: Pinchers replaced by permanent teeth.
3½ to 4 years: Intermediates or laterals replaced.
4 to 4½ years: Tusks cut.
4½ to 5 years: Corner teeth replaced.
5 to 6 years: Leveling of lower pinchers.
7 years: Leveling of permanent intermediate.
8 years: Dental star and notches in pinchers.
9 years: Dental star in intermediates.
10 years: Dental star in corner teeth.

Cattle.—Cattle have 20 temporary and 32 permanent teeth. The temporary are 8 incisors in the lower jaw and 12 molars. The permanent teeth are 8 incisors and 24 molars. Cattle have no incisors in the upper jaw. The table for cattle is as follows:

At birth: Temporary incisors appear.
5 to 6 months: Teeth decayed on border.
6 to 7 months: Leveling of pinchers.
12 months: Leveling of first intermediates.
15 months: Leveling of the second intermediates.
18 months: Intermediate incisors become stumps.
2 years: Permanent pinchers cut.
2½ to 3 years: Permanent first intermediates cut.
3½ years: Second intermediates or laterals cut.
4 years: Corner teeth replaced.
5 to 6 years: Leveling of permanent pinchers.
7 years: Leveling of first intermediates.
8 years: Leveling of second intermediates.
9 years: Leveling of corner teeth.
10 to 12 years: Dental star in pinchers and intermediates.
13 years: Dental star in corner teeth.

Sheep.—Sheep have 20 temporary and 32 permanent teeth. The table for changes is as follows:

1 month: Milk incisors appear.
3 months: Milk incisors decayed on border.
15 months: Permanent incisors cut.
2 years: First permanent intermediates cut.
33 months: Second permanent intermediates cut.
40 months: Corner teeth cut.

Hogs.—Hogs have 28 temporary and 44 permanent teeth. The table for changes is as follows:

At birth: Temporary corner incisors cut.
1 to 2 months: Temporary central incisors cut.
3 months: Temporary lateral incisors cut.
9 to 12 months: Permanent corner incisors cut.
12 to 15 months: Permanent central incisors cut.
18 to 20 months: Permanent lateral incisors cut.

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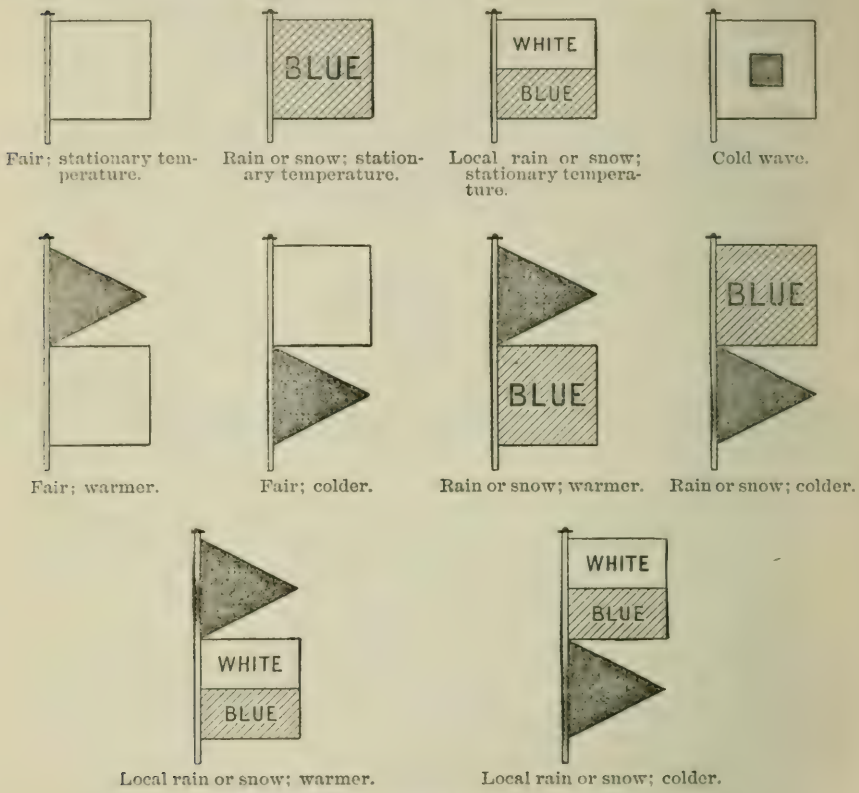
[1] Exact correspondence of the condition of an animal's teeth with its age is, of course, not to be expected. It is only hoped that the tables here given, and approved by the Bureau of Animal Industry, will aid in forming a reasonably accurate opinion in any actual case.

WEATHER BUREAU SIGNALS.

The following illustrations (fig. 135) show how flags are used in the weather service to convey information of forecasts. They are self-explanatory.



Fair; stationary temperature. Rain or snow; stationary temperature. Local rain or snow; stationary temperature. Cold wave.

Fair; warmer. Fair; colder. Rain or snow; warmer. Rain or snow; colder.

Local rain or snow; warmer. Local rain or snow; colder.

FIG. 135.—Temperature and rainfall signals.

Recent extension of the publication of United States weather forecasts has been largely through cooperation with the post-offices of the country. An arrangement was made in 1895 by which daily telegraph reports of weather forecasts began to be sent to postmasters at distributing offices. The forecasts were bulletined in these offices and sent out by cards to outlying post-offices. This plan has been taken up extensively by postmasters and weather forecasts are now sent to several hundred post-offices that are reached by wire.

Weather forecasts can be obtained anywhere that wires run by payment for transmission of dispatches and for material for signaling or other method of announcement. Where evidence is supplied that value of the service to the public will warrant the expense, flags will be supplied and telegraph service paid for by the Weather Bureau. Where such an extension of the service is desired a letter should be addressed to the Chief of the Weather Bureau in Washington or to the chief office of the section in which the new station is desired, and each case will be considered and disposed of on its merits.

Another method of supplying information as to weather probabilities is by means of whistle signals. One long whistle, fifteen to twenty seconds, calls attention to the fact that a weather signal is about to be given. Then very short blasts, one to three seconds each, indicate the probable change in temperature; while a series of longer whistles, four to six seconds each, tell whether it will be fair or "falling" weather. One short blast means colder; two, warmer; three, cold wave. One long blast means fair weather; two, rain or snow; three, local rain or snow.

By repeating each combination a few times at intervals of ten seconds possibility of error from failure to hear the warning signal or other cause may be avoided.

A system of whistle signals is in use at present by the Florida Central Railroad through the truck-growing section of that State. It has been found to be very useful in giving warning of cold waves and frosts.

Warnings of wind storms are given on the sea coast and on the Gulf and the Great Lakes. The principal ports have a special service of this kind, and from these ports announcements are sent to minor stations in the vicinity. Practically there are no volunteer stations in the service. Displaymen are in the employ of the Weather Bureau, except in a few cases where they are connected with the Light-House and Life-Saving services under the Treasury Department. The following illustrations (fig. 136) show the warnings given by these flags:

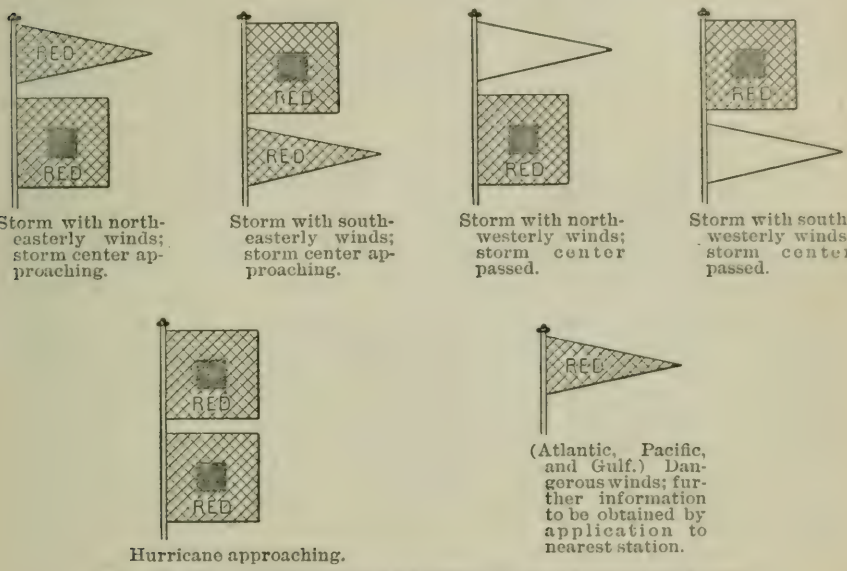


FIG. 136.—Storm information and hurricane signals for use on the coast.

In addition to the display of flags as shown here, night signals are given by means of lanterns. A red light indicates easterly winds, and a white light above a red light westerly winds. No hurricane signal is displayed at night.

When Weather Bureau flags are displayed side by side a streamer is added at the end, which is to be considered the top of the flagstaff.

RECKONING OF AMOUNT AND VALUE OF HAY.

Four hundred cubic feet of hay is roughly estimated as a ton. But there is great variation in the ratio of weight to volume, dependent upon the kind of hay, time of cutting, and treatment in storing. In general, the finer the stalk of the plant the heavier the hay; also, of course, the more closely packed in putting away and the nearer the bottom of the mow the heavier. Grass allowed to stand till nearly ripe before cutting will be the lighter.

In estimating by measurement multiply together the figures representing the length, width, and height of hay, and divide the product by the number of feet in a ton. For example, if the hay is 40 feet long, 16 feet wide, and 18 feet from the bottom to the top of the mow, and the bulk agreed is 400 feet to the ton, the mow will contain 40 times 16 times 18, which equals 11,520 cubic feet; 11,520 divided by 400 equals 28 tons and 320 cubic feet, or $28\frac{4}{5}$ tons. The table on the following page is from the American Agriculturist annual.

Table for finding the value of hay.

Pounds.	$4.	$5.	$6.	$7.	$8.	$9.	$10.	$11.	$12.	$13.	$14.	$15.	$16.	$17.	$18.
50	0.10	0.13	0.15	0.18	0.20	0.23	0.25	0.28	0.30	0.33	0.35	0.38	0.40	0.43	0.45
70	.14	.18	.21	.25	.28	.32	.35	.39	.42	.46	.49	.53	.56	.60	.63
90	.18	.23	.27	.32	.36	.41	.45	.50	.58	.59	.63	.68	.72	.77	.81
100	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90
300	.60	.75	.90	1.05	1.20	1.35	1.50	1.65	1.70	1.95	2.10	2.25	2.40	2.55	2.70
400	.80	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.25	3.40	3.60
500	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50
700	1.40	1.75	2.10	2.45	2.80	3.15	3.50	3.85	4.20	4.55	4.90	5.25	5.60	5.95	6.30
900	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.95	5.40	5.85	6.30	6.75	7.20	7.65	8.10
1,000	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00
1,200	2.40	3.00	3.60	4.20	4.80	5.40	6.00	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80
1,500	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00	9.75	10.50	11.25	12.00	12.75	13.50
1,600	3.20	4.00	4.80	5.60	6.40	7.20	8.00	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40
1,700	3.40	4.25	5.10	5.95	6.80	7.65	8.50	9.35	10.20	11.05	11.90	12.75	13.60	14.45	15.30
1,800	3.60	4.50	5.40	6.30	7.20	8.10	9.00	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20
1,900	3.80	4.75	5.70	6.65	7.60	8.55	9.50	10.45	11.40	12.35	13.30	14.25	15.20	16.15	17.10
2,000	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.10	18.00

The price per ton of 2,000 pounds being known, it is very easy to find the value of any fraction of a ton at $4 to $18 per ton. If a farmer has 1,565 pounds of hay on his wagon, and the dealer has bought it at $7 per ton, he finds, by looking across the table from 1,500 pounds to the column at the top of which is $7, that the value of 1,500 pounds at $7 per ton is $5.25, the value of 60 pounds 21 cents, and the value of 5 pounds 2 cents, making a total of $5.48. If the price was $7.50 per ton, he would also find the value of 1,565 pounds at 50 cents per ton, and add it to $5.48, the value at $7 per ton. To find the value at 50 cents, first find it at $5, and take one-tenth of that sum. The value of 1,500 pounds at $5 per ton is $3.75, at 50 cents, 37.5 cents. The value of 60 pounds at $5 per ton is 15 cents, and at 50 cents it is 1.5 cents, making the value of 1,565 pounds at 50 cents per ton, 39 cents, which sum, added to $5.48, gives $5.87, the value of 1,565 pounds at $7.50 per ton.

To find the value of any fraction of a ton at $7.40, $7.60, $7.70, $7.80, or $7.90, find the value at $7 and add to it one-tenth the value at $4, $6, $7, $8, or $9.

To find the value at $7.30, add one-thirtieth of the value at $9 to the value at $7.

To find the value at $7.25, add one-twentieth of the value at $5 to the value at $7; and to find it at $7.20, add one-twentieth of the value at $4 to the value at $7. To find the value at $7.10, add one-one-hundredth of the value at $10 to the value at $7.

CUBA: ITS POPULATION AND RESOURCES.

The island of Cuba, the largest of the West Indies, lies directly south of the State of Florida, between longitude 74° and 85° west of Greenwich and between 19° and 23° north latitude. From Key West, Fla., to the nearest point of the island is 86 miles; from Key West to each of the two principal seaports of Cuba—Havana and Matanzas, both situated on the north coast—95 miles. The island is 760 miles long and from 135 to 160 miles wide. Measuring from the extremities of the capes the coast line is about 2,200 miles, but including all indentations is about 6,500 miles. There are 32 harbors on the northern coast, of which Havana, Mariel, Cabanas, Bahia Honda, Matanzas, Cardenas, Sagua, Caibarien, Nuevitas, and Gibara are the most important. The southern coast has 12 important harbors, Guantanamo, Santiago de Cuba, and Cienfuegos being the best. Most of the important harbors of the island will admit vessels drawing 26 feet of water.

The exact area of the island is not known; it has been estimated all the way from 35,000 to 72,000 square miles. A chain of mountains extends through the Eastern provinces, the highest of which is about 8,000 feet. The territory is well supplied with streams, there being more than 200 rivers. The Cauto River, in the province of Santiago de Cuba, is 150 miles long and is navigable for small craft for 50 miles. Another large stream is the Sagua, in Santa Clara province. This is 111 miles long and has a navigable channel for 12 miles.

The climate of Cuba in the rural districts in the east and center of the island is considered healthful. Malarial fever prevails in some localities and yellow fever in many cities, but this is believed to be due in large part to bad sanitary conditions.

At Havana the maximum temperature occurs between noon and 2 o'clock p. m. and the minimum between dawn and sunrise. The average annual temperatures at Havana during the last ten years have been as follows: Mean, 76.8°; highest,

100.6°; lowest, 49.6°. The temperature at Matanzas is slightly higher than at Havana, and the annual average is about 4° higher at Santiago de Cuba.

There are only two seasons in Cuba, the dry and the rainy. The rainy season begins in May and ends with October, and two-thirds of the annual rainfall occurs during the months from June to October.

The soil is very rich and fertilizers are seldom used. The mountains are of coral formation, and the lowlands in eastern Cuba are extremely rich in lime and phosphates.

The population of the six provinces of Cuba in 1890 was as follows:

Pinar del Rio	225,891
Havana	451,[illegible]
Matanzas	259,578
Santa Clara	354,122
Puerto Principe	67,789
Santiago de Cuba	272,379
Total	1,631,687

The present population, exclusive of the military, is about 1,500,000. Of this number 460,000 are negroes, 860,000 white natives, 140,000 white Europeans, 30,000 Chinese, and 10,000 of other nationalities.

The landowners are generally Cubans, but there are large holdings in the hands of Spanish, Americans, English, Germans, and French. Nearly all of the professional and literary men are Cubans. While Spanish, German, and English capital is very conspicuous in the cigar and tobacco trade, the business is mostly in the hands of Cubans. Private banking and similar interests are principally in the hands of the Spanish.

The sugar industry is largely controlled by the Spanish, Americans, English, and French, but it is also followed to a great extent by Cubans. The mining industry is almost entirely American. The railroads are owned by Spanish, English, American, and French capital, but have been mostly under Spanish and English management. The great majority of merchants are Spanish. The blacks form the bulk of ordinary laborers throughout the island. They are nearly all Cubans by birth. There are many Spaniards among the cigar makers, but Cubans are in a majority.

In the cities, especially in Havana, a large proportion of the ordinary white labor is Spanish peasantry, but the great majority of the country population—small farmers, peasantry, day laborers, etc.—are Cubans. The seafaring people along the coast are to a great extent Spanish, and the machinists, steam engineers, and railroad hands are Spanish and Cubans. The chief engineers of nearly all the sugar estates are Americans, English, or French.

The wealth of Cuba lies in the great fertility of its soil. The principal industry of Cuba has for many years been the cultivation of sugar cane and the making of sugar. The production of sugar in 1823 was 75,000 tons; in 1848 it had risen to 225,000 tons, and in 1894 to 1,054,214 tons. The exports of sugar in 1895 amounted to 5,996,272 sacks and 3,743 hogsheads, or 832,431 tons.

Cattle raising has been an important industry in the past, but has never been developed to the extent which the natural conditions would seem to warrant. The numbers of domestic animals on the island in 1891 were as follows: Horses, 531,416; mules, 43,309; cattle, 2,485,768; hogs, 570,194, and sheep, 78,484. All of these have practically disappeared, and consequently it will be necessary to restock the pastures of the island.

About 80,000 persons are employed in the cultivation of tobacco.

Besides sugar, tobacco, and coffee Cuba produces all the fruits known to the tropics and many belonging to the temperate zone. Among these are the pineapple, banana, orange, mango, and guava. The cocoanut is also an important product.

The forest wealth of Cuba is very great and but slightly developed. The island is rich in cabinet wood, the most important being mahogany and cedar. There are 32 species of palm trees, the wood and leaves of which are used in the manufacture of several articles of trade.

Iron mining is the most important industry on the eastern end of the island. The mines are all located near Santiago. In 1897 two American companies employed 800 to 1,400 men and shipped to the United States from 30,000 to 50,000 tons of ore per month.

The following table shows the extent of trade between the United States and Cuba. The principal imports are sugar and molasses, tobacco, and fruits. The

chief exports are lard and meats, breadstuffs, iron and steel manufactures, wood and manufactures of wood, and kerosene.

Value of merchandise imported and exported by the United States in our trade with Cuba during the fiscal years 1887 to 1896, inclusive, and the nine months ended March 31, 1897.

Years ended June 30—	Imports.	Exports.			Total trade.
		Domestic merchandise.	Foreign merchandise.	Total.	
1887	$49,515,434	$10,138,930	$407,481	$10,546,411	$60,061,845
1888	49,319,087	9,724,124	329,436	10,053,560	59,372,647
1889	52,130,623	11,297,198	394,113	11,691,311	63,821,934
1890	53,801,591	12,669,509	414,906	13,084,415	66,886,006
1891	61,714,395	11,929,605	295,283	12,224,888	73,939,283
1892	77,931,671	17,622,411	331,159	17,953,570	95,885,241
1893	78,706,506	23,604,094	553,604	24,157,698	102,864,204
1894	75,678,261	19,855,237	270,084	20,125,321	95,803,582
1895	52,871,259	12,533,260	274,401	12,807,661	65,678,920
1896	40,017,730	7,312,348	218,532	7,530,880	47,548,610
1897 (nine months ended Mar. 31)	8,841,831	5,685,888	399,098	6,084,986	14,926,817

A BRIEF ACCOUNT OF THE PHILIPPINE ISLANDS.

The Philippine Islands, recently ceded to the United States by the treaty of Paris, lie wholly within the Tropics, and extend on the south to within 4½° of the equator.

The number of islands is variously stated at from 600 to 2,000, but it is believed that 1,200 is nearly correct; of these about 600 are habitable. The most important islands and their areas in square miles are as follows:

Luzon	41,000
Mindanao	37,500
Samar	5,300
Panay	4,600
Palawan	4,150
Mindoro	4,050
Leyte	3,090
Negros	2,300
Cebu	1,650
Masbate	1,350
Bohol	925
Catanduanes	450

Among the other islands the following are said to contain from 100 to 250 square miles each: Basilan, Busuanga, Culion, Marandaque, Tablos, Dinagat, Sulu, Guimaras, Tawi, Camiguin, Siargao, and Polillo.

The climate is hot. There is a hot season, a dry season, and a wet season, but never a cool season. The burning sun of the dry season is not so hard to bear as the "muggy" weather when there is an alternation of bright sunshine and heavy showers, or rainfall day after day without intermission. Since the islands extend through about 16° of latitude, it necessarily follows that the intensity of the heat varies considerably in different parts of the group.

The only place where reliable weather records have been kept is in Manila, and there the average temperature is 80°. The lowest temperature during the year is 60° and the highest 100°. There is no month in the year in which it does not rise to 91°. But malaria is more serious than the heat. While some of the islands are free from it others are veritable pest holes. There are malarial fevers which recur every third day, some every second day, and others daily. There is also a malignant type which is local in its occurrence, which terminates in a few hours with black vomit and death. Much of the illness from malaria is due to causes which can be remedied. Smallpox, though never epidemic, is always present. The climate affects women and children quicker than it does men.

The population of the Philippine Islands numbers probably 7,500,000. The natives are mostly of the Malayan race. Nearly half of the population inhabit the island of Luzon. The Tagals of Luzon are a copper-colored people, and like all people of the Malay race are short of stature. They are the most advanced and influential of the entire population. There are many very intelligent men

among them, and at present they number about 2,000,000, and are rapidly increasing. The Vicols, who occupy the Camarines Peninsula, with the islands of Catanduanes, Burias, Ticao, and half of Masbate, are next in point of intelligence, and, like the Tagals, have made considerable progress in civilization. They number between 400,000 and 500,000. The Visayas occupy the islands between Luzon and Mindanao, and are estimated at 2,500,000. In addition to these are the Moors of the Sulu Archipelago, the Negritos, and some other families of the Malay race. The Negritos are a race of small blacks, believed to be the aborigines of the archipelago and are almost extinct. They are occasionally met in the mountains of Luzon, Negros, and Mindanao.

Spanish rule in Mindanao was confined to narrow strips of territory along the coasts and the more important towns, and the Moslem population of Basilan, Sulu, and Tawi Tawi is virtually independent. Wild Malay tribes are found in some parts of Luzon, Negros, and Mindanao, and there are probably some in the mountains of Panay and Samar. They people the whole of Mindoro and Palawan, except a few points along the coast. The remainder of the important islands were, until recently, under Spanish control.

The Mohammedan tribes of the southern islands are a brave, warlike people, well provided with excellent steel weapons. They are born pirates, and particularly in Sulu, have a fanatical hatred of all Christians.

Pagan Malays form the wild population of the northern islands. Of the independent tribes inhabiting Mindanao, 17 are pagan and 6 Mohammedan.

Chinese form an important and at present a necessary element in the population of the Philippines. In Manila alone they number 40,000. In some of the larger cities there are a few coolies, but the great majority of the Chinese are in business, and the retail business of the Philippines is almost entirely in their hands.

The people of mixed blood and the civilized natives compose the bulk of the population of the islands.

The principal city is Manila. It is situated on the island of Luzon and has a population of considerably over 300,000.

The soil of the islands is remarkably fertile. The principal products are sugar, abaca or manila hemp, tobacco, rice, coffee, maize, cacao, yams, cocoanuts, and bananas.

Gold mining is being carried on in the island of Luzon with favorable prospects, and coal mining in Cebu.

The extent of the trade of the Philippines can be approximated from the following statement, which presents the latest official figures. The leading exports are manila hemp, sugar, leaf tobacco, cigars and cigarettes, coffee, and sapan wood. Leading imports are breadstuffs, meat products, canned goods, cotton manufactures, iron manufactures.

Trade of the Philippine Islands, by countries, during the calendar year 1893.

Countries.	Imports.			Exports.			Total imports and exports.	
	Pesos.	*Dollars.*	*Per ct.*	*Pesos.*	*Dollars.*	*Per ct.*	*Dollars.*	*Per ct.*
United Kingdom	6,929,662	4,247,883	26.73	16,247,877	9,959,949	44.90	14,207,832	37.32
China (including Hongkong)	3,650,340	2,237,471	14.08	7,929,654	4,866,640	21.94	7,104,111	18.66
Spain	8,327,691	5,104,875	32.13	3,130,919	1,919,253	8.65	7,024,128	18.45
United States	1,560,695	956,706	6.02	4,885,639	2,994,897	13.50	3,951,603	10.38
Germany	2,033,031	1,246,248	7.84	32,182	19,728	.09	1,265,976	3.32
Egypt (Port Said)	5,195	3,185	.02	1,887,055	1,156,765	5.21	1,159,950	3.05
France	778,183	477,026	3.00	394,525	241,844	1.09	718,870	1.89
Singapore	254,707	156,135	.98	831,831	509,912	2.30	666,047	1.75
French Indo-China *a*	844,915	517,933	3.26	9,340	5,725	.03	523,658	1.38
Japan	298,006	182,678	1.15	498,666	305,682	1.38	488,360	1.28
Russia	428,965	262,956	1.66				262,956	.69
Switzerland	337,357	206,800	1.30				206,800	.54
Belgium	127,801	78,342	.49	74,034	45,383	.20	123,725	.32
Australasia	106,687	65,399	.41	75,985	46,579	.21	111,978	.29
Dutch East Indies				154,277	94,572	.43	94,572	.25
Austria-Hungary	102,725	62,970	.40	350	214		63,184	.17
Netherlands	66,230	40,599	.26	18,012	11,041	.05	51,640	.14
Italy	52,831	32,385	.20	1,150	705		33,090	.09
British India	4,250	2,605	.02	6,480	3,972	.02	6,577	.02
Sulu Islands	8,645	5,299	.03				5,299	.01
Sweden and Norway	2,375	1,456	.01				1,456	
Denmark	2,205	1,352	.01				1,352	
Portugal	325	199		590	362		561	
Total	25,922,515	15,890,502	100.00	36,187,966	22,183,223	100.00	38,073,725	100.00

a Through Saigon.

POSTAL REGULATIONS.

Domestic mail in the United States is divided into four classes. First class is everything mailable which bears handwriting or typewriting other than the addresses of the sender and person addressed, except manuscript copy accompanying proof sheets and corrected proofs; also first class are all packages so sealed or otherwise closed as to prevent inspection, except merchandise sealed up in fixed quantities by manufacturers and so packed for mailing that each package of fixed quantity as sealed at factory may be examined. The rate of postage for first-class matter is 2 cents an ounce or fraction thereof. But "drop letters," where carriers are not employed, pay 1 cent an ounce. One 2-cent stamp will carry any mailable package of the first class, and any additional postage required will be collected from the recipient. Soldiers' and sailors' letters, properly certified by specified officers, go unpaid; but postage is collected on delivery.

Second-class mail consists of such newspapers and other periodicals as are approved as second class by the official of the Post-Office Department assigned to pass upon them. The rate of postage for second-class mail is 1 cent per pound or fraction thereof when sent by the publisher or news agents to subscribers or news agents. But one copy to each subscriber in the county of publication goes free, except where letter carriers are employed.

Third-class matter consists of books, circulars, pamphlets, and other matter wholly in print (not included in the second class), manuscripts accompanying proof sheets and corrected proofs. The rate of postage is 1 cent an ounce or fraction thereof, and must be fully prepaid. Seeds, bulbs, roots, and plants, although called fourth-class mail, are mailable at the third-class rate.

Fourth-class mail comprises everything mailable which is not included in another class. The rate of postage is 1 cent for each ounce or fraction thereof, and must be prepaid.

Nothing is mailable that weighs over 4 pounds or is liable to injure postal employees or to damage other mail.

Much mail is sent free under the franking privilege on the ground that its transmission does the public a service equivalent to the rate of postage.

The application of the regulations for domestic mail is extended to new territory of the United States as promptly as practicable. Information as to this extension must be obtained from local postmasters.

FOREIGN MAILS.

Mail matter for or from foreign countries (except Canada and Mexico) is classified as "letters," "post cards," "newspapers and other printed matter," "commercial or business papers," and "samples of merchandise."

The limit of weight for a single rate on letters for Canada and Mexico is 1 ounce, and on letters for other foreign countries is half an ounce.

Letters carried by vessels not regularly employed in carrying the mails (commonly called "ship letters") are subject to double rates of domestic postage (4 cents per ounce) on delivery. Postage can be prepaid upon articles (other than the reply half of double postal cards) only by postage stamps of the country in which the articles *are mailed*. Canada and Mexico are the only foreign countries to which second-class matter in domestic mails (periodicals) may be sent at the pound rate of postage. Periodicals for all other foreign countries, whether "transient" or for regular subscribers, are required to be prepaid with postage stamps at the rate applicable to "printed matter" for those countries.

Rates of postage chargeable in the United States on mail matter for foreign countries.

Countries or places of destination.	Letters per 15 grams or one-half ounce.	Post cards.		Registration fee.	Printed matter of all kinds per 2 ounces.	Commercial papers per 2 ounces.	Samples of merchandise per 2 ounces.
		Single, each.	With paid reply, each.				
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
All of the countries and colonies of the Universal Postal Union (except Canada and Mexico) and countries and colonies *not* in the Universal Postal Union	5	2	4	8	1		
Canada	United States domestic rates					The same as for "printed matter," except that the lowest charge on any package, whatever its weight, is 5 cents.	
At least one single rate of postage (2 cents) must be prepaid on ordinary letters. Plants and seeds are subject to the rate of 1 cent per ounce. "Printed matter" is subject to the domestic rate.							
Mexico. At least one single rate (2 cents) must be prepaid on ordinary letters.							

On articles for the following places, countries, and colonies not in the Universal Postal Union, additional postage may be collected on delivery:

Africa.—Abyssinia (articles may be registered for delivery at Djibouti, Somali coast); Bechuanaland Protectorate, including Kanye; Macloutsie, Molepolole, Palachwe; (Khamastown), Shoshong and Tati River; Rhodesia (British Central Africa), including Mashonaland, Matebeleland, British Nyasseland; Barotse, Lake Moero, Tanganyika and Upper Zambesi; Comoro Islands (Grand Comoro), Anjouan, Mohele; Morocco, except European post-offices; Niger Coast Protectorate, including Benin, Bonny Brass, Calabar (new and old), Opobo and Warree, or Forcados; West Coast, native possessions.

Asia.—Afghanistan, China.[1]

Oceanica.—Cook Islands (Rarotonga), Friendly (Tonga) Islands, Navigators Islands or Samoa, Pitcairn Islands, Savage Islands, Society Islands; other islands in the Southern Pacific Ocean.

Articles destined for the above-named places can not be sent under registration *through to destination.*

Letters, postal cards, printed matter of all kinds, commercial papers and samples of merchandise are transmissible in the mails for all foreign countries, whether said countries are embraced in the Postal Union or not.

Packets of printed matter, commercial papers, and samples must not contain any letter or manuscript note having the character of an actual and personal correspondence, and must be made up in such manner as to admit of being easily examined. Unpaid letters and postal cards received from foreign countries are chargeable with 10 cents per half ounce. Prepayment of postage upon ordinary letters is optional *with senders.* Full prepayment is required upon *all registered articles*, and postage upon all articles other than letters is required to be prepaid, at least in part.

Newspapers and other political publications of foreign origin are not allowed circulation in Russia by mail, except such as are addressed to members of the reigning imperial family, the minister of the empire, or members of the diplomatic corps. Nonpolitical publications and newspapers are only admitted to circulation

[1]Articles of every kind and nature which are admitted to the United States domestic mails are admitted to the mails exchanged between the United States and the United States Postal Agency at Shanghai, China; subject, however, to the following rates of postage, which must be prepaid by means of United States postage stamps:

First-class matter, 5 cents for each half ounce or fraction of half ounce. Postal cards, single, 2 cents; double, 4 cents each. Second and third class matter, and samples of merchandise not exceeding 8 ounces, 1 cent for each 2 ounces or fraction of an ounce. Packages of third and fourth class matter must not exceed 4 ounces in weight.

by mail when addressed to the Public Imperial Library, the Academy of Sciences, the higher establishments of education and established bookstores, but any person in Russia may subscribe at the Russian post-offices for foreign newspapers and publications, whether political or not.

COIN AND CURRENCY OF THE UNITED STATES.

There are ten different kinds of money in circulation in the United States, namely, gold coins, standard silver dollars, subsidiary silver, gold certificates, silver certificates, Treasury notes, United States notes, national-bank notes, and nickle and bronze coins. The United States notes are commonly known as greenbacks, and also as legal tenders.

While all these forms of money are available as money, they do not all possess the full legal-tender quality. When gold coin is not below the standard prescribed by law it is legal tender at its nominal or face value for all debts, public and private. When below the standard it is legal tender in proportion to its weight. Standard silver dollars are legal tender to any amount. Subsidiary silver is legal tender to the amount of $10 in any one payment. Treasury notes are legal tender for all debts, public and private.

United States notes are legal tender for all debts except duties on imports and interest on the public debt. Gold certificates, silver certificates, and national-bank notes are *not* legal tender; but the certificates are receivable for all public dues. The national-bank notes are receivable for all public dues except duties on imports. They may be paid out by the Government for salaries and other debts owing by the United States within the United States, except interest on the public debt and in redemption of the national currency. All national banks are by law required to receive the notes of national banks at par. The nickel and copper coins are legal tender up to 25 cents.

Gold is now coined in denominations of $2.50, $5, $10, and $20, called, respectively, quarter eagles, half eagles, eagle, and double eagles. The coinage of the $1 and $3 gold pieces was discontinued under the act of September 26, 1890. The gold unit of value is the dollar, which contains 23.22 grains fine gold and 2.58 grains of copper alloy. The weight of the quarter eagle is 67.5 grains; half eagle, 135 grains; eagle, 270 grains; double eagle, 516 grains.

The silver now coined consists of the standard dollar, half dollar, quarter dollar, and dime. The coinage of the silver trade dollar, 20-cent, half-dime, and 3-cent piece have been discontinued. The silver unit is the dollar. It contains 371.25 grains of fine silver, and of copper alloy 41.25 grains.

Other coins are: Five-cent (nickel), weight, 77.16 grains; composed of 75 per cent copper and 25 per cent nickel. Cent (bronze), weight, 48 grains; composed of 95 per cent copper and 5 per cent tin and zinc.

The first paper money issued by the United States Government was authorized by the acts of July 17 and August 5, 1861. The notes issued under these acts were called "demand notes," because they were payable on demand at certain designated subtreasuries. The act of February 25, 1862, provided for the substitution of the United States notes for the demand notes, and they were therefore canceled when received. The following table presents a view of the currency circulation:

Kinds and denominations of paper currency in circulation.

United States notes.	Treasury notes.	National-bank notes.	Silver certificates.	Gold certificates.
$1	$1	----------	$1	----------
2	2	----------	2	----------
5	5	$5	5	----------
10	10	10	10	----------
20	20	20	20	$20
50	50	50	50	50
100	100	100	----------	100
500	----------	500	500	500
1,000	1,000	1,000	1,000	1,000
5,000	----------	----------	----------	5,000
10,000	----------	----------	----------	10,000

The issue of the gold certificates was suspended under the act of April, 1893, and has never been resumed, but there are nearly $37,000,000 of these certificates outstanding.

Several years ago a very dangerous counterfeit of the $100 silver certificate appeared. All certificates of that denomination were called in, and they are canceled when they reach the Treasury. These certificates to the amount of nearly $7,000,000 are still outstanding, but no $100 silver certificates are now issued.

LEGAL HOLIDAYS.

January 1: All States except Massachusetts, Minnesota, New Hampshire, and Rhode Island; New Year's.

January 8: Louisiana only; Anniversary of Battle of New Orleans.

January 19: Florida, Georgia, North Carolina, and Virginia; Lee's Birthday.

February 12: Illinois, Minnesota, New Jersey, New York, and Washington; Lincoln's Birthday.

February 22: All States except Iowa, Mississippi, and New Mexico; Washington's Birthday.

March 2: Texas; Texan Independence Anniversary.

April, first Saturday: Utah; Arbor Day.

April, first Wednesday: Rhode Island; Election Day.

April 19: Massachusetts; Concord Day.

April 21: Texas; Anniversary of Battle of San Jacinto.

April 22: Nebraska; Arbor Day.

April 26: Alabama, Florida, Georgia, and Tennessee; Memorial Day.

May, first Friday: Rhode Island and Idaho; Arbor Day.

May 10: North Carolina; Memorial Day.

May 20: North Carolina; Mecklenburg Declaration of Independence.

May 30: All States except Arkansas, Alabama, Florida, Georgia, Kentucky, Louisiana, New Mexico, North Carolina, South Carolina, Texas, and Virginia; Memorial Day.

June 3: Florida; Jefferson Davis's Birthday.

July 4: All States; Independence Day.

July 24: Utah; Pioneers' Day.

August 16: Vermont; Bennington Battle Day.

September, first Monday: All States; Labor Day.

September 9: California; Admission Day.

October, first Monday: California,

October 15: Connecticut; Lincoln Day.

October 31: Nevada; Admission into the Union Anniversary.

November, general election day (first Tuesday after first Monday): Arizona, California, Colorado, Florida, Idaho, Indiana, Illinois, Maryland, Minnesota, Missouri, Montana, Nevada, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Washington, West Virginia, Wisconsin, and Wyoming.

November, last Thursday: Thanksgiving Day; in all States, though not a statutory holiday in some.

December 25: All States; Christmas Day.

Arbor Day is a legal holiday in Idaho, Kansas, Rhode Island, and Wyoming, the day being set by the governor.

Mardi Gras (the last day before Lent) is observed as a holiday in Alabama and Louisiana.

Good Friday is observed as a holiday in Alabama, Georgia, Louisiana, Maryland, Minnesota, Pennsylvania, and Tennessee.

Every Saturday after 12 o'clock noon is a legal holiday in New York, New Jersey, and New Orleans; also from June to September in Colorado and Pennsylvania.

STRENGTH OF ROPES.

Hemp rope 1 inch in circumference is calculated to sustain a weight of 200 pounds; 1½ inches, 450 pounds; 2 inches, 800 pounds; 2½ inches, 1,250 pounds; 3 inches, 1,800 pounds; 4 inches, 3,200 pounds; 5 inches, 5,000 pounds; 6 inches, 7,200 pounds. Hemp is considered twice as strong as manila and wire rope twice as strong as hemp.

MIXTURE FOR CLEANING A PLOW.

Pour slowly a half pint of sulphuric acid into a quart of water. Considerable heat will be generated, and it is not advisable to pour the water into the acid. Rub the mixture on the rusty parts, scour, and wash off with water.

STATISTICS OF THE PRINCIPAL CROPS AND FARM ANIMALS.

Acreage, production, and value of the principal farm crops in the United States, 1866 to 1898.[1]

[From Division of Statistics.]

Year.	Corn.			Wheat.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Bushels.*	
1866	31,306,538	867,946,295	$411,450,830	15,424,496	151,999,906	$232,109,630
1867	32,520,249	768,320,000	437,769,763	18,321,561	212,441,400	308,387,146
1868	34,887,246	906,527,000	424,056,649	18,460,132	224,036,600	243,032,746
1869	37,103,245	874,320,000	522,550,509	19,181,004	260,146,900	199,024,996
1870	38,646,977	1,094,255,000	540,520,456	18,992,591	235,884,700	222,766,969
1871	34,091,137	991,898,000	430,355,910	19,943,893	230,722,400	264,075,851
1872	35,526,836	1,092,719,000	385,736,210	20,858,359	249,997,100	278,522,068
1873	39,197,148	932,274,000	411,961,151	22,171,676	281,254,700	300,669,533
1874	41,036,918	850,148,560	496,271,235	24,967,027	308,102,700	265,881,167
1875	44,841,371	1,321,069,000	484,674,804	26,381,512	292,136,000	261,396,926
1876	49,033,364	1,283,827,500	436,108,521	27,627,021	289,356,500	278,697,238
1877	50,969,113	1,342,558,000	467,635,230	26,277,546	364,194,146	385,689,444
1878	51,585,000	1,388,218,750	440,280,517	32,108,560	420,122,400	325,814,119
1879	53,085,450	1,547,901,790	580,486,217	32,545,950	448,756,630	497,030,142
1880	62,317,842	1,717,434,543	679,714,499	37,986,717	498,549,868	474,201,850
1881	64,262,025	1,194,916,060	759,482,170	37,709,020	383,280,000	456,880,427
1882	65,659,545	1,617,025,100	783,867,175	37,067,194	504,185,470	445,602,125
1883	68,301,889	1,551,066,895	658,051,485	36,455,593	421,086,160	383,649,272
1884	69,683,780	1,795,528,000	640,735,560	39,475,885	512,765,000	330,862,260
1885	73,130,150	1,936,176,000	635,674,630	34,189,246	357,112,000	275,320,390
1886	75,694,208	1,665,441,000	610,311,000	36,896,184	457,218,000	314,226,620
1887	72,392,720	1,456,161,000	646,106,770	37,641,783	456,329,000	310,612,960
1888	75,672,763	1,987,790,000	677,561,580	37,336,138	415,868,000	385,218,630
1889	78,319,651	2,112,892,000	597,918,829	38,123,859	490,560,000	342,491,707
1890	71,970,763	1,489,970,000	754,433,451	36,087,154	399,262,000	334,773,678
1891	76,204,515	2,060,154,000	836,439,228	39,916,897	611,780,000	513,472,711
1892	70,626,658	1,628,464,000	642,146,630	38,554,430	515,949,000	322,111,881
1893	72,036,465	1,619,496,131	591,625,627	34,629,418	396,131,725	213,171,381
1894	62,582,269	1,212,770,052	554,719,162	34,882,436	460,267,416	225,902,025
1895	82,075,830	2,151,138,580	544,985,534	34,047,382	467,102,947	237,938,998
1896	81,027,156	2,283,875,165	491,006,967	34,618,646	427,684,346	310,602,539
1897	80,095,051	1,902,967,933	501,072,952	39,465,096	530,149,168	428,547,121
1898	77,721,781	1,924,184,660	552,023,428	44,055,278	675,148,705	392,770,320

Year.	Oats.			Rye.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Bushels.*	
1866	8,864,219	268,141,078	$94,057,945	1,548,063	20,864,944	$17,149,716
1867	10,746,416	278,698,000	123,902,556	1,689,175	23,184,000	23,289,584
1868	9,665,736	254,960,800	106,355,976	1,651,321	22,504,800	21,349,199
1869	9,461,441	288,334,000	109,521,734	1,657,584	22,527,900	17,341,861
1870	8,792,395	247,277,400	96,443,637	1,176,137	15,473,000	11,326,967
1871	8,365,809	255,743,000	92,591,359	1,069,531	15,365,500	10,927,625
1872	9,000,769	271,747,000	81,303,518	1,048,654	14,888,600	10,051,061
1873	9,751,700	270,340,000	93,474,161	1,159,355	15,142,000	10,638,258
1874	10,897,412	240,369,000	113,133,934	1,116,716	14,990,900	11,610,339
1875	11,915,075	354,317,500	113,441,491	1,359,788	17,722,100	11,894,223
1876	13,358,908	320,884,000	103,844,896	1,468,374	20,374,800	12,504,970
1877	12,826,148	406,394,000	115,546,194	1,412,902	21,170,100	12,201,759
1878	13,176,500	413,578,560	101,752,468	1,622,700	25,842,790	13,566,002
1879	12,683,500	363,761,320	120,533,294	1,625,450	23,639,460	15,507,431
1880	16,187,977	417,885,380	150,243,565	1,767,619	24,540,829	18,564,560
1881	16,831,600	416,481,000	193,198,970	1,789,100	20,704,950	19,327,415
1882	18,494,691	488,250,610	182,978,022	2,227,894	29,960,037	18,439,194
1883	20,324,962	571,502,400	187,040,264	2,314,754	28,058,582	16,300,503
1884	21,300,917	583,628,000	161,528,470	2,343,963	28,640,000	14,857,040
1885	22,783,630	629,409,000	179,631,860	2,129,501	21,756,000	12,594,829
1886	23,658,474	624,134,000	186,137,930	2,129,918	24,489,000	13,181,330
1887	25,920,906	659,618,000	200,699,790	2,053,447	20,693,000	11,283,140
1888	26,998,282	701,735,000	195,424,240	2,364,805	28,415,000	16,721,869
1889	27,462,316	751,515,000	171,781,068	2,171,493	28,420,239	12,009,752
1890	26,431,369	523,621,000	222,018,486	2,144,853	25,807,472	16,229,992
1891	25,581,864	738,394,000	232,312,267	2,176,466	31,751,868	24,589,217
1892	27,063,835	661,035,000	209,253,611	2,163,657	27,078,824	15,169,656
1893	27,273,633	638,854,850	187,576,002	2,038,485	26,555,446	13,642,222
1894	27,023,553	662,036,928	214,816,920	1,944,780	26,727,615	13,395,476
1895	27,878,406	824,443,537	163,655,068	1,890,345	27,210,070	11,964,826
1896	27,565,985	707,346,404	132,485,033	1,831,201	24,369,047	9,969,769
1897	25,790,375	638,767,860	147,974,719	1,703,561	27,365,324	12,239,647
1898	25,777,110	730,906,643	186,405,364	1,643,207	25,657,522	11,875,350

[1] All values in this and the following tables are in gold.

Acreage, production, and value of the principal farm crops in the United States, 1866 to 1898—Continued.

Year.	Barley.			Buckwheat.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Bushels.*	
1866	492,532	11,283,807	$7,916,342	1,045,624	22,791,839	$15,413,160
1867	1,131,217	25,727,000	18,027,746	1,227,826	21,359,000	16,812,070
1868	937,498	22,896,100	24,948,127	1,113,993	19,863,760	15,490,426
1869	1,025,795	28,652,200	20,298,164	1,028,693	17,431,100	12,534,851
1870	1,108,924	26,295,400	20,792,215	556,992	9,841,500	6,937,471
1871	1,177,735	26,718,500	20,264,015	413,915	8,328,700	6,208,165
1872	1,397,082	26,846,400	18,415,839	448,497	8,133,500	5,979,222
1873	1,387,106	32,044,491	27,794,229	454,152	7,837,700	5,878,629
1874	1,580,626	32,552,500	27,997,824	452,590	8,016,600	5,843,645
1875	1,789,902	36,908,600	27,367,522	575,530	10,082,100	6,254,564
1876	1,766,511	38,710,500	24,402,691	686,441	9,668,800	6,435,836
1877	1,614,654	34,441,400	21,629,130	649,923	10,177,000	6,808,180
1878	1,790,400	42,245,630	24,454,301	673,100	12,246,850	6,441,240
1879	1,680,700	40,283,100	23,714,444	639,900	13,140,000	7,856,191
1880	1,843,329	45,165,346	30,090,742	822,802	14,617,535	8,682,488
1881	1,967,510	41,161,350	33,862,513	828,815	9,486,200	8,205,705
1882	2,272,103	48,953,926	30,768,015	847,112	11,019,353	8,038,862
1883	2,379,009	50,136,097	29,420,423	857,349	7,668,954	6,303,980
1884	2,608,818	61,203,000	29,779,170	879,403	11,116,000	6,549,020
1885	2,729,359	58,360,000	32,867,696	914,394	12,626,000	7,057,363
1886	2,632,957	59,428,000	31,840,510	917,915	11,869,000	6,465,120
1887	2,901,953	56,812,000	29,464,390	910,506	10,844,000	6,122,320
1888	2,996,382	63,884,000	37,672,032	912,630	12,050,000	7,627,647
1889	3,220,834	78,332,976	32,614,271	837,163	12,110,329	6,113,119
1890	3,135,302	67,168,344	42,140,502	844,579	12,432,831	7,132,872
1891	3,352,579	86,839,153	45,470,342	849,364	12,760,932	7,271,506
1892	3,400,361	80,096,762	38,026,062	861,451	12,143,185	6,295,643
1893	3,220,371	69,869,495	28,729,386	815,614	12,122,311	7,074,450
1894	3,170,602	61,400,465	27,134,127	789,232	12,668,200	7,040,238
1895	3,299,973	87,072,744	29,312,413	763,277	15,341,399	6,936,325
1896	2,950,539	69,695,223	22,491,241	754,898	14,089,783	5,522,339
1897	2,719,116	66,685,127	25,142,139	717,836	14,997,451	6,319,188
1898	2,583,125	55,792,257	23,064,359	678,332	11,721,927	5,271,462

Year.	Potatoes.			Hay.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Bushels.*		*Acres.*	*Tons.*	
1866	1,069,381	107,200,976	$50,722,553	17,668,904	21,778,627	$229,835,771
1867	1,192,195	97,783,000	64,462,486	20,020,554	26,277,000	268,390,623
1868	1,131,552	106,690,000	62,918,660	21,541,573	26,141,900	263,589,235
1869	1,222,250	133,886,000	57,481,362	18,591,281	26,420,000	268,933,048
1870	1,325,119	114,775,030	74,621,019	19,861,805	24,525,000	305,743,224
1871	1,220,915	120,461,700	64,905,189	19,009,052	22,239,400	317,939,799
1872	1,331,331	113,516,000	60,602,129	20,318,936	23,812,800	308,024,517
1873	1,295,139	106,089,000	69,153,709	21,894,084	25,085,100	314,241,037
1874	1,310,041	105,981,000	65,223,314	21,769,772	25,133,900	300,222,454
1875	1,510,041	166,877,000	57,357,515	23,507,964	27,873,600	300,377,839
1876	1,741,983	124,827,000	77,319,541	25,282,797	30,867,100	276,991,422
1877	1,792,287	170,092,000	74,272,500	25,367,708	31,629,300	264,879,796
1878	1,776,800	124,126,650	72,923,575	26,931,500	39,608,296	285,015,625
1879	1,836,800	181,626,400	79,153,673	27,484,991	35,493,000	330,804,494
1880	1,842,510	167,659,570	81,062,214	25,863,955	31,925,233	371,811,084
1881	2,041,670	109,145,494	99,291,341	30,888,700	35,135,064	415,131,366
1882	2,171,635	170,972,508	95,304,844	32,339,585	38,138,049	371,170,326
1883	2,289,275	208,164,425	87,849,991	35,515,948	46,864,009	384,834,451
1884	2,220,980	190,642,000	75,524,290	38,571,593	48,470,460	396,139,309
1885	2,265,823	175,029,000	78,153,403	39,849,701	44,731,550	389,752,873
1886	2,287,136	168,051,000	78,441,940	36,504,688	41,796,499	353,457,699
1887	2,357,322	134,103,000	91,506,740	37,664,739	41,454,458	413,440,283
1888	2,533,280	202,365,000	81,413,589	38,591,903	46,643,094	408,499,565
1889	2,647,989	204,990,345	72,704,413	52,947,236	66,829,612	470,374,948
1890	2,651,579	148,078,945	112,205,235	50,712,513	60,197,589	473,569,972
1891	2,714,770	254,426,971	91,024,521	51,044,490	60,817,771	494,113,616
1892	2,547,962	156,654,819	103,567,520	50,853,061	59,823,735	490,427,798
1893	2,605,186	183,034,203	108,661,801	49,613,469	65,766,158	570,882,872
1894	2,737,973	170,787,338	91,526,787	48,321,272	54,874,408	468,578,321
1895	2,954,952	297,237,370	78,984,901	44,206,453	47,078,541	393,185,615
1896	2,767,465	252,234,540	72,182,350	43,259,756	59,282,158	388,145,614
1897	2,534,577	164,015,964	89,643,059	42,426,770	60,664,876	401,390,728
1898	2,557,729	192,306,338	79,574,772	42,780,827	66,376,920	398,060,647

Acreage, production, and value of the principal farm crops in the United States, 1866 to 1898—Continued.

Year	Tobacco.			Cotton.		
	Area.	Production.	Value.	Area.	Production.	Value.
	Acres.	*Pounds.*		*Acres.*	*Bales.*	
1866	520,107	388,128,684	$37,398,333	.....	2,097,254	$204,561,896
1867	494,333	313,724,000	29,572,660	.....	2,519,554	199,583,510
1868	427,189	320,982,000	29,822,873	.....	2,366,467	226,794,168
1869	481,101	273,775,000	25,520,065	7,933,000	3,122,551	261,067,657
1870	330,668	250,628,000	24,010,018	9,985,000	4,352,317	292,703,086
1871	350,769	263,196,100	23,292,645	8,911,000	2,974,351	242,672,804
1872	416,512	342,504,000	31,647,817	9,560,000	3,930,508	280,552,629
1873	480,878	372,810,000	28,421,703	10,816,000	4,170,388	289,853,486
1874	281,662	178,355,000	21,066,515	10,982,000	3,832,991	228,113,080
1875	559,049	379,347,000	26,453,881	11,635,000	4,632,313	233,109,945
1876	540,457	381,002,000	25,923,894	11,500,000	4,474,069	211,655,041
1877	.....	.....	.....	11,825,000	4,773,865	235,721,194
1878	542,850	392,546,700	22,093,240	12,266,800	4,694,942	193,467,706
1879	492,100	391,278,350	22,727,524	12,595,500	4,735,082	242,140,987
1880	602,516	446,296,889	36,414,615	15,475,300	5,708,942	280,266,242
1881	646,239	449,880,014	43,372,336	16,851,000	5,456,048	244,135,547
1882	671,522	513,077,558	43,189,950	16,791,557	6,957,000	309,696,500
1883	638,739	451,545,641	40,455,362	16,777,993	5,700,000	250,594,750
1884	724,668	541,504,000	44,160,151	17,439,612	5,682,000	253,993,385
1885	752,520	562,736,000	43,265,598	18,300,865	6,575,300	269,989,812
1886	750,210	532,537,000	39,468,218	18,454,603	6,254,460	279,381,938
1887	598,620	386,240,000	40,977,259	18,641,067	7,020,209	337,972,456
1888	747,326	565,795,000	43,666,665	19,058,591	6,940,898	354,454,340
1889	695,361	488,256,619	32,396,740	20,171,896	7,472,511	402,951,814
1890	722,198	522,215,116	43,100,532	20,809,053	8,652,597	369,568,858
1891	742,945	556,877,039	47,492,584	20,714,937	9,035,379	326,513,298
1892	725,195	498,621,686	46,728,959	18,067,924	6,700,365	262,252,286
1893	702,952	483,023,963	39,155,442	19,525,000	7,493,000	274,479,637
1894	523,103	406,678,385	27,760,739	23,687,950	9,476,435	287,120,818
1895	633,950	491,544,000	35,574,220	20,184,368	7,161,094	260,338,096
1896	594,749	403,004,320	24,258,070	23,273,209	8,532,705	291,811,564
1897	.....	.....	.....	24,319,584	10,897,857	319,491,412

Acreage, production, value, and disposition of the corn crop of the United States in 1898, by States.

States and Territories.	Crop of 1898.			Stock on hand March 1, 1899.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Maine	10,893	435,720	$209,146	122,002	28	435,720	0
New Hampshire	23,823	976,743	449,302	312,558	32	976,743	0
Vermont	46,142	1,984,106	873,007	694,437	25	1,984,106	0
Massachusetts	39,091	1,563,640	766,184	469,092	30	1,563,640	0
Rhode Island	7,730	262,820	168,205	113,013	43	257,564	5,256
Connecticut	44,805	1,657,785	862,048	547,069	33	1,657,785	0
New York	474,895	15,671,535	6,738,760	6,268,614	40	15,201,389	470,146
New Jersey	252,293	9,334,841	3,733,936	4,013,982	43	8,121,312	1,213,529
Pennsylvania	1,221,355	45,190,135	18,076,054	18,527,955	41	38,411,615	6,778,520
Delaware	208,784	5,219,660	1,618,076	2,557,604	49	3,392,740	1,826,860
Maryland	585,935	18,163,985	6,357,395	7,447,234	41	12,351,510	5,812,475
Virginia	1,761,662	38,756,564	13,564,797	18,663,151	48	32,555,514	6,201,050
North Carolina	2,433,600	34,070,400	14,650,272	16,013,088	47	31,685,472	2,384,928
South Carolina	1,751,907	17,519,070	8,058,772	8,759,535	50	16,993,498	525,572
Georgia	2,954,072	26,586,648	12,761,591	13,559,190	51	25,789,049	797,599
Florida	471,608	4,244,472	2,122,236	1,952,457	46	4,202,027	42,445
Alabama	2,645,442	39,681,630	16,269,468	20,237,631	51	36,507,100	3,174,530
Mississippi	2,218,303	39,931,074	15,573,119	20,364,848	51	37,934,520	1,996,554
Louisiana	1,319,915	23,758,470	9,740,973	11,404,066	48	23,045,716	712,754
Texas	4,213,468	105,336,700	35,814,478	49,508,249	47	89,536,195	15,800,505
Arkansas	2,208,261	45,965,220	13,155,914	19,960,697	44	42,189,655	3,175,565
Tennessee	2,941,067	76,467,742	22,175,645	34,410,484	45	62,703,548	13,764,194
West Virginia	700,994	20,328,826	7,521,666	8,334,819	41	18,702,320	1,626,506
Kentucky	2,747,653	85,177,243	22,997,856	38,329,759	45	74,104,201	11,073,042
Ohio	2,779,147	102,828,439	27,763,679	38,040,522	37	80,206,182	22,622,257
Michigan	980,606	33,340,604	11,335,805	11,002,399	33	30,673,356	2,667,248
Indiana	3,587,627	129,154,572	32,288,643	50,370,283	39	86,533,563	42,621,009
Illinois	6,665,327	199,959,810	49,989,952	81,983,522	41	119,975,886	79,983,924
Wisconsin	1,009,355	35,327,425	9,891,679	12,717,873	36	32,147,957	3,179,468
Minnesota	954,125	30,532,000	7,327,680	11,296,840	37	27,784,120	2,747,880
Iowa	7,285,710	254,999,850	58,649,966	114,749,932	45	178,499,895	76,499,955

Acreage, production, value, and disposition of the corn crop of the United States in 1898, by States—Continued.

States and Territories.	Crop of 1898.			Stock on hand March 1, 1899.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Missouri	5,951,211	154,731,186	41,777,501	55,703,335	36	143,900,382	10,831,204
Kansas	8,302,628	132,842,048	34,538,932	42,509,455	32	111,587,320	21,254,728
Nebraska	7,559,746	158,754,666	34,926,027	66,676,960	42	107,953,173	50,801,493
South Dakota	1,003,927	28,109,956	6,465,290	12,087,281	43	23,050,164	5,059,792
North Dakota	24,308	461,852	166,267	64,659	14	461,852	0
Montana	1,598	44,744	29,531	4,474	10	44,744	0
Wyoming	2,477	39,632	21,798	3,963	10	39,632	0
Colorado	172,994	3,113,892	1,245,557	467,084	15	2,989,336	124,556
New Mexico	24,258	509,418	285,274	122,260	24	448,288	61,130
Utah	8,053	169,113	101,468	30,440	18	152,202	16,911
Washington	5,700	68,400	28,728	6,156	9	68,400	0
Oregon	13,656	327,744	196,646	36,052	11	317,912	9,832
California	45,540	1,184,040	734,105	142,085	12	1,041,955	142,085
Total	77,721,781	1,924,184,660	552,023,428	809,533,169	41.6	1,528,179,358	396,005,302

Acreage, production, value, and disposition of the wheat crop of the United States in 1898, by States.

States and Territories.	Crop of 1898.			Stock on hand March 1, 1899.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Maine	1,808	35,256	$31,378	9,167	26	35,256	0
New Hampshire	516	9,804	9,020	2,353	24	9,804	0
Vermont	3,870	87,075	78,368	32,218	37	87,075	0
Connecticut	300	6,000	5,280	2,400	40	6,000	0
New York	379,069	8,036,263	5,786,109	1,848,340	23	6,750,461	1,285,802
New Jersey	124,616	2,168,318	1,582,872	542,080	25	1,778,021	390,297
Pennsylvania	1,520,568	26,609,940	18,094,759	10,111,777	38	18,094,759	8,515,181
Delaware	74,343	988,762	682,246	306,516	31	415,280	573,482
Maryland	767,316	11,739,935	8,217,954	2,113,188	18	4,695,974	7,043,961
Virginia	753,625	10,626,112	7,013,234	3,400,356	32	5,950,623	4,675,489
North Carolina	573,331	5,274,645	4,114,223	1,687,886	32	4,852,673	421,972
South Carolina	111,482	1,181,709	1,110,806	212,708	18	1,181,709	0
Georgia	260,736	2,607,360	2,555,213	651,840	25	2,398,771	208,589
Alabama	43,309	519,708	467,737	83,153	16	504,117	15,591
Mississippi	2,165	30,094	24,978	6,019	20	30,094	0
Texas	631,653	9,348,464	6,356,956	1,495,754	16	6,917,863	2,430,601
Arkansas	212,276	2,335,036	1,354,321	467,007	20	1,914,750	420,286
Tennessee	1,059,097	13,980,080	9,366,654	3,355,219	24	8,388,048	5,592,032
West Virginia	421,500	5,816,700	4,129,857	1,919,511	33	4,013,523	1,803,177
Kentucky	939,314	14,465,496	8,968,570	3,616,359	25	8,968,570	5,496,926
Ohio	2,491,312	42,103,173	27,788,094	13,894,047	33	19,367,440	22,735,733
Michigan	1,637,589	34,061,851	21,799,585	11,921,648	35	11,531,029	22,480,822
Indiana	2,463,207	38,426,029	24,208,398	10,759,288	28	13,833,370	24,592,659
Illinois	1,757,668	19,334,348	11,600,609	3,673,526	19	11,793,952	7,540,396
Wisconsin	760,554	13,689,972	8,077,083	5,612,889	41	10,678,178	3,011,794
Minnesota	4,963,159	78,417,942	42,345,672	24,309,553	31	20,388,657	58,029,255
Iowa	1,328,720	22,189,624	11,538,604	8,875,850	40	11,094,812	11,094,812
Missouri	1,439,230	14,104,454	8,321,628	3,102,980	22	11,001,474	3,102,980
Kansas	4,573,198	64,939,412	32,469,706	18,183,035	28	19,481,824	45,457,588
Nebraska	2,114,592	34,679,309	16,299,275	11,444,172	33	11,790,965	22,888,344
South Dakota	3,390,397	42,040,923	21,020,462	11,771,458	28	10,089,822	31,951,101
North Dakota	3,864,892	55,654,445	28,383,767	11,687,433	21	6,121,989	49,532,456
Montana	71,188	2,100,046	1,218,027	609,013	29	2,100,046	0
Wyoming	22,136	524,623	361,990	125,910	24	472,161	52,462
Colorado	255,877	6,729,565	3,768,556	2,153,461	32	4,576,104	2,153,461
New Mexico	192,728	4,586,926	2,843,894	825,647	18	4,036,495	550,431
Arizona	24,307	770,532	708,889	223,454	29	693,479	77,053
Utah	182,328	5,105,184	2,756,799	1,531,555	30	3,369,421	1,735,763
Nevada	36,699	1,064,271	1,011,057	393,780	37	691,776	372,495
Idaho	135,384	4,196,904	2,140,421	1,678,762	40	1,049,226	3,147,678
Washington	969,134	23,453,043	12,664,643	11,022,930	47	4,925,139	18,527,904

Acreage, production, value, and disposition of the wheat crop of the United States in 1898, by States—Continued.

States and Territories.	Crop of 1898.			Stock on hand March 1, 1899.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Oregon	1,205,281	24,708,260	15,319,121	7,659,561	31	6,671,230	18,037,030
California	1,343,341	12,224,403	8,801,570	2,322,637	19	6,234,446	5,989,957
Oklahoma	951,463	14,176,799	7,371,935	2,410,056	17	7,230,167	6,946,632
Total	44,055,278	675,148,705	392,770,320	198,056,496	29.3	276,266,573	398,882,132

Acreage, production, value, and disposition of the oat crop of the United States in 1898, by States.

States and Territories.	Crop of 1898.			Stock on hand March 1, 1899.		Retained and consumed in county where grown.	Shipped out of county where grown.
	Acreage.	Production.	Value.				
	Acres.	*Bushels.*		*Bushels.*	*Per ct.*	*Bushels.*	*Bushels.*
Maine	140,217	5,047,812	$1,716,256	2,069,603	41	4,795,421	252,391
New Hampshire	30,538	1,007,754	382,947	342,636	34	1,007,754	0
Vermont	108,090	4,107,420	1,437,597	1,642,968	40	4,107,420	0
Massachusetts	15,121	483,872	179,033	151,839	32	483,872	0
Rhode Island	3,653	98,631	36,493	45,370	46	96,658	1,973
Connecticut	19,949	562,562	202,522	157,517	28	562,562	0
New York	1,408,238	38,726,545	12,005,229	17,814,211	46	34,853,891	3,872,654
New Jersey	98,137	1,923,485	596,280	788,629	41	1,769,606	153,879
Pennsylvania	1,163,043	27,098,902	8,129,671	10,568,572	39	24,660,001	2,438,901
Delaware	17,587	386,914	116,074	193,457	50	309,531	77,383
Maryland	78,335	1,527,532	442,984	381,883	25	1,206,750	320,782
Virginia	427,369	6,880,641	1,995,386	2,545,837	37	6,330,190	550,481
North Carolina	443,260	6,338,618	2,345,289	1,711,427	27	6,021,687	316,931
South Carolina	244,658	4,208,118	1,893,653	547,055	13	4,123,956	84,162
Georgia	433,521	7,196,449	3,454,296	1,295,361	18	7,124,485	71,964
Florida	40,461	623,099	336,473	81,003	13	623,099	0
Alabama	320,433	5,383,274	2,207,142	968,989	18	5,060,278	322,996
Mississippi	130,070	2,406,295	1,010,644	553,448	23	2,406,295	0
Louisiana	36,593	662,333	251,687	125,843	19	649,086	13,247
Texas	711,166	21,121,630	5,914,056	4,646,759	22	15,841,222	5,280,408
Arkansas	317,089	7,229,629	2,096,592	2,385,778	33	6,868,148	361,481
Tennessee	361,232	6,755,038	1,891,411	2,161,612	32	5,876,883	878,155
West Virginia	149,265	2,910,668	873,200	931,414	32	2,736,028	174,640
Kentucky	422,592	9,466,061	2,555,836	3,502,443	37	8,803,437	662,624
Ohio	897,222	27,724,160	6,653,798	9,980,698	36	20,238,637	7,485,523
Michigan	847,032	27,782,650	7,501,316	10,557,407	38	21,114,814	6,667,836
Indiana	1,093,790	31,938,668	7,345,894	8,942,827	28	21,079,521	10,859,147
Illinois	3,044,951	88,303,579	29,309,823	32,672,324	37	48,566,968	39,736,611
Wisconsin	1,790,671	64,643,223	15,514,374	28,443,018	44	47,189,553	17,453,670
Minnesota	1,550,925	56,298,578	11,822,701	27,023,317	48	42,223,934	14,074,644
Iowa	3,630,239	123,428,126	29,622,750	50,605,532	41	78,994,001	44,434,125
Missouri	933,304	15,866,168	3,649,219	5,394,497	34	14,755,536	1,110,632
Kansas	1,482,736	26,689,248	5,871,635	10,141,914	38	22,418,968	4,270,280
Nebraska	1,752,182	56,245,012	11,249,008	23,060,467	41	33,747,025	22,498,017
South Dakota	601,738	16,126,578	3,386,581	7,740,757	48	13,385,060	2,741,518
North Dakota	490,573	15,069,591	3,915,754	7,379,690	49	13,554,532	1,506,059
Montana	61,047	2,478,508	867,478	1,115,329	45	1,858,881	619,627
Wyoming	13,282	414,398	165,759	149,183	36	410,254	4,144
Colorado	85,564	3,063,191	1,255,908	1,010,853	33	2,205,498	857,693
New Mexico	6,998	271,522	111,324	40,728	15	263,376	8,146
Utah	24,432	969,950	368,581	329,783	34	824,458	145,492
Idaho	29,411	1,282,320	461,635	294,934	23	1,282,320	0
Washington	78,043	3,270,062	1,308,001	981,001	30	1,929,361	1,340,701
Oregon	185,495	4,953,555	1,981,422	1,436,331	29	3,269,346	1,684,209
California	58,888	1,943,304	971,652	291,496	15	1,748,974	194,330
Total	25,777,110	730,906,643	186,405,364	283,208,940	38.7	537,379,217	193,527,426

Cotton crop of 1897–98.

[In commercial bales.]

States and Territories.	Movement and mill purchases.			Taken from other States and ports.			Total crop.
	Forwarded by rail, etc.	Bought by mills.	Total.	Taken from other States.	Taken from ports.	Total.	
Alabama	1,038,181	97,404	1,135,585	20,941	1,963	22,904	1,112,681
Arkansas	963,497	1,645	965,142	22,875		22,875	942,267
Florida	53,657		53,657				53,657
Georgia	1,254,066	285,219	1,539,285	188,004	500	188,504	1,350,781
Indian Territory	221,998		221,998	14,612		14,612	207,386
Kansas	139		139				139
Kentucky	35	26,516	26,551	26,516		26,516	35
Louisiana	881,987	16,065	898,052	93,742	15,985	109,727	788,325
Mississippi	1,561,529	20,508	1,582,037	57,266		57,266	1,524,771
Missouri	26,848	4,023	30,871	4,023		4,023	26,848
North Carolina	367,780	334,873	702,653	52,596	3,331	55,927	646,726
Oklahoma	110,175		110,175				110,175
South Carolina	636,542	398,456	1,034,998	1,581	3,332	4,913	1,030,085
Tennessee	257,960	35,773	293,733	25,098		25,098	268,635
Texas	2,918,454	14,312	2,932,766	102,991	7,367	110,358	2,822,408
Utah	60		60				60
Virginia	12,878	42,880	55,758	42,880		42,880	12,878
Total	10,305,786	1,277,674	11,583,460	653,125	32,478	685,603	10,897,857

Comparative acreage and production, 1896 and 1897.

States and Territories.	Acres.		Bales.		Acres.		Bales.	
	1896.	1897.	1896.	1897.	Increase.	Decrease.	Increase.	Decrease.
Alabama	2,656,333	2,709,460	833,789	1,112,681	53,127		278,892	
Arkansas	1,542,662	1,619,785	605,643	942,267	77,133		336,624	
Florida	264,325	251,109	48,730	53,657		13,216	4,927	
Georgia	3,468,335	3,537,702	1,299,340	1,350,781	69,367		51,441	
Indian Territory	141,124	317,992	87,705	207,386	176,868		119,681	
Kansas	150	285	61	139	135		78	
Kentucky	1,200	105	414	35		1,095		379
Louisiana	1,245,399	1,245,399	567,251	788,325	0	0	221,074	
Mississippi	2,835,316	2,778,610	1,201,000	1,524,771		56,706	323,771	
Missouri	77,868	83,319	24,119	26,848	5,451		2,729	
North Carolina	1,228,714	1,302,437	521,795	646,726	73,723		124,931	
Oklahoma	78,550	216,664	35,251	110,175	138,114		74,924	
South Carolina	2,014,348	2,074,778	936,463	1,030,085	60,430		93,622	
Tennessee	912,337	967,077	236,781	268,635	54,740		31,854	
Texas	6,758,656	7,164,175	2,122,701	2,822,408	405,519		699,707	
Utah	155	75	123	60		80		63
Virginia	47,747	50,612	11,539	12,878	2,865		1,339	
Total	23,273,269	24,319,584	8,532,705	10,897,857	a1,046,375		2,365,152	

a Net increase.

United States crops, exports, imports, and consumption of cotton, 1888–89 to 1897–98.

Years.	United States crop (commercial bales).	Exports (commercial bales). a	Consumed by United States mills (commercial bales).	Average net weight per bale.	Average price (middling upland), New York.	Imports (500-pound bales). a
				Pounds.	*Cents.*	
1888–89	6,938,290	4,813,374	2,314,091	470	10.71	10,995
1889–90	7,311,322	4,979,412	2,390,959	471	11.53	15,946
1890–91	8,652,597	5,817,990	2,632,023	473	9.03	17,212
1891–92	9,035,379	5,893,868	2,876,846	473	7.64	41,818
1892–93	6,700,365	4,473,206	2,431,134	475	8.24	57,328
1893–94	7,549,817	5,300,458	2,319,688	474	7.67	86,736
1894–95	9,901,251	6,850,327	2,946,677	484	6.50	55,412
1895–96	a 7,161,094	4,701,791	2,504,972	477	8.16	98,694
1896–97	a 8,532,075	6,036,713	2,847,351	477	7.72	110,701
1897–98	a 10,897,857	7,648,699	3,443,581	482	6.22	103,798

a Estimates of Department; all other figures are those of Latham & Co.

THE WORLD'S CONSUMPTION OF COTTON.

There are no available statistics showing the annual production of cotton in the various countries of the world except for the United States, India, and Egypt.

India, next to the United States, is the largest producer of cotton, its crop in 1897-98 being estimated at 2,844,000 bales of 400 pounds each. The Indian mills consume a little over 1,000,000 bales, the remainder of the crop being exported. In 1897-98 about 641,000 bales were exported to Europe, 450,000 to Japan, and perhaps a small amount to China.

China perhaps ranks third among the cotton-producing countries, "but," says United States Consul-General Goodnow, in a recent report, "no one can tell the annual production of cotton in China with any degree of accuracy. There are no statistics, either national or provincial, on such subjects." He roughly estimates the crop at 660,000,000 pounds, or, say, 1,320,000 bales of 500 pounds each. The entire crop is consumed at home, with the exception of the exports to Japan, which Mr. Thomas Ellison estimated to be 70,467,000 pounds in 1897, or about 141,000 bales of 500 pounds each.

Egypt follows China in cotton production, although it ranks third as an exporter of cotton. The crop of 1897-98 amounted to 843,211 bales of about 735 pounds each. There are very few mills in Egypt, and hence practically the entire crop is exported, most of it going to European countries, except about 61,000 bales to the United States and a small amount to Japan.

The approximate production of all other countries, as estimated by this Department in 1896 (Circular No. 1), is as follows, in bales of 500 pounds: Korea, 400,000; Asiatic Russia, 300,000; Brazil, 224,800; Africa, 100,000; Turkey, 93,600; Japan, 73,200; Mexico, 64,000; Peru and West Indies, 46,400; Persia, 32,800; Greece, 7,760; Java, 5,200; Malta, 3,680; Tahiti, 920; Italy, 456; Fiji Islands, 440. Siam is also a cotton-producing country, but to what extent is not known. In 1896, according to a report of the United States consul-general at Singapore, Mr. Pratt, Siam exported 115,536 pounds of raw cotton to Japan, and Korea exported to the same country 4,153 pounds. Anam and other French Indian provinces also produce cotton. United States Consul Lyon, at Hiogo, Japan, reports that in 1897 the imports into Japan from these possessions amounted to 2,191,200 pounds, or about 4,382 bales of 500 pounds.

The following table, compiled by Messrs. Latham, Alexander & Co., of New York, gives the consumption of cotton (in 500-pound bales) in Great Britain, the European continent, the United States, and India, and indicates the progress of the cotton industry during the past ten years:

Years.	Great Britain.	Continent of Europe.	United States.	India.	Total.
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*
1888-89	3,016,000	3,256,000	2,148,000	697,000	9,117,000
1889-90	3,227,000	3,432,000	2,185,000	791,000	9,635,000
1890-91	3,384,000	3,631,000	2,367,000	924,000	10,306,000
1891-92	3,181,000	3,619,000	2,576,000	914,000	10,290,000
1892-93	2,866,000	3,661,000	2,551,000	918,000	9,996,000
1893-94	3,233,000	3,827,000	2,264,000	959,000	10,283,000
1894-95	3,250,000	4,030,000	2,743,000	1,052,000	11,075,000
1895-96	3,276,000	4,160,000	2,572,000	1,105,000	11,113,000
1896-97	3,224,000	4,368,000	2,738,000	1,004,000	11,334,000
1897-98	3,380,000	4,576,000	2,962,000	1,058,000	11,976,000

SPINDLES IN OPERATION IN 1898.

The Department is indebted to Mr. Thomas Ellison, of Liverpool, for the following estimate of the number of spindles in operation in 1898 in all countries of the world except the United States and Brazil. Mr. Ellison says that no reliable data as to the latter country, where a considerable number of spindles have been put up in the past few years, are available; also that there are some spindles at work in Turkey and Egypt (Alexandria), but that they are not yet important.

Greece	70,000
Portugal	230,000
Holland	290,000
Sweden	360,000
Belgium	900,000
Poland	965,000
Switzerland	1,710,000

Italy		1,886,000
Spain		2,615,000
Austria		3,140,000
France		5,300,000
Russia		6,000,000
Germany		7,884,000
The Continent		31,350,000
Great Britain		44,900,000
United States:		
North	13,900,000	
South	3,456,537	
		17,356,537
East India		4,065,618
Japan		1,150,000
China		565,000
Canada		491,252
Mexico		448,156
Total world's spindles		100,326,563

CONSUMPTION OF AMERICAN COTTON BY FOREIGN COUNTRIES.

The following table, compiled from the reports of the Bureau of Statistics of the Treasury Department, gives the number of bales of cotton exported to foreign countries in 1889, as compared with the fiscal year ended June 30, 1898, the bales being reduced to the uniform weight of 500 pounds each.

The export value of the cotton is also added to the table. With the exception of Russia and the Netherlands, the increase in exports to nearly all other countries has been very large, in most of them the amount being more than double what it was ten years ago. In 1889 only 47 bales were exported to Japan, and not a bale to either China or the British East Indies. In 1898 Japan had increased her takings of American cotton to 224,214 bales, while China and the British East Indies are shown in our export trade as consumers of American cotton, over 13,000 bales having been sent to Chinese ports in 1898. Although there has been so large an increase in the export of cotton since 1889, owing to the extremely low prices in 1897–98 the value of the total exports was $7,333,055 less than in 1889.

Exports of cotton from United States to foreign countries.

[In bales of 500 pounds.]

Countries.	1889.		1898.	
	Bales.	Value.	Bales.	Value.
Austria-Hungary	5,610	$275,275	35,614	$987,724
Belgium	147,807	7,556,687	161,942	4,809,609
Denmark			24,741	732,810
France	400,196	20,174,839	842,658	24,599,724
Germany	660,756	32,308,593	1,858,524	54,886,245
Italy	131,068	6,460,413	387,581	11,468,625
Netherlands	44,354	2,188,771	43,509	1,292,788
Portugal			18,835	588,923
Russia	144,036	7,506,201	103,825	3,153,758
Spain	181,533	9,200,998	263,648	8,180,970
Sweden and Norway	8,717	420,412	25,613	744,287
United Kingdom	2,940,800	146,605,505	3,532,101	105,853,614
Other Europe	9,547	475,182		
Dominion of Canada	61,143	2,980,556	122,495	3,961,586
Mexico	33,803	1,607,395	42,433	1,321,473
West Indies (French)			17	633
China			11,302	370,670
East Indies (British)			297	9,130
Hongkong			1,800	72,000
Japan	47	2,341	224,214	7,428,226
All other countries	216	12,102		
Total	4,769,633	237,775,270	7,700,529	230,442,215

Wheat crop of the world, 1894 to 1898.

Countries.	1894.	1895.	1896.	1897.	1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	460,267,000	467,103,000	427,684,000	530,149,000	675,149,000
Ontario	20,507,000	18,183,000	19,184,000	29,765,000	33,042,000
Manitoba	17,714,000	32,777,000	14,825,000	18,837,000	26,112,000
Rest of Canada	6,362,000	6,500,000	6,800,000	7,500,000	9,000,000
Total Canada	44,583,000	57,460,000	40,809,000	56,102,000	68,154,000
Mexico	8,570,000	10,035,000	12,700,000	13,500,000	15,000,000
Total North America	513,420,000	534,598,000	481,193,000	599,751,000	758,303,000
Chile	16,000,000	15,000,000	12,000,000	10,500,000	14,000,000
Argentina	80,000,000	60,000,000	48,000,000	32,000,000	52,000,000
Uruguay	4,799,000	8,915,000	4,059,000	3,600,000	6,000,000
Total South America	100,799,000	83,915,000	64,059,000	46,100,000	72,000,000
Great Britain	61,638,000	38,348,000	58,851,000	56,672,000	75,330,000
Ireland	1,532,000	1,109,000	1,191,000	1,355,000	1,840,000
Total United Kingdom	62,570,000	39,457,000	60,042,000	58,027,000	77,170,000
Norway	275,000	260,000	300,000	300,000	300,000
Sweden	4,362,000	3,705,000	4,704,000	4,678,000	4,542,000
Denmark	3,262,000	3,467,000	3,689,000	3,474,000	3,600,000
Netherlands	4,166,000	4,282,000	5,015,000	4,400,000	5,000,000
Belgium	17,618,000	18,730,000	20,554,000	17,728,000	20,865,000
France	347,531,000	340,432,000	339,793,000	246,596,000	371,881,000
Spain	105,600,000	81,218,000	71,892,000	94,637,000	99,000,000
Portugal	9,000,000	7,000,000	5,600,000	8,200,000	8,200,000
Italy	121,595,000	118,162,000	145,233,000	86,919,000	133,372,000
Switzerland	4,500,000	5,000,000	4,840,000	4,300,000	4,500,000
Germany	110,681,000	103,160,000	110,539,000	107,015,000	115,000,000
Austria	48,190,000	41,767,000	43,991,000	35,859,000	41,200,000
Hungary	141,855,000	158,012,000	149,954,000	89,924,000	119,638,000
Croatia-Slavonia	8,786,000	8,661,000	9,614,000	6,271,000	8,000,000
Bosnia-Herzegovina	2,000,000	2,000,000	2,050,000	2,000,000	2,100,000
Total Austria-Hungary	200,831,000	210,440,000	205,609,000	134,054,000	170,938,000
Roumania	43,587,000	68,502,000	71,194,000	36,448,000	58,457,000
Bulgaria	30,600,000	37,000,000	48,275,000	30,739,000	35,000,000
Servia	7,500,000	9,400,000	9,300,000	7,000,000	11,000,000
Montenegro	250,000	220,000	220,000	200,000	220,000
Turkey in Europe	20,000,000	21,500,000	24,000,000	17,800,000	21,000,000
Greece	5,500,000	4,000,000	4,800,000	3,200,000	4,000,000
Russia proper	339,667,000	292,272,000	300,423,000	238,557,000	329,035,000
Poland	16,749,000	17,387,000	19,476,000	17,808,000	24,852,000
North Caucasus	61,678,000	67,127,000	45,148,000	29,883,000	40,849,000
Finland	148,000	100,000	98,000	90,000	100,000
Total Russia in Europe	418,242,000	376,886,000	365,145,000	286,338,000	404,835,000
Total Europe	1,517,670,000	1,452,821,000	1,500,734,000	1,152,053,000	1,548,831,000
Siberia	35,421,000	30,829,000	34,160,000	42,835,000	43,000,000
Central Asia	6,000,000	7,462,000	12,820,000	11,087,000	11,000,000
Trans Caucasia	47,000,000	47,000,000	42,000,000	40,000,000	40,000,000
Total Russia in Asia	88,421,000	85,361,000	88,980,000	93,922,000	94,000,000
Turkey in Asia	45,000,000	46,000,000	44,000,000	48,000,000	44,000,000
Cyprus	2,000,000	2,200,000	2,400,000	2,400,000	2,400,000
Persia	22,000,000	22,000,000	20,000,000	20,000,000	20,000,000
British India	252,784,000	231,379,000	205,610,000	182,667,000	242,921,000
Japan	20,398,000	20,341,000	18,000,000	18,000,000	18,000,000
Total Asia	430,513,000	410,281,000	379,000,000	364,989,000	421,321,000
Algeria	28,900,000	24,400,000	17,600,000	16,000,000	22,000,000
Tunis	10,700,000	7,500,000	5,600,000	6,000,000	6,500,000
Egypt	12,000,000	14,000,000	12,000,000	12,000,000	14,000,000
Cape Colony	3,195,000	2,542,000	2,257,000	2,200,000	1,939,000
Total Africa	54,795,000	48,442,000	37,457,000	36,200,000	44,439,000
West Australia	567,000	176,000	194,000	252,000	421,000
South Australia	14,047,000	8,027,000	6,116,000	2,893,000	4,141,000

Wheat crop of the world, 1894 to 1898—Continued.

Countries.	1894.	1895.	1896.	1897.	1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Queensland	426,000	562,000	128,000	620,000	1,041,000
New South Wales	6,708,000	7,263,000	5,359,000	9,132,000	10,893,000
Victoria	15,736,000	11,807,000	5,848,000	7,315,000	10,944,000
Tasmania	860,000	899,000	1,202,000	1,327,000	1,721,000
New Zealand	5,046,000	3,727,000	7,059,000	6,113,000	5,849,000
Total Australasia	43,360,000	32,461,000	25,906,000	27,652,000	34,980,000

RECAPITULATION BY CONTINENTS.

North America	513,420,000	534,598,000	481,193,000	599,751,000	758,303,000
South America	100,799,000	83,915,000	64,059,000	46,100,000	72,000,000
Europe	1,517,670,000	1,452,821,000	1,500,734,000	1,152,053,000	1,548,881,000
Asia	430,513,000	410,281,000	379,000,000	364,989,000	421,321,000
Africa	54,795,000	48,442,000	37,457,000	36,200,000	44,439,000
Australasia	43,360,000	32,461,000	25,906,000	27,652,000	34,980,000
Grand total	2,660,557,000	2,562,518,000	2,488,349,000	2,226,745,000	2,879,924,000

The most trustworthy estimates that can be obtained for the principal wheat-growing countries of the Southern Hemisphere and for India for the year 1898-99 are given below:

Countries.	Production.
	Bushels.
Argentina	70,000,000
Chile	15,000,000
Uruguay	7,000,000
Australasia	57,000,000
India	230,000,000

Average yield per acre of the principal farm crops, 1894 to 1898.

[From Division of Statistics.]

States and Territories.	Corn.					Wheat.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	39.9	42.0	37.0	37.0	40.0	21.1	19.2	22.0	16.5	19.5
New Hampshire	34.3	40.2	42.0	34.0	41.0	20.0	19.3	21.0	16.0	19.0
Vermont	40.8	45.6	41.0	35.0	43.0	22.7	29.0	24.5	17.0	22.5
Massachusetts	34.5	43.9	43.0	32.5	40.0	.....	.....	.....	.....	.....
Rhode Island	31.4	30.9	34.0	31.0	34.0	.....	.....	.....	.....	.....
Connecticut	31.0	37.9	38.0	31.5	37.0	.....	.....	.....	20.0	22.0
New York	28.2	35.6	34.0	31.0	33.0	14.8	18.1	16.0	21.4	21.2
New Jersey	33.1	33.0	33.0	31.5	37.0	15.3	12.4	15.3	18.5	17.4
Pennsylvania	32.0	33.5	40.0	36.0	37.0	15.0	16.6	14.0	19.7	17.5
Delaware	22.0	21.0	22.0	29.0	25.0	13.0	11.6	18.0	21.5	13.3
Maryland	22.9	26.8	32.0	33.0	31.0	15.3	17.0	17.0	19.2	15.3
Virginia	19.1	18.6	21.5	18.0	22.0	9.5	9.3	9.3	12.0	14.1
North Carolina	13.4	14.5	12.0	13.0	14.0	5.0	6.9	7.3	8.0	9.2
South Carolina	11.2	11.1	9.0	9.0	10.0	5.6	6.4	6.8	8.7	10.6
Georgia	11.7	13.0	11.0	11.0	9.0	6.9	6.2	8.0	9.4	10.0
Florida	10.1	11.2	10.0	8.0	9.0	.....	.....	.....	.....	.....
Alabama	13.7	15.9	12.5	12.0	15.0	8.3	7.5	8.0	10.0	12.0
Mississippi	17.2	15.8	13.5	14.5	18.0	9.8	8.0	8.5	10.0	13.9
Louisiana	16.2	18.8	13.0	17.0	18.0	.....	.....	.....	.....	.....
Texas	19.0	26.4	9.5	18.5	25.0	15.1	5.7	11.7	15.8	14.8
Arkansas	19.2	21.5	13.5	16.0	20.0	8.8	9.4	8.0	10.5	11.0
Tennessee	21.9	25.0	23.0	21.0	26.0	8.1	8.8	8.5	11.2	13.2
West Virginia	18.5	24.2	30.0	24.5	29.0	12.1	10.6	10.3	13.4	13.8
Kentucky	23.0	31.2	28.0	23.0	31.0	12.5	10.9	8.7	13.6	15.4
Ohio	26.3	32.6	41.0	32.5	37.0	19.0	13.3	9.0	16.9	16.9
Michigan	23.2	33.8	38.0	31.5	34.0	15.8	13.2	12.8	15.6	20.8
Indiana	28.9	32.8	35.0	30.0	36.0	18.4	9.2	9.0	13.0	15.6
Illinois	28.8	37.4	40.5	32.5	30.0	18.2	11.0	14.7	7.9	11.0
Wisconsin	20.7	31.8	37.0	33.0	35.0	16.5	15.5	13.3	12.5	18.0
Minnesota	18.4	31.2	30.5	26.0	32.0	13.5	23.0	14.2	13.0	15.8
Iowa	15.0	35.1	39.0	29.0	35.0	11.8	19.5	16.0	13.0	16.7

Average yield per acre of the principal farm crops, 1894 to 1898—Continued.

States and Territories.	Corn.					Wheat.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Missouri	22.0	36.0	27.0	26.0	26.0	15.3	12.0	11.7	9.0	9.8
Kansas	11.2	24.3	28.0	18.0	16.0	10.4	7.7	10.6	15.5	14.2
Nebraska	6.0	16.1	37.5	30.0	21.0	7.0	12.0	14.0	14.5	16.4
South Dakota	4.2	11.1	26.0	24.0	28.0	6.6	12.0	11.2	8.0	12.4
North Dakota	19.2	21.3	35.0	17.0	19.0	11.8	21.0	11.8	10.3	14.4
Montana	22.7	25.0	26.0	18.0	28.0	24.8	23.9	26.5	32.5	29.5
Wyoming	30.0	27.5	25.0	12.0	16.0	19.6	26.0	24.5	25.0	23.7
Colorado	19.7	20.7	16.0	19.0	18.0	17.9	23.5	17.5	24.0	26.3
New Mexico	19.1	27.2	16.0	27.0	21.0	18.0	20.4	21.0	24.0	23.8
Arizona	18.6	26.0	.....	.....	.....	17.0	20.5	23.0	18.0	31.7
Utah	24.4	20.3	25.0	22.0	21.0	22.0	22.4	26.5	21.0	28.0
Nevada	.....	.....	.....	.....	.....	20.0	21.7	30.0	24.3	20.0
Idaho	28.6	30.7	.....	.....	.....	20.6	17.8	24.5	22.0	31.0
Washington	20.8	17.1	14.0	18.0	12.0	16.6	15.5	18.0	23.5	24.2
Oregon	25.4	26.4	22.0	25.0	24.0	17.7	20.0	17.0	17.0	20.5
California	19.3	34.5	37.0	31.5	26.0	11.3	13.0	14.6	10.0	9.1
Oklahoma	.....	.....	.....	.....	.....	11.3	11.4	13.0	19.0	14.9
General average	19.4	26.2	28.2	23.8	24.8	13.2	13.7	12.4	13.4	15.3

States and Territories.	Oats.					Barley.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	33.5	40.1	40.0	31.0	36.0	26.1	32.4	30.6	25.0	27.0
New Hampshire	31.1	36.9	38.0	35.0	36.0	24.4	25.6	29.3	22.5	23.5
Vermont	32.9	43.8	40.5	33.0	38.0	27.9	33.2	33.0	28.5	30.0
Massachusetts	31.9	36.0	36.0	32.0	32.0	21.7	22.5	30.0	24.5	24.5
Rhode Island	30.0	32.4	30.0	32.0	27.0	30.0	23.5	29.0	28.0	28.0
Connecticut	25.8	31.9	29.0	29.0	28.2	.....	.....	.....	.....	.....
New York	22.1	31.7	33.0	31.0	27.5	17.5	22.9	23.2	25.0	25.2
New Jersey	28.4	35.5	34.0	25.0	19.6	.....	.....	.....	.....	.....
Pennsylvania	22.3	31.7	31.0	28.2	23.3	16.6	20.2	17.2	24.5	19.4
Delaware	19.0	19.1	29.0	22.0	22.0	.....	.....	.....	.....	.....
Maryland	21.4	26.2	24.0	24.0	19.5	.....	.....	.....	.....	.....
Virginia	12.0	17.7	18.5	12.0	16.1	.....	.....	.....	.....	.....
North Carolina	10.9	15.1	12.0	13.0	14.3	.....	.....	.....	.....	.....
South Carolina	12.0	15.2	11.0	15.5	17.2	.....	.....	.....	.....	.....
Georgia	13.4	14.5	12.0	14.0	16.6	.....	.....	.....	.....	.....
Florida	11.8	10.2	12.0	9.0	15.4	.....	.....	.....	.....	.....
Alabama	13.2	14.9	14.0	13.0	16.8	.....	.....	.....	.....	.....
Mississippi	13.0	15.7	13.0	14.0	18.5	.....	.....	.....	.....	.....
Louisiana	22.3	15.0	10.0	18.0	18.1	.....	.....	.....	.....	.....
Texas	32.7	20.7	20.0	25.0	29.7	15.3	21.6	12.0	25.0	20.0
Arkansas	18.5	25.4	16.0	17.0	22.8	.....	.....	.....	.....	.....
Tennessee	14.6	22.5	16.5	10.0	18.7	13.8	23.1	14.0	18.0	18.0
West Virginia	18.5	23.4	24.0	20.0	19.5	.....	.....	.....	.....	.....
Kentucky	21.0	26.2	21.0	18.0	22.4	28.7	33.3	14.8	20.0	16.0
Ohio	30.3	31.7	31.0	32.0	30.9	28.5	28.2	20.2	28.5	28.7
Michigan	26.1	23.9	30.0	26.0	32.8	20.6	18.1	22.3	21.5	25.2
Indiana	32.3	22.9	29.0	30.2	29.2	20.7	15.0	20.3	19.0	23.4
Illinois	36.1	24.4	28.0	32.0	29.0	23.5	20.0	23.7	25.0	27.3
Wisconsin	32.9	33.8	23.4	34.0	36.1	28.6	29.3	27.1	28.0	29.1
Minnesota	28.1	30.9	23.0	26.0	36.3	23.5	26.0	27.2	25.5	28.4
Iowa	25.6	46.2	27.5	30.0	34.0	15.5	28.0	26.3	24.0	26.0
Missouri	23.3	27.7	18.0	22.0	17.0	14.0	15.3	17.5	19.0	20.0
Kansas	17.9	17.9	13.0	21.0	18.0	8.8	14.1	4.6	17.5	28.0
Nebraska	12.6	23.8	19.0	31.0	32.1	5.7	28.4	19.9	22.0	27.1
South Dakota	7.6	25.3	27.5	22.0	26.8	14.7	19.5	28.5	20.0	23.0
North Dakota	25.9	32.1	32.0	23.0	30.7	20.1	30.4	16.1	22.5	26.4
Montana	40.1	35.8	47.0	42.0	40.6	22.5	25.0	25.0	38.0	36.0
Wyoming	30.4	41.0	32.0	35.0	31.2	.....	.....	.....	.....	.....
Colorado	13.5	34.3	28.0	34.0	35.8	27.8	31.3	20.0	28.0	30.5
New Mexico	35.0	39.9	27.0	35.5	38.8	27.0	28.0	19.0	32.5	33.8
Arizona	.....	.....	.....	.....	.....	25.0	25.7	.....	.....	.....
Utah	33.0	33.8	38.0	35.0	39.7	33.0	30.0	27.1	31.0	37.0
Nevada	.....	.....	.....	.....	.....	32.5	32.1	.....	.....	.....
Idaho	38.5	35.2	42.0	36.3	43.6	32.6	24.5	15.3	35.0	35.0
Washington	36.5	40.3	36.0	18.0	41.9	33.7	37.3	26.0	15.0	39.8
Oregon	26.7	28.8	21.0	32.0	27.0	38.6	22.1	21.8	32.5	29.1
California	35.6	28.1	31.0	18.0	33.0	15.2	20.3	21.6	23.0	10.5
General average	24.5	29.6	25.7	27.2	28.4	19.4	26.4	23.6	24.5	21.6

Average yield per acre of the principal farm crops, 1894 to 1898—Continued.

States and Territories.	Hay.					Cotton.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
Maine	0.95	1.02	1.00	1.10	1.20	.....	.....	.....	.....	.....
New Hampshire	.95	.95	.96	1.15	1.25	.....	.....	.....	.....	.....
Vermont	1.20	1.07	1.25	1.30	1.45	.....	.....	.....	.....	.....
Massachusetts	1.26	1.11	1.28	1.40	1.42	.....	.....	.....	.....	.....
Rhode Island	.75	.91	1.10	1.15	1.18	.....	.....	.....	.....	.....
Connecticut	.87	.85	1.07	1.20	1.31	.....	.....	.....	.....	.....
New York	1.17	.73	.81	1.35	1.40	.....	.....	.....	.....	.....
New Jersey	1.16	1.21	1.15	1.75	1.42	.....	.....	.....	.....	.....
Pennsylvania	1.18	1.01	1.06	1.40	1.45	.....	.....	.....	.....	.....
Delaware	1.30	1.23	1.10	1.35	1.38	.....	.....	.....	.....	.....
Maryland	1.03	1.25	.87	1.35	1.20	.....	.....	.....	.....	.....
Virginia	.72	1.13	1.08	1.08	1.32	0.21	0.18	0.24	0.25	0.29
North Carolina	1.45	1.63	1.26	1.25	1.70	.35	.38	.42	.50	.46
South Carolina	1.53	1.00	1.33	1.00	1.60	.38	.42	.46	.50	.50
Georgia	1.16	1.60	1.38	1.35	1.75	.33	.35	.37	.38	.37
Florida	1.23	1.53	1.40	1.00	1.60	.24	.20	.18	.21	.23
Alabama	2.68	1.56	1.40	1.45	1.90	.32	.28	.31	.41	.38
Mississippi	1.84	1.95	1.35	1.48	1.90	.41	.41	.42	.55	.46
Louisiana	1.96	2.02	1.90	1.90	2.10	.55	.45	.46	.63	.53
Texas	1.33	1.48	1.00	1.40	1.50	.45	.33	.31	.39	.40
Arkansas	1.32	1.20	1.18	1.30	1.54	.48	.44	.39	.58	.56
Tennessee	1.18	1.39	1.40	1.45	1.50	.33	.24	.26	.28	.34
West Virginia	1.02	.71	1.22	1.35	1.54	.....	.....	.....	.....	.....
Kentucky	1.26	1.35	1.20	1.17	1.45	.....	.....	.....	.....	.....
Ohio	1.27	.58	1.26	1.44	1.39	.....	.....	.....	.....	.....
Michigan	1.20	.58	1.16	1.49	1.36	.....	.....	.....	.....	.....
Indiana	1.27	.61	1.30	1.43	1.45	.....	.....	.....	.....	.....
Illinois	1.14	.66	1.38	1.29	1.56	.....	.....	.....	.....	.....
Wisconsin	1.31	.88	1.25	1.35	1.50	.....	.....	.....	.....	.....
Minnesota	1.02	1.30	1.69	1.57	1.80	.....	.....	.....	.....	.....
Iowa	.73	1.08	1.74	1.50	1.75	.....	.....	.....	.....	.....
Missouri	.85	1.17	1.43	1.15	1.60	.....	.....	.....	.....	.....
Kansas	.77	1.24	1.42	1.30	1.46	.....	.....	.....	.....	.....
Nebraska	.59	.99	1.66	1.60	1.60	.....	.....	.....	.....	.....
South Dakota	.94	.79	1.28	1.25	1.38	.....	.....	.....	.....	.....
North Dakota	1.19	1.42	1.65	1.60	1.50	.....	.....	.....	.....	.....
Montana	1.20	.94	1.38	1.50	1.45	.....	.....	.....	.....	.....
Wyoming	1.60	1.08	1.55	1.65	1.96	.....	.....	.....	.....	.....
Colorado	2.27	2.42	2.20	2.25	2.20	.....	.....	.....	.....	.....
New Mexico	1.88	2.61	3.00	3.50	3.75	.....	.....	.....	.....	.....
Arizona	1.82	1.85	3.20	3.00	3.50	.....	.....	.....	.....	.....
Utah	2.52	2.56	2.70	2.95	3.25	.....	.....	.....	.....	.....
Nevada	4.04	3.01	2.55	2.50	2.69	.....	.....	.....	.....	.....
Idaho	2.53	2.57	2.60	2.30	3.75	.....	.....	.....	.....	.....
Washington	2.05	1.85	1.95	2.25	1.75	.....	.....	.....	.....	.....
Oregon	2.00	1.78	1.98	1.90	1.90	.....	.....	.....	.....	.....
California	1.93	1.66	1.65	1.60	1.60	.....	.....	.....	.....	.....
Oklahoma	.....	.....	.....	.....	.....	.45	.54	.45	.51	.49
Indian Territory	.....	.....	.....	.....	.....	.45	.32	.62	.65	.64
General average	1.14	1.06	1.37	1.43	1.55	.40	.35	.37	.45	.43

Average value per acre of the principal farm crops, 1894 to 1898.

[From Division of Statistics.]

States and Territories.	Corn.					Wheat.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
Maine	$28.73	$22.68	$17.39	$17.39	$19.20	$16.67	$15.74	$18.48	$17.49	$17.56
New Hampshire	26.07	20.50	18.90	15.30	18.86	16.00	14.67	21.00	17.60	17.48
Vermont	28.15	21.89	15.58	15.05	18.92	15.21	20.01	22.79	17.68	20.25
Massachusetts	21.05	22.83	19.78	15.28	19.60	.....	.....	.....	.....	.....
Rhode Island	23.55	17.30	16.66	16.74	21.76	.....	.....	.....	.....	.....
Connecticut	21.08	19.33	15.96	15.43	19.24	.....	.....	.....	20.00	17.60
New York	17.20	16.02	12.92	12.40	14.19	9.18	12.31	14.08	19.26	15.26
New Jersey	17.87	13.86	11.88	11.97	14.80	9.33	8.80	13.62	17.20	12.70
Pennsylvania	17.60	13.07	13.20	22.24	14.80	8.40	10.79	11.62	17.93	11.90
Delaware	9.90	7.14	5.50	8.70	7.75	7.15	7.42	15.66	20.21	9.18
Maryland	11.45	9.92	10.24	9.90	10.85	8.26	10.88	14.96	17.86	10.71
Virginia	8.98	6.88	6.88	6.84	7.70	5.32	6.05	7.44	11.04	9.31
North Carolina	6.30	5.51	4.44	5.59	6.02	3.25	4.97	6.06	7.52	7.18
South Carolina	7.28	5.11	4.14	4.41	4.60	4.87	5.63	6.05	10.27	9.96
Georgia	6.79	5.33	4.73	5.28	4.32	5.24	5.08	7.12	9.68	9.80
Florida	7.17	5.25	5.30	4.40	4.50	.....	.....	.....	.....	.....

Average value per acre of the principal farm crops, 1894 to 1898—Continued.

States and Territories.	Corn.					Wheat.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895	1896.	1897.	1898.
Alabama	$7.26	$5.88	$5.63	$5.52	$6.15	$6.47	$6.00	$6.80	$10.10	$10.80
Mississippi	8.43	5.85	5.94	6.53	7.02	7.35	4.88	6.97	9.90	11.54
Louisiana	10.04	7.24	5.85	7.65	7.38	.....	.....	.....	.....	.....
Texas	10.64	8.18	3.99	7.58	8.50	8.15	3.76	8.78	14.06	10.06
Arkansas	9.02	6.88	4.99	6.40	5.89	4.84	5.55	5.68	8.82	6.38
Tennessee	8.54	6.75	6.44	7.56	7.54	4.13	5.46	6.29	10.64	8.84
West Virginia	10.55	9.68	10.20	9.80	10.73	7.23	7.31	8.03	11.93	9.80
Kentucky	10.12	8.42	7.00	8.05	8.57	6.25	6.65	6.61	12.10	9.55
Ohio	11.31	8.89	8.61	8.12	9.99	9.31	7.98	7.02	14.87	11.15
Michigan	11.09	10.82	9.12	8.50	11.56	8.22	7.92	10.75	13.57	13.31
Indiana	10.69	7.54	6.65	6.30	9.00	8.46	5.24	7.20	11.57	9.83
Illinois	11.23	8.23	7.29	6.83	7.50	8.19	5.83	10.88	7.03	6.60
Wisconsin	9.32	9.54	8.14	8.25	9.80	8.42	7.91	9.31	10.50	10.62
Minnesota	7.91	6.24	5.79	6.24	7.68	6.62	10.12	9.66	10.01	8.53
Iowa	6.75	6.32	5.46	4.93	8.05	7.40	8.97	9.92	9.75	8.68
Missouri	8.80	7.20	5.40	6.24	7.02	6.58	6.12	8.19	7.65	5.78
Kansas	4.82	4.62	5.04	3.96	4.16	4.58	3.47	6.68	11.47	7.10
Nebraska	3.00	2.90	4.88	5.10	4.62	3.43	4.80	8.12	10.00	7.71
South Dakota	1.93	2.55	4.68	5.04	6.44	3.04	4.56	6.94	5.52	6.20
North Dakota	8.45	5.11	8.75	5.44	6.84	5.07	7.98	7.55	7.62	7.34
Montana	26.81	18.75	15.00	11.70	18.48	13.39	17.45	17.49	22.10	17.11
Wyoming	19.50	15.67	19.50	6.00	8.80	12.35	16.64	15.19	17.50	16.35
Colorado	12.02	8.49	5.76	7.22	7.20	11.64	13.16	10.67	16.80	14.73
New Mexico	14.23	15.23	8.86	15.66	11.76	15.84	14.89	15.86	18.00	14.76
Arizona	18.60	19.50	.....	.....	.....	17.00	13.33	18.40	13.32	29.16
Utah	14.15	9.95	12.75	12.10	12.60	11.66	9.86	18.02	14.28	15.12
Nevada	.....	.....	.....	.....	.....	15.00	10.63	20.70	21.87	27.55
Idaho	16.87	19.03	.....	.....	.....	9.48	8.37	15.93	15.40	15.81
Washington	14.35	6.84	7.98	9.90	5.04	6.47	6.35	13.32	15.98	13.07
Oregon	14.22	14.52	12.32	13.25	14.40	7.61	9.40	12.24	12.24	12.71
California	11.00	18.29	19.61	17.64	16.12	6.44	7.89	12.12	8.30	6.55
Oklahoma	.....	.....	.....	.....	.....	5.76	5.47	8.84	14.44	7.75
General average	8.86	6.64	6.06	6.26	7.10	6.48	6.99	8.97	10.86	8.92

States and Territories.	Oats.					Barley.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
Maine	$14.74	$13.63	$12.40	$9.92	$12.24	$17.23	$16.85	$13.16	$13.75	$15.12
New Hampshire	15.24	12.92	13.30	13.30	12.54	15.37	14.34	15.53	13.50	13.63
Vermont	16.78	14.37	12.56	10.56	13.30	16.74	15.09	13.53	13.11	14.10
Massachusetts	13.72	12.24	12.00	10.56	11.84	13.67	14.03	17.49	22.77	16.17
Rhode Island	14.10	12.64	9.30	10.88	9.99	21.09	17.03	17.40	15.12	17.08
Connecticut	11.09	9.89	8.99	9.86	10.15	.....	.....	.....	.....	.....
New York	8.62	8.88	8.58	8.37	8.56	9.80	18.55	9.05	10.50	12.10
New Jersey	10.79	10.29	9.52	7.50	6.08	.....	.....	.....	.....	.....
Pennsylvania	8.47	8.56	7.43	7.61	6.99	7.97	8.28	6.88	9.55	8.54
Delaware	6.65	5.54	6.09	5.06	6.69	.....	.....	.....	.....	.....
Maryland	8.35	7.07	5.52	6.24	5.65	.....	.....	.....	.....	.....
Virginia	4.44	5.31	4.81	3.48	4.67	.....	.....	.....	.....	.....
North Carolina	4.80	5.74	4.29	4.81	5.29	.....	.....	.....	.....	.....
South Carolina	6.36	7.45	5.28	6.98	7.74	.....	.....	.....	.....	.....
Georgia	6.83	6.67	4.92	5.88	7.97	.....	.....	.....	.....	.....
Florida	7.20	6.63	6.36	4.77	8.32	.....	.....	.....	.....	.....
Alabama	6.73	6.26	5.74	5.59	6.89	.....	.....	.....	.....	.....
Mississippi	6.11	6.12	5.72	6.16	7.77	.....	.....	.....	.....	.....
Louisiana	10.48	5.40	3.40	6.84	6.88	.....	.....	.....	.....	.....
Texas	12.75	5.38	6.80	6.75	8.32	8.44	11.66	6.00	10.75	10.00
Arkansas	7.40	8.13	4.96	5.61	6.61	.....	.....	.....	.....	.....
Tennessee	5.11	6.08	4.29	2.80	5.24	7.73	11.35	6.30	10.62	10.08
West Virginia	7.21	7.49	6.72	6.00	5.85	.....	.....	.....	.....	.....
Kentucky	7.56	6.81	5.04	4.86	6.05	13.49	12.65	5.92	8.00	6.40
Ohio	9.39	6.97	5.27	6.40	7.42	13.68	11.56	7.68	11.69	12.63
Michigan	8.87	5.50	5.70	5.98	8.86	10.30	7.78	9.37	8.60	11.09
Indiana	9.69	4.58	4.64	5.74	6.72	9.32	6.00	6.70	8.36	10.30
Illinois	10.47	4.15	4.20	5.76	6.67	11.28	9.00	7.35	9.50	10.65
Wisconsin	9.87	6.08	5.95	6.46	8.06	12.87	9.96	7.40	8.96	11.64
Minnesota	8.43	5.59	4.95	4.94	7.62	9.66	8.64	5.44	6.12	9.37
Iowa	7.17	6.45	3.30	4.80	8.16	6.51	6.44	5.52	5.76	8.84
Missouri	6.76	4.99	3.06	4.18	3.91	7.14	7.34	4.38	7.00	7.20
Kansas	5.55	3.04	2.08	4.32	3.96	4.31	5.31	1.01	4.38	7.56
Nebraska	4.54	3.33	2.09	4.65	6.42	2.45	6.82	3.78	5.28	6.78
South Dakota	2.65	4.35	3.58	3.96	5.63	4.72	3.71	5.42	4.40	6.21
North Dakota	7.51	5.14	3.96	5.98	7.98	7.24	6.68	3.38	6.07	7.66
Montana	12.46	15.75	14.57	13.86	14.21	9.00	14.75	13.75	19.00	20.52
Wyoming	14.39	15.99	16.26	12.25	12.48	.....	.....	.....	.....	.....
Colorado	6.21	9.69	8.40	10.88	14.68	16.04	18.78	9.20	14.28	14.03

Average value per acre of the principal farm crops, 1894 to 1898—Continued.

States and Territories.	Oats.					Barley.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
New Mexico	$17.50	$17.96	$10.80	$14.56	$15.91	$18.29	$12.04	$12.55	$17.[illegible]	$14.59
Arizona	.....	.....	.....	.....	.....	18.75	17.99	.....	.....	.....
Utah	11.22	10.14	14.82	11.55	15.09	15.18	11.70	11.38	13.95	17.39
Nevada	.....	.....	.....	.....	.....	16.57	16.05	.....	.....	.....
Idaho	12.32	10.21	12.60	11.62	15.70	15.32	10.29	3.37	14.70	16.80
Washington	11.32	11.28	14.40	16.80	16.76	10.78	14.17	10.40	19.35	17.91
Oregon	7.48	7.78	6.93	11.20	10.80	12.74	8.84	9.81	14.63	14.26
California	15.66	10.96	13.64	8.82	16.50	6.84	8.12	10.37	12.42	6.82
General average	7.95	5.87	4.81	5.75	7.23	.....	.....	.....	9.25	8.93

States and Territories.	Hay.					Cotton.				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
Maine	$9.12	$9.87	$10.25	$10.73	$9.12	.....	.....	.....	.....	.....
New Hampshire	9.97	11.88	12.38	13.23	11.56	.....	.....	.....	.....	.....
Vermont	11.93	13.11	12.85	12.03	9.21	.....	.....	.....	.....	.....
Massachusetts	19.53	19.42	20.99	19.46	17.18	.....	.....	.....	.....	.....
Rhode Island	12.25	15.70	18.26	16.67	14.93	.....	.....	.....	.....	.....
Connecticut	13.54	13.68	15.74	15.60	14.61	.....	.....	.....	.....	.....
New York	11.30	10.00	9.75	11.14	8.05	.....	.....	.....	.....	.....
New Jersey	16.34	15.29	16.50	18.81	13.63	.....	.....	.....	.....	.....
Pennsylvania	13.35	12.42	12.88	12.81	11.46	.....	.....	.....	.....	.....
Delaware	19.50	14.96	14.30	13.50	11.66	.....	.....	.....	.....	.....
Maryland	11.46	14.44	10.31	14.17	11.16	.....	.....	.....	.....	.....
Virginia	8.56	12.92	11.03	11.07	11.22	$5.94	$7.31	$8.07	$8.63	$8.50
North Carolina	15.85	16.56	13.55	12.19	15.81	10.00	15.52	14.45	12.88	13.39
South Carolina	16.45	7.62	15.06	11.50	15.20	10.44	17.26	15.97	13.04	13.72
Georgia	14.36	17.44	15.25	17.55	20.56	9.10	14.25	12.71	11.93	11.25
Florida	19.99	20.24	18.20	14.25	22.56	6.67	8.28	7.92	7.48	6.55
Alabama	25.49	15.93	13.72	13.86	17.57	8.97	11.47	10.65	10.39	11.12
Mississippi	17.79	18.91	12.77	14.06	15.96	11.07	16.69	14.47	14.74	13.05
Louisiana	28.85	19.47	16.63	16.62	19.74	15.41	18.42	15.40	16.42	15.50
Texas	10.13	9.52	7.20	10.15	8.77	12.58	13.40	11.60	10.89	12.30
Arkansas	11.66	11.12	8.90	11.25	10.39	11.17	17.98	12.71	13.98	16.82
Tennessee	13.30	15.05	13.54	15.59	14.25	7.61	9.92	8.62	8.71	10.32
West Virginia	10.87	9.04	11.94	11.95	12.94	.....	.....	.....	.....	.....
Kentucky	13.19	14.77	11.35	11.70	13.19	.....	.....	.....	.....	.....
Ohio	10.74	7.40	9.99	9.00	7.99	.....	.....	.....	.....	.....
Michigan	10.85	7.59	9.84	11.55	9.72	.....	.....	.....	.....	.....
Indiana	9.63	7.34	9.33	8.44	8.12	.....	.....	.....	.....	.....
Illinois	9.50	6.77	8.82	7.93	9.29	.....	.....	.....	.....	.....
Wisconsin	10.42	8.47	8.25	8.44	8.62	.....	.....	.....	.....	.....
Minnesota	5.41	6.66	6.41	7.06	6.06	.....	.....	.....	.....	.....
Iowa	5.39	6.97	6.94	6.37	7.09	.....	.....	.....	.....	.....
Missouri	6.65	7.96	6.94	7.07	9.28	.....	10.13	9.96	7.04	11.95
Kansas	4.04	4.04	3.83	4.42	4.74	.....	.....	.....	.....	.....
Nebraska	4.20	3.52	4.05	4.80	5.28	.....	.....	.....	.....	.....
South Dakota	4.02	2.60	3.99	3.69	4.14	.....	.....	.....	.....	.....
North Dakota	4.61	4.94	5.59	5.20	4.87	.....	.....	.....	.....	.....
Montana	8.60	10.72	9.47	11.63	9.86	.....	.....	.....	.....	.....
Wyoming	16.10	7.02	11.07	9.90	11.40	.....	.....	.....	.....	.....
Colorado	17.12	14.21	13.68	12.38	11.88	.....	.....	.....	.....	.....
New Mexico	21.62	20.88	17.10	24.50	27.56	.....	.....	.....	.....	.....
Arizona	21.84	16.65	28.00	15.00	42.00	.....	.....	.....	.....	.....
Utah	14.01	13.49	13.50	14.01	14.62	.....	.....	.....	.....	.....
Nevada	29.29	20.32	12.29	12.50	18.20	.....	.....	.....	.....	.....
Idaho	10.98	16.06	12.25	12.08	18.37	.....	.....	.....	.....	.....
Washington	15.13	12.49	13.83	20.25	13.30	.....	.....	.....	.....	.....
Oregon	11.72	10.89	13.07	14.73	13.78	.....	.....	.....	.....	.....
California	18.34	11.72	10.48	14.40	22.80	.....	.....	.....	.....	.....
Oklahoma	.....	.....	.....	.....	.....	.....	22.14	15.92	15.08	14.44
Indian Territory	.....	.....	.....	.....	.....	.....	13.22	21.16	19.20	18.85
General average	9.70	8.89	8.97	9.46	9.30	10.94	14.54	14.54	12.17	12.48

Prices of principal agricultural products on the farm December 1, 1894 to 1898.

[From Division of Statistics.]

States and Territories.	Corn (per bushel).					Wheat (per bushel).				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*					
Maine	72	54	47	47	48	$0.79	$0.82	$0.84	$1.06	$0.89
New Hampshire	76	51	45	45	46	.80	.76	1.00	1.10	.92
Vermont	69	48	38	43	44	.67	.69	.93	1.04	.90
Massachusetts	61	52	46	47	49	------	------	------	------	------
Rhode Island	75	56	49	54	64	------	------	------	------	------
Connecticut	68	51	42	49	52	------	.68	------	1.00	.88
New York	61	45	38	40	43	.62	.68	.88	.90	.72
New Jersey	54	42	36	38	40	.61	.71	.89	.93	.73
Pennsylvania	55	39	33	34	40	.56	.65	.83	.91	.68
Delaware	45	34	25	30	31	.55	.64	.87	.94	.69
Maryland	50	37	32	30	35	.54	.64	.88	.93	.70
Virginia	47	37	32	38	35	.56	.65	.80	.92	.66
North Carolina	47	38	37	43	43	.65	.72	.83	.94	.78
South Carolina	65	46	46	49	46	.87	.88	.89	1.18	.94
Georgia	58	41	43	48	48	.76	.82	.89	1.03	.98
Florida	71	47	53	55	50	------	------	------	------	------
Alabama	53	37	45	46	41	.78	.80	.85	1.01	.90
Mississippi	49	37	44	45	39	.75	.61	.82	.99	.83
Louisiana	62	40	45	45	41	------	------	------	------	------
Texas	56	31	41	41	34	.54	.66	.75	.89	.68
Arkansas	47	32	37	40	29	.55	.59	.71	.84	.58
Tennessee	39	27	28	36	29	.51	.62	.74	.95	.67
West Virginia	57	40	34	40	37	.60	.69	.78	.89	.71
Kentucky	44	27	25	35	27	.50	.61	.76	.89	.62
Ohio	43	27	21	25	27	.49	.60	.78	.88	.66
Michigan	50	32	24	27	34	.52	.60	.84	.87	.64
Indiana	37	23	19	21	25	.46	.57	.80	.89	.63
Illinois	39	22	18	21	25	.45	.53	.74	.89	.60
Wisconsin	45	30	22	25	28	.51	.51	.70	.84	.59
Minnesota	43	20	19	24	24	.49	.44	.68	.77	.54
Iowa	45	18	14	17	23	.50	.46	.62	.75	.52
Missouri	40	20	20	24	27	.43	.51	.70	.85	.59
Kansas	43	19	18	22	26	.44	.45	.63	.74	.50
Nebraska	50	18	13	17	22	.49	.40	.58	.69	.47
South Dakota	46	23	18	21	23	.46	.38	.62	.69	.50
North Dakota	44	24	25	32	36	.43	.38	.64	.74	.51
Montana	82	75	60	65	66	.54	.73	.66	.68	.58
Wyoming	65	57	78	50	55	.63	.64	.62	.70	.69
Colorado	61	41	36	38	40	.65	.56	.61	.70	.56
New Mexico	75	56	55	58	56	.88	.73	.66	.75	.62
Arizona	100	75	------	------	------	1.00	.65	.80	.74	.92
Utah	58	49	51	55	60	.53	.44	.68	.68	.54
Nevada	------	------	------	------	------	.75	.49	.69	.90	.95
Idaho	59	62	------	------	------	.46	.47	.65	.70	.51
Washington	69	40	57	55	42	.39	.41	.74	.68	.54
Oregon	56	55	56	53	60	.43	.47	.72	.72	.62
California	57	53	53	56	62	.57	.60	.83	.83	.72
Oklahoma	------	------	------	------	------	.51	.48	.68	.76	.52
General average	45.7	25.3	21.5	26.3	28.7	.491	.509	.726	[illegible]	[illegible]

Prices of principal agricultural products on the farm December 1, 1894 to 1898—Continued.

States and Territories.	Oats (per bushel).					Barley (per bushel).				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	44	34	31	32	34	66	52	43	55	56
New Hampshire	49	35	35	38	38	63	56	53	60	58
Vermont	51	33	31	32	35	60	47	41	46	47
Massachusetts	43	34	35	33	37	63	65	58	66	66
Rhode Island	47	39	31	34	37	72	75	60	54	61
Connecticut	43	31	31	34	36	.....	.....	.....	.....	.....
New York	39	28	26	27	31	56	81	39	42	48
New Jersey	38	29	28	30	31	.....	.....	.....	.....	.....
Pennsylvania	38	27	24	27	30	48	41	40	39	44
Delaware	35	29	21	23	30	.....	.....	.....	.....	.....
Maryland	39	27	23	26	29	.....	.....	.....	.....	.....
Virginia	37	30	26	29	29	.....	.....	.....	.....	.....
North Carolina	44	38	35	37	37	.....	.....	.....	.....	.....
South Carolina	53	49	48	45	45	.....	.....	.....	.....	.....
Georgia	51	46	41	42	48	.....	.....	.....	.....	.....
Florida	61	65	53	53	54	.....	.....	.....	.....	.....
Alabama	51	42	41	43	41	.....	.....	.....	.....	.....
Mississippi	47	39	44	44	42	.....	.....	.....	.....	.....
Louisiana	47	36	34	38	38	.....	.....	.....	.....	.....
Texas	39	26	34	27	28	55	54	50	43	50
Arkansas	40	32	31	33	29	.....	.....	.....	.....	.....
Tennessee	35	27	26	28	28	56	50	45	59	56
West Virginia	39	32	28	30	30	.....	38	.....	.....	.....
Kentucky	36	26	24	27	27	47	38	40	40	40
Ohio	31	22	17	20	24	48	41	38	41	44
Michigan	34	23	19	23	27	50	43	42	40	44
Indiana	30	20	16	19	23	45	40	33	44	44
Illinois	29	17	15	18	23	48	45	31	38	39
Wisconsin	30	18	17	19	24	45	34	27	32	40
Minnesota	30	14	15	19	21	41	24	20	24	33
Iowa	28	14	12	16	24	42	23	21	24	34
Missouri	29	18	17	19	23	51	48	35	40	36
Kansas	31	17	16	18	22	49	23	22	25	27
Nebraska	36	14	11	15	20	43	24	19	24	25
South Dakota	35	17	13	18	21	35	19	19	22	27
North Dakota	29	16	18	26	26	36	20	21	27	29
Montana	31	44	31	33	35	40	59	55	50	57
Wyoming	48	39	53	35	40	.....	28	.....	.....	.....
Colorado	46	28	30	32	41	58	60	46	51	46
New Mexico	50	45	40	41	41	70	68	65	55	55
Arizona	.....	.....	.....	.....	.....	75	70	.....	.....	.....
Utah	34	30	39	33	38	46	39	42	45	47
Nevada	.....	.....	.....	.....	.....	51	50	.....	.....	.....
Idaho	32	29	30	32	36	47	42	22	42	48
Washington	31	28	40	35	40	32	38	40	43	45
Oregon	28	27	33	35	40	33	40	45	45	49
California	44	39	44	49	50	45	40	48	54	65
General average	32.4	19.9	18.7	21.2	25.5	44.2	33.7	32.3	37.7	41.3

Prices of principal agricultural products on the farm December 1, 1894 to 1898—Continued.

States and Territories.	Hay (per ton).					Cotton (per pound).				
	1894.	1895.	1896.	1897.	1898.	1894.	1895.	1896.	1897.	1898.
						Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	$9.60	$9.63	$10.25	$9.75	$7.60	.....	.....	.....	.....	.....
New Hampshire	10.50	12.50	12.90	11.50	9.25	.....	.....	.....	.....	.....
Vermont	9.94	12.25	10.28	9.25	6.35	.....	.....	.....	.....	.....
Massachusetts	15.50	17.50	16.40	13.90	12.10	.....	.....	.....	.....	.....
Rhode Island	16.33	17.25	16.60	14.50	12.65	.....	.....	.....	.....	.....
Connecticut	15.56	16.10	14.71	13.00	11.15	.....	.....	.....	.....	.....
New York	9.66	13.70	12.04	8.25	5.75	.....	.....	.....	.....	.....
New Jersey	14.09	12.64	14.35	10.75	9.60	.....	.....	.....	.....	.....
Pennsylvania	11.31	12.30	12.15	9.15	7.90	.....	.....	.....	.....	.....
Delaware	15.00	12.16	13.00	10.00	8.45	.....	.....	.....	.....	.....
Maryland	11.13	11.55	11.85	10.50	9.30	.....	.....	.....	.....	.....
Virginia	11.89	11.43	10.21	10.25	8.50	5.0	7.8	7.1	6.9	5.9
North Carolina	10.93	10.14	10.75	9.75	9.30	4.8	8.2	6.7	7.0	5.9
South Carolina	10.75	7.62	11.32	11.50	9.50	5.0	8.8	6.8	6.9	5.6
Georgia	12.38	10.90	11.05	13.00	11.75	4.5	7.0	7.0	6.7	5.6
Florida	16.25	13.23	13.00	14.25	14.10	4.8	11.5	8.7	6.8	5.6
Alabama	9.51	10.21	9.80	10.25	9.25	4.8	7.8	6.5	6.7	5.7
Mississippi	9.67	9.70	9.46	9.50	8.40	4.1	7.5	6.7	6.7	5.7
Louisiana	10.64	9.64	8.75	8.75	9.40	4.3	7.8	6.7	6.7	5.7
Texas	7.62	6.43	7.20	7.25	5.85	4.5	7.3	6.5	6.6	5.8
Arkansas	8.83	9.27	7.54	8.65	6.75	4.8	7.6	6.4	6.5	5.8
Tennessee	11.27	10.83	9.67	10.75	9.50	4.5	7.3	6.2	6.6	5.7
West Virginia	10.66	12.73	9.79	8.85	8.40	.....	.....	.....	.....	.....
Kentucky	10.47	10.94	9.46	10.00	9.10	.....	.....	.....	.....	.....
Ohio	8.46	12.76	7.93	6.25	5.75	.....	.....	.....	.....	.....
Michigan	9.04	13.09	8.48	7.75	7.15	.....	.....	.....	.....	.....
Indiana	7.58	12.03	7.18	5.90	5.60	.....	.....	.....	.....	.....
Illinois	8.33	10.25	6.39	6.15	5.90	.....	.....	.....	.....	.....
Wisconsin	7.96	9.63	6.60	6.25	5.75	.....	.....	.....	.....	.....
Minnesota	5.30	5.12	3.79	4.50	3.70	.....	.....	.....	.....	.....
Iowa	7.39	6.45	3.99	4.25	4.05	.....	.....	.....	.....	.....
Missouri	7.82	6.80	4.85	6.15	5.80	4.6	7.4	6.2	6.4	5.8
Kansas	5.25	3.26	2.70	3.40	3.25	.....	.....	.....	.....	.....
Nebraska	7.12	3.56	2.44	3.00	3.30	.....	.....	.....	.....	.....
South Dakota	4.28	3.29	3.12	2.95	3.00	.....	.....	.....	.....	.....
North Dakota	3.87	3.48	3.39	3.25	3.25	.....	.....	.....	.....	.....
Montana	7.17	1.40	6.86	7.75	6.80	.....	.....	.....	.....	.....
Wyoming	10.00	6.50	7.14	6.00	5.90	.....	.....	.....	.....	.....
Colorado	7.54	5.87	6.22	5.50	5.40	.....	.....	.....	.....	.....
New Mexico	11.30	8.00	5.70	7.00	7.35	.....	.....	.....	.....	.....
Arizona	12.00	9.00	8.75	5.00	12.00	.....	.....	.....	.....	.....
Utah	5.56	5.27	5.00	4.75	4.50	.....	.....	.....	.....	.....
Nevada	7.25	6.75	4.82	5.00	7.00	.....	.....	.....	.....	.....
Idaho	4.34	6.25	4.71	5.25	4.90	.....	.....	.....	.....	.....
Washington	7.38	6.75	7.09	9.00	7.60	.....	.....	.....	.....	.....
Oregon	5.86	6.12	6.60	7.75	7.25	.....	.....	.....	.....	.....
California	9.50	7.06	6.35	9.60	14.25	.....	.....	.....	.....	.....
Oklahoma	.....	.....	.....	.....	.....	4.6	7.5	6.2	6.7	5.8
Indian Territory	.....	.....	.....	.....	.....	.....	7.3	.....	6.4	5.8
General average	8.54	8.35	6.55	6.62	6.00	4.6	7.6	6.6	6.6	5.7

Wholesale prices of principal agricultural products in leading cities of the United States, 1893 to 1898.

[From Division of Statistics.]

CORN (PER BUSHEL).

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco (per cental).
1893.	*Steamer mixed.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 3 yellow.*	*No. 2.*	*No. 1 white.*
August 1	$0.49	$0.46¼ to $0.46¾	$0.47 to $0.48	$0.51	$0.41	$0.38 to $0.38⅞	$0.28¾	$0.35 to $0.36	$0.34½ to $0.34¾	$1.00 to $1.02½
September 1	.50	.45 .45¼	.47	.50	.41½	.37¼ .37⅞	.30¾	.35 .36	.34 .34½	.90 .95
October 2	.51	.49	.50 .51	.53	$0.42¾ to .43	.39⅞ .40½	.31	.37 .38	.35⅞ .36	.92½ .96
November 1	.50	.45⅞ .46¼	.47	$0.51 to .52	.39	.38½ .38¾	$0.31½ to .32	.37 .38	.35¾	.85 .87½
December 1	.46½	.44¼ .45¼	.43 .44	.49	.40	.34⅞ .35⅛	.30 .30¼	.33 .34	.34	.90 .92½
1894.										
August 1	.57	.53½ .54	.52 .53	.56 .57	.50	.46¼ .46⅞	.41 .42	.45½ .46	.44½ .45	1.35 1.37½
September 1	.65½	.63 .64	.61 .62	.70	.56	.53⅞ .57½	.52½	.57 .58	.53½ .54	1.25 1.25½
October 1	.60	.55⅛ .55¼	.59	.71	.54½	.49⅞ .49½	.46	.54 .54½	.49½ .50½	1.30 1.32½
November 1	.61½	.60	.55	.57	.52½	.52 .52½	.42½ .43	.54½ .55	.48½ .48¾	1.30 1.32½
December 1	.54	.58	.43 .44	.53 .54	.46	.46⅞ .47	.41½ .41⅞	.51 .52	.45½ .45¼	1.27½ 1.30
1895.										
August 1	.54	.48¼ .49¼	.49	.53 .54	.43½	.43 .44½	.38 .38¾	*No. 3.* .42½ .43	.39	1.07½ 1.10
September 3	$0.45 to .46	.40⅞ .41½	.41	.45	.37 .37½	.35⅞ .36⅞	.30	.35½ .36½	.33 .33⅞	1.10 1.12½
October 1	.44½ .42	.37 .37⅞	.39	.38	.33¾	.30½ .31½	.26¾ .26⅞	.31½ .32	.28	1.10 1.12½
November 1	.39 .39½		.37⅞ .36	.39	.32	.29⅞ .29½	.23½	.30 .30½	.26⅞	.87½ .90
December 1	.38		.35 .36	.37	.30	.26½ .26⅞	.22½ .23	.24 .24½	.24½	.85 .87½
1896.										
August 1	.33¾	.30⅞ .31	.31 .31½	.32 .33	.26¾	.24½ .24½	.21½ .22	.23½ .24	.22	.80 .82½
September 1	.29½ .30	.25½ .26⅛	.28 .29	.28 .29	.24½ .25	.20½ .20⅞	.18 .18½	.19 .20	.18½ .18¾	.77½ .80
October 1	.31	.28 .29½	.28 .29	.28 .29	.25½	.22⅞ .23½	.20½ .20⅞	.20 .21	.21	.77½ .80
November 2	.34	.31 .31½	.31 .31½	.35 .36	.26	.24 .24½	.19 .21	.23 .23½	.22½	.87½
December 1	.30	.28⅞ .29½	.27½ .28	.34 .35	.22 .22½	.23 .23¾	.18½ .19	.24½ .25	.21	.85 .87½
1897.	*Steamer yellow.*									
August 2	.35½ .36½	.33½ .33⅞	.32½ .33	.36½ .38	.28½ .29	.28 .28½	.24 .25	.23½ .24	.25½	.95 1.00
September 1	.40½ .41	.35⅞ .37½	.37½ .38	.41 .42	.31	.30 .31½	.25½ .26	.26½ .28	.27½	1.05 1.10
October 1	.35⅞	.32½ .32½	.35	.41 .42	.30½	.27⅞ .28½	.24 .25	.26 .26½	.26½ .26	1.05½ 1.10
November 1	.36⅞ .37	.31 .31½	.30 .30	.39 .40	.25½	.26½ .27	.22 .22½	.24 .25	.24½ .24	1.10 1.12½
December 1	.36½ .36½	.32 .32½	.32½	.38 .39	.27½ .27½	.25½ .26½	.24	.24	.24½ .25	.87½ .92½

Wholesale prices of principal agricultural products in leading cities of the United States, 1893 to 1898—Continued.

CORN (PER BUSHEL)—Continued.

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco (per cental).
1898.	*Steamer yellow.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 2.*	*No. 3.*	*No. 2.*	*Mixed.*
August 1	$0.41	$0.37½	$0.39 $0.41		$0.35 $0.36	$0.33 $0.33½	$0.31 $0.31½		$0.33	$1.07½
September 1	.38	.35½	.35 .36		.30 .31	.30½ .31½	.27½ .28		.29½	1.05 $1.07½
October 1	.37½	.35	.35½ .36½		.31	.29 .29½	.26½ .26¾		.29½ $0.30	1.05 1.07½
November 1	.40½	.38½ $0.39½	.39 .40		.35½	.32½ .32½	.29½	$0.30 $0.31	.32	1.00 1.05
December 1	.42½	.39½	.38 .41		.34	.33½ .34½	.31½ .31½	.32 .32½	.33½	1.02½ 1.05

WHEAT (PER BUSHEL).

Date.	Boston.	New York.	Richmond.	New Orleans.	Cincinnati.	Chicago.	Kansas City.	St. Paul.	St. Louis.	San Francisco (per cental).
1893.		*No. 2 red.*	*No. 2 red.*		*No. 2 red.*	*No. 2 red winter.*	*No. 2 hard.*	*No. 2 northern.*	*No. 2 red winter.*	*No. 1 white.*
August 1		$0.66½ to $0.68½	$0.64 to $0.64½		$0.52½ to $0.53	$0.57½ to $0.59½	$0.46½	$0.54 to $0.55	$0.54½ to $0.54½	$1.07½ to $1.10
September 1		.69 .69½	.63½ .64		.57 .58	.62½ .63½	.51½	.56 .57	.59½	1.01½ 1.02½
October 2		.72½ .72½	.70 .71		.64	.66 .66½	.55	.58 .59	.62½	1.01 1.05
November 1		.67½ .68½	.69		.59½	.62½ .62½	$0.50½ to .51	.58 .59	.58½	1.02½ 1.05
December 1		.68½ .69½	.64		.59 .60	.63 .63½	.53 .53½	.57 .58	.59½	1.02½ 1.03½
1894.										
August 1		.55½ .56½	.54		.48 .48½	.52 .53	.44 .45	.56½ .57	.47½	.87½ .90
September 1		.57 .58	.57 .57½		.51	.53 .53½	.53 .53½	.52 .54½	.49½ .50½	.85 .86½
October 1		.56 .57½	.55		.51½ .51½	.51½ .52	.54½	.53 .54	.48½ .48½	.77½ .78½
November 1		.56½ .57	.56 .56½		.51	.52½ .53½	.47½ .48	.54½ .55	.48½ .48½	.85 .86½
December 1		.60½ .61½	.60		.53	.55½ .56	.53 .54	.57½ .58½	.52½ .52½	.92½ .93½
1895.										
August 1		.75 .75½	.72		.71	.67½ .69½	.68½	.67 .67½	.68½	.96 .97½
September 3		.65½ .67	.67		.64	.60 .61½	.60	.55½ .58	.61½ .61½	.92½ .93½
October 1		.66½ .69½	.72		.70	.61½ .61½	.64	.55 .55½	.64½	.96½ .97½
November 1		.70½ .71½	.72 .73		.66½	.58½ .62½	.58	.53½ .54	.61½	.97½ .98½
December 1		.70½ .71½	.71		.67½	.59½ .61½	.57½ .58	.53 .54	.63	.97½ 1.00
1896.										*Milling.*
August 1		.68½ .68½	.64		.62	.61½ .62	.53	.55 .56	.59 .59½	1.00 1.02½
September 1		.66½ .67	.64 .64½		.61	.60 .60½	.51	.53 .53½	.58½ .58½	1.00 1.02½
October 1		.79½ .80	.72 .72		.74 .75	.70½ .72	.65	.64½ .65	.68½ .69	1.12½ 1.15
November 2		.86½ .88	.79 .80		.81½ .82	.77½ .78	.65	.69 .70	.76 .77	1.37½ 1.42½
December 1		1.01 1.02½	.95 .96		.97	.90½ .92½	.82 .83	.80½ .81½	.91 .92	1.57½ 1.60

1897.			*No. 2 red winter.*						*No. 3 red winter.*					*No. 2 red winter.*		*No. 1 northern.*				
August 2	.....		.82	.84		.77	.....			.75	.77	.77½		.73	.74		.80¼		.79	1.47½	1.52½
September 1	.....		.96½	1.00½		.96	.....			.95½	.94¾	.95¾		.89	.91		1.01¼	.94½	.95	1.52¼	1.57¼
October 1	.....		.93½	.95		.95*	.....		.91	.92	.94½	.95¾			.91		.87¼	.96½	.97¼	1.47¼	1.50
November 1	.....		1.03	1.04		1.00	.....			.96	.96	.99½			.94		.94½		1.00	1.52½	1.55
December 1	.....		.98	.99¼		.98	.....			.94		.96½			.89		.90¼		.97½	1.47½	1.50
1898.														*No. 2 hard.*		*No. 2 northern.*				*Shipping.*	
August 1	.....		$0.72		$0.72 to $0.73		.....		$0.67		$0.65½ to $0.65½			$0.58½ to $0.61		.....		$0.63 to $0.63½		$1.15 to $1.18¾	
September 1	.....		.72½		.70		.....		.66 to $0.67½		.66	.67		.60¼	.64½	.....		.65½	.65½	1.08¾	1.12½
October 1	.....		.71¾		.71		.....		.69		.64			.59	.63	.....		.65	.65½	1.15	1.17½
November 1	.....		.71½		.71		.....		.68		.66	.67½		.61	.63¾	$0.61 to $0.65		.68¾	.69	1.20	1.22½
December 1	.....		.73¾		.73		.....		.68½		.68½	.70		.62	.63¾	.63	.64½	.70½	.70¾	1.15	1.16½

OATS (PER BUSHEL).

1893.	*No. 2 white.*		*No. 2 mixed.*		*No. 2 mixed.*		*No. 2.*		*No. 2 mixed.*		*No. 2.*		*No. 2 mixed.*		*No. 2 white.*		*No. 2.*		*No. 1.*	
August 1		$0.39	$0.35½ to $0.36		$0.32 to $0.33		$0.38 to $0.38½		$0.21 to $0.22		$0.23 to $0.23¾			$0.23	$0.29½ to $0.30½			$0.22½	$1.05 to $1.10	
September 1	$0.35 to	.35½	.30½	.30½	.31	.32		.34	.26½	.26½	.23½	.24	$0.27 to	.29	.26½	.27½	$0.23½ to	.23½	1.07½	1.10
October 2	.37	.37½	.34½	.34½	.34	.35		.36	.31	.32	.27¾	.28		.28½	.26½	.27½		.27½	1.10	1.12½
November 1		.37½	.34½	.34½	.34½	.35		.38		.29½		.28	.26½	.27½	.27½	.28		.28½	1.05	1.10
December 1		.38	.34¾	.34½	.34½	.35		.38	.31½	.32		.28¾	.27	.27½	.27	.27½		.27½	1.05	1.07½
1894.																						
August 1	.44	.45		.40		.34½	.38	.39	.30½	.31	.28¾	.29	.27½	.28	.32	.33		.28½	1.12½	1.15
September 1	.38	.38½	.33½	.34	.34	.34½	.38½	.39		.31	.29½	.30½		.31	.32	.32½		.30½	1.02½	1.05
October 1	.37	.37½	.32½	.32½	.33	.34		.38		.31½	.28½	.28½	.28½	.29½	.31½	.32	.28½	.29½	1.00	1.02½
November 1	.37½	.38	.32½	.32½	.32½	.33		.38		.30½	.28½	.29	.29	.30	.30½	.31		.29½	.95	.97½
December 1		.40	.33½	.33½	.34	.35	.38	.38½	.31½	.32½	.29½	.29½	.30½	.31	.31	.31½		.30	.95	.97½
1895.															*No. 3 white.*				*No. 1 feed.*	
August 1	.33	.33½		.28	.28½	.29		.32	.25	.27	.22½	.22½		.19	.24	.24½		.24	.87½	.90
September 3	.27½	.28		.24	.24	.24½		.28	.21½	.22	.19	.20½		.17½	.18½	.19	.18	.21	.82½	.85
October 1	.27½	.28	.24	.24½	.24½	.25	.27½	.28	.21	.21½	.18½	.18½	.18	.19	.18½	.19		.19	.70	.72½
November 1	.26	.27		.24	.23	.23½		.27	.20	.20½		.18	.15	.16	.17	.17½		.17½	.65	.67½
December 1		.25½	.22½	.22½	.23	.23½		.26	.21½	.21½		.17½		.18½	.16½	.16½		.18	.65	.67½
1896.																						
August 1		.27		.23	.23	.23½		.25½		.21½		.18½		.20	.17½	.17½		.19	.80	.85
September 1		.26		.20	.20½	.21		.26		.17½	.15½	.16		.17	.17	.17		.17	.87½	.90
October 1		.25½		.22	.19	.19½		.25		.18	.18	.18½		.15	.18½	.19		.16	.92½	.95
November 2	.26	.26½	.22½	.23	.20	.20½	.25	.26	.19	.19½	.18½	.18½		.16	.17	.17½	.16½	.17	1.12½	1.20
December 1		.26½	.23½	.23½	.21½	.22	.25	.25½	.19½	.20		.18½	.17½	.18	.18	.18½		.19	1.17½	1.30

Wholesale prices of principal agricultural products in leading cities of the United States, 1893 to 1895—Continued.

OATS (PER BUSHEL)—Continued.

Date.	Boston.		New York.		Richmond.		New Orleans.		Cincinnati.		Chicago.		Kansas City.		St. Paul.		St. Louis.		San Francisco (per cental).	
1893.	*No. 2 white.*		*No. 2 mixed.*		*No. 2 mixed.*		*No. 2.*		*No. 2 mixed.*		*No. 2.*		*No. 2 mixed.*		*No. 3 white.*		*No. 2.*		*White.*	
August		$0.27½		$0.21¾	$0.21¾	$0.23	$0.25¼	$0.26	$0.20¼	$0.21	$0.17½	$0.17¾	$0.15	$0.16½	$0.18	$0.19½		$0.18¼	$1.10	$1.17½
September	$0.28¼	.28½	$0.23½	.24	.23	.23½	.26	.26½	.20	.21½	.19	.19½	.18½	.19	.19	.21		.19½	1.10	1.35
October		.29	.23½	.23½	.24½	.24½	.26	.26½	.20	.21½	.19	.19½	.18	.19	.19½	.20½		.20	1.20	1.30
November		.29½		.24	.22	.23½	.26	.26½	.20½	.21		.19½	.18	.18½		.20½	$0.18	.18½	1.12½	1.17½
December		.29½	.26½	.26½		.27	.29	.29½	.23½	.23½	.21½	.21½		.22½		.21½		.20½	1.10	1.17½
1894.															*No. 3 white.*				*White, good to choice.*	
August 1	.33½	.34	.27½		.27	.27½			.23½	.24½	.21	.21½	.24				.24		1.25	1.30
September 1	.31½		.26½		.24				.22		.20½	.21	.20				.22		1.17½	1.22½
October 1	.30½	.31	.26		.26	.26½			.21½	.24½	.20½	.23	.22				.23	.23½	1.17½	1.25
November 1	.32	.32½	.29		.28	.29			.26½		.24½	.25½	.24½	.24½	.22	.22½	.26½		1.17½	1.25
December 1	.34½	.35	.31½		.32	.32½			.28½	.29	.27½	.28½	.28		.22	.22½	.27½		1.17½	1.25

BARLEY (PER BUSHEL).

Date.	Boston.		New York.		Richmond.		New Orleans.		Cincinnati.		Chicago.		Kansas City.		St. Paul.		St. Louis.		San Francisco (per cental).	
1893.	*Six-rowed State.*		*Two-rowed State.*						*No. 2 spring.*		*Fair to choice.*				*No. 2.*		*Choice.*		*No. 1. Chevalier.*	
August 1	$0.70 to $0.75								$0.60 to $0.65		$0.30 to $0.35				$0.50 to $0.55				$1.17½ to $1.20	
															Sample.					
September 1	.70	.75							.50	.52	.45	.52			.30	.45			1.17½	1.20
October 2	.70	.75	.55	.60					.56	.58	.46	.58			.35	.48	.55	.58	1.15	1.17½
November 1	.70	.75	.60	.65					.58	.60	.40	.54			.35	.48		.57	1.15	1.17½
December 1	.70	.75	.63	.64					.58	.60	.46	.52			.35	.48		.57	1.15	1.17½
1894.	*Six-rowed western.*		*No. 2 Milwaukee.*												*No. 2 round.*				*Brewing.*	
August 1	.68	.73							*a* .57	*a* .60		*a* .44			.52	.55			.95	.97½
September 1	.68	.73							.55	.60	.55	.57½			.45	.50		.60	.90	.92½
October 1	.68	.73	.61	.62					.62	.63	.52	.44½			.45	.50	.55	.57	.90	.92½
November 1	.65	.70	.61	.62					.60	.62	.53	.56			.45	.50	.55	.56	.90	.92½
December 1	Nominal.		.63	.64					.60	.62	.52	.54½			.46	.50		.55		
1895.	*Western.*										*No. 3.*				*No. 3.*					
August 1	Nominal.								.60	.62		.37			.40	.45			.72½	.75
September 3	Nominal			.50					.54	*a* .58	.36	.42			.32	.33			.70	.72½
October 1	.45	.55		.50					.44	*a* .45	.25	.37			.32	.34		.40		.67½
November 1	.45	.55		.50					.40	.45	.28	.30			.32	.35	.35	.37	.70	.72
December 1	.45	.50		.48					.39	.44	.28	.40			.28	.30	.34	.35	.75	.80½

1896.	*Malting.*														*No. 4.*			
August 1	$0.45	$0.50								$0.45	$0.28	$0.30			$0.21	$0.24	Out of season.	$0.80	$0.82½
September 1		.49								.45	.25	.32			.21	.24	Out of season.	.75	.77½
October 1	.42	.43		$0.48						.45	.32	.36			.24	.25	$0.35	.77½	.82½
November 2	.40	.42		.48					$0.40	.42	.24	.38			.22	.23	.37	.87½	.92½
December 1	.40	.42		.47					*a* .30	*a* .33½	.25	.37			.21	.25	.36	1.00	1.05
1897.			*Western.*						*No. 2 fall.*		*Choice.*								
August 2	.40	.42	$0.57	.59					.35	.36	.31	.33				.27	Out of season.	1.00	1.08½
September 1	.40	.42	.57	.59					.35	.36	.40	.42				.28	Out of season.	1.02½	1.12½
October 1	.40	.42	.47	.57					.45	.46	.35	.38				.29	.49	.51	1.02½	1.12½
	Six-rowed State.																		
November 1	.50	.53	.46	.56					.45	.46	.36	.38				.30	.47	.50	1.02½	1.12½
December 1	.50	.56	.44	.55					.45	.46	.35	.38				.30	.35	.41	.95	1.07½
1898.	*No. 2 six-rowed State.*								*No. 3.*		*Fair to choice.*				*No. 3.*				*Brewing, good to choice.*	
August 1	.50	.56									.31	.32					.44		1.30	1.32½
September 1	.50	.56							.45		.31	.32					.35		1.22½	1.27½
October 1	.50	.56							.42		.33						.40	.43	1.25	1.37½
November 1	.50	.57							.42	.45	.36½	.37½					.45	.47	1.25	1.37½
December 1	.50	.57							.47	.51	.41	.43			.30	.36	.48	.50	1.32½	1.37½

HAY (PER TON).

1893.	*Fair to good.*		*Prime timothy.*		*No. 1 timothy.*		*Choice.*		*No. 1 timothy.*		*No. 1 timothy.*		*Choice prairie.*	*Timothy.*		*Timothy (fancy).*	*No. 1 barley.*	
August 1	$17.00	$18.00		$20.00	$17.00	$17.50	$18.00	$18.50		$13.50	$9.50	$10.50	$7.00	$6.00	$8.00	$15.00	$7.00	$9.00
September 1	17.00	18.00	$17.00	18.00	15.00	15.50	16.50	17.50	$12.00	13.00	10.00	10.50	7.00	7.50	9.00	11.50	8.50	9.00
October 2	16.00	17.00	17.00	18.00	15.00	15.50	16.00	16.50		12.50	10.00	11.00	6.50	7.00	8.50	12.50	8.50	9.00
November 1	15.00	16.00	17.00	18.00	14.50	15.50	17.00	18.00	11.50	12.00	10.50	11.00	7.00	7.50	8.50	12.00	10.00	11.00
December 1	15.00	16.50		17.00	14.00	14.50	16.50	17.00	11.00	12.00	10.00	10.50	7.00	7.50	8.50	12.50	10.00	11.00
1894.																		
August 1	15.00	15.50		18.00	13.00	13.50		17.00	11.00	11.50	11.00	12.00	6.75	9.00	10.00	12.00	9.00	10.00
September 1	15.00	15.50	15.00	16.00	13.50	14.00	15.50	16.50	10.00	10.50	9.50	10.00	8.00	9.00	10.00	12.00	8.00	9.00
October 1	13.00	13.50		15.00	12.00	12.50	16.00	16.50	9.50	10.00	10.00	10.50	8.50	9.50	10.50	11.50	9.00	10.00
November 1	13.00	13.50		15.00	12.50	13.00	16.00	16.50	9.00	9.50	10.00	10.50	8.50	9.50	10.50	12.00	9.00	10.00
December 1	13.00	13.50		15.00	12.50	13.00	16.00	17.00	10.00	10.50	10.00	11.00	8.50	10.00	11.00	12.00	9.00	10.00
1895.														*Wild.*				
August 1	16.00	17.00		21.00	16.00	17.00	20.00	21.00	16.50	17.00	12.00	13.00	7.00	7.00	8.50	16.00	6.00	7.00
September 2	16.00	17.00		19.00	14.00	16.00	20.00	21.00	13.50	14.00	11.50	12.00	6.50	6.00	8.00	14.00	6.00	7.00

a Extra No. 3.

Wholesale prices of principal agricultural products in leading cities of the United States, 1893 to 1898—Continued.

HAY (PER TON)—Continued.

Date.	Boston.		New York.		Richmond.		New Orleans.		Cincinnati.		Chicago.		Kansas City.	St. Paul.		St. Louis.		San Francisco (per cental).	
1896.																			
	Fair to good.		*Prime timothy.*		*No. 1 timothy.*		*Choice.*		*No. 1 timothy.*		*No. 1 timothy.*		*Choice prairie.*	*Wild.*		*Timothy (fancy)*		*No. 1 barley.*	
October 1	$16.00	$17.00		$17.00	$15.50	$16.50	$19.00	$20.00	$13.50	$14.00	$11.50	$12.50	$6.50	$7.00	$8.50		$13.00	$7.00	$7.50
November 1	16.00	17.00		18.00	16.50	17.00	19.00	20.00	13.75	14.75	11.50	12.00	6.50	7.50	8.75		13.00	8.00	9.00
December 1	17.00	18.00		18.00	16.50	17.00		22.00	14.00	14.75	12.00	13.00	7.00	6.50	8.25		15.00	8.00	9.00
1896.																			
			Per cwt.																
August 1	16.00	17.00	.95	1.00	14.00	15.00	16.50	17.00	13.00	13.50	8.00	8.50	6.00	5.00	6.50	$12.50 to	13.00	7.00	8.00
September 1	16.00	17.00	.90	.92½	11.50	12.50	16.00		9.00	9.50	7.58	8.00	5.00	6.00	6.50	9.00		7.00	8.00
October 1	14.00	15.00	.77½	.80	10.00	12.00	15.00		10.00	10.50	8.00	8.50	5.00	6.00	6.50		11.25	5.00	7.00
November 2		15.00	.85		11.00	12.50	16.00	16.50	9.50	10.00	8.50	9.00	5.50	5.50	6.50	10.00	10.50	5.00	8.00
December 1	15.00		.80	.82½	11.00	13.00	15.50	16.50	10.00	10.50	9.00	9.50	6.00	6.00	6.75		11.50	6.00	8.50
1897.																			
	Prime.		*Per ton.*								*Choice timothy.*			*Fancy timothy.*					
August 2	15.00	16.50	15.50	16.00	13.00		15.00	16.00	10.50	11.00	8.50	10.50	5.50	8.00	8.50	9.75	10.00	9.00	11.00
September 1	15.00	16.50	15.00	16.00	12.00	12.50	15.00	16.00	8.50	8.75	8.50	9.00	5.50	7.75	8.50	9.00	9.50	9.00	11.00
October 1	14.50	15.50	15.00	15.50	12.50	13.00	14.50	15.50	8.50	9.00	9.00	9.50	5.75	8.00	8.50	9.50	10.00	9.50	11.00
November 1	13.50	15.00	14.50	15.00	12.50	13.00	15.00	15.50	8.75	9.00	9.00	9.50	6.75	7.50	8.00	9.50	10.00	9.50	11.00
December 1	13.50	15.00	15.00	15.50	12.50	13.00	16.50	17.00	8.50	9.00	9.00	9.50	7.00	6.75		9.75	10.50	9.00	12.00
1898.																			
	Clover, mixed.		*Per cwt.*								*No. 1 timothy.*			*Timothy.*				*Timothy.*	
August 1	8.00	10.00	.77½		10.50	11.00	.....		8.00	8.50	6.50	8.00	$5.25	.....		11.50		11.50	13.00
September 1	8.00	10.00	.65	.67½	9.00	9.50	.....		7.50	7.75	7.00	7.50	5.25	5.50		9.00		12.00	14.00
October 1	6.00	9.00	.60	.65	9.50	10.00	.....		7.50	8.00	7.00	7.50	6.25	6.50		9.50		11.50	13.00
November 1	6.00	9.00	.60	.65	10.00		.....		7.75	8.25	8.00	8.50	7.00	.....		9.00		11.00	12.50
December 1	6.00	9.00	.62½	.67½	9.50	10.00	.....		8.00		8.00	8.50	7.00	.....		9.50		11.00	12.50

Wholesale prices of principal agricultural products in leading cities of the United States, 1893 to 1898—Continued.

COTTON (PER POUND).

Date.	Boston.	New York.	New Orleans.	Cincinnati.	St. Louis.
1893.	*Middling.*	*Middling.*	*Middling.*	*Middling.*	*Middling*
August 1	$0.08	$0.08	$0.07⅞	$0.08⅛	$0.07 3/16
September 1	.07⅞	.07 13/16	.07 3/16	.07⅞	.07 3/16
October 2	.08	.08 1/16	.07 15/16	.08⅛	.07 13/16
November 1	.08 3/16	.08 3/16	.07⅞	.08	.07 15/16
December 1	.08 1/16	.08 1/16	.07½	.07⅞	.07 3/16
1894.					
August 1	.06 15/16	.06 13/16	.06⅝	.07¼	.06⅞
September 1	.06⅛	----------	.06 7/16	.07	.06⅝
October 1	.06 5/16	.06½	.05⅝	.06½	.05⅞
November 1	.05½	.05⅝	.05 3/16	.05⅝	.05½
December 1	.05 13/16	.05 13/16	.05 5/16	.05¾	.05⅝
1895.					
August 1	.07½	.07½	.06¾	.07	.06 11/16
September 3	----------	.08¼	.07 15/16	.07⅞	.07⅞
October 1	.09½	.09 1/16	.08⅝	.08⅞	.08⅝
November 1	.09	.09	.08⅝	.09	.08⅝
December 2	.08 3/16	.08 3/16	.08 3/16	.08⅝	.08 1/16
1896.					
August 1	.07 7/16	.07 7/16	.06 13/16	.07	.06½
September 1	.07½	.08 3/16	.07⅛	.07¼	.07 3/16
October 1	.08⅝	.08⅝	.07⅝	.08	.07⅛
November 2	.08½	.08 3/16	.07 5/16	.07⅞	.07 5/16
December 1	.07 11/16	.07 11/16	.07⅞	.07½	.07¼
1897.					
August 2	.08	.08	.07 11/16	.08¼	.07 13/16
September 1	.08	.07 13/16	.07 7/16	.08⅛	.07 11/16
October 1	.06½	.06¾	.06 7/16	.06½	.06½
November 1	.06	.06	.05¼	.05⅞	.05 7/16
December 1	.05 13/16	.05 13/16	.05½	.05½	.05 5/16
1898.					
August 1	.06 1/16	.06 1/16	.05 11/16	.06	.05 13/16
September 1	.05½	.05 15/16	.05⅝	.05⅞	.05½
October 1	.05 7/16	.05½	.04¾	.05½	.05
November 1	.05 5/16	.05 5/16	.04 13/16	.05¼	.04 15/16
December 1	.05 5/16	.05½	.05	.05 5/16	.05 3/16

Number and value of farm animals in the United States, 1880 to 1899.

[From Division of Statistics.]

January 1—	Horses.		Mules.		Milch cows.	
	Number.	Value.	Number.	Value.	Number.	Value.
1880	11,201,800	$613,296,611	1,729,500	$105,948,319	12,027,000	$279,899,420
1881	11,429,626	667,954,325	1,720,731	120,096,164	12,368,653	296,277,060
1882	10,521,554	615,824,914	1,835,166	130,945,378	12,611,632	326,480,310
1883	10,838,111	765,041,308	1,871,079	148,732,390	13,125,685	396,575,405
1884	11,169,683	833,734,400	1,914,126	161,214,976	13,501,206	423,486,649
1885	11,564,572	852,282,947	1,972,569	162,497,097	13,904,722	412,903,936
1886	12,077,657	860,823,208	2,052,593	163,381,096	14,235,388	389,985,523
1887	12,496,744	901,685,755	2,117,141	167,057,538	14,522,083	378,789,589
1888	13,172,996	946,096,154	2,191,727	174,853,565	14,856,414	366,252,173
1889	13,663,294	982,194,827	2,257,574	179,444,481	15,298,625	366,226,376
1890	14,213,367	978,516,562	2,331,027	182,394,669	15,952,583	352,152,173
1891	14,656,750	941,823,222	2,296,532	178,847,370	16,019,591	346,397,990
1892	15,498,140	1,007,593,636	2,314,699	174,882,070	16,416,351	351,378,132
1893	16,206,802	992,225,185	2,331,128	164,763,751	16,424,087	357,299,785
1894	16,081,139	769,224,799	2,352,231	146,232,811	16,487,400	358,998,661
1895	15,893,318	576,730,580	2,333,108	110,927,834	16,504,629	362,601,729
1896	15,124,057	500,140,186	2,278,916	103,204,457	16,137,586	363,955,545
1897	14,364,667	452,649,396	2,215,654	92,302,690	15,941,727	369,239,963
1898	13,960,911	478,362,407	2,257,665	99,032,062	15,840,886	434,813,826
1899	13,665,307	511,074,813	2,134,213	95,963,261	15,900,115	474,253,125

Number and value of farm animals in the United States, 1880 to 1899—Cont'd.

January 1—	Cattle, other than milch cows.		Sheep.		Swine.		Total value of farm animals.
	Number.	Value.	Number.	Value.	Number.	Value.	
1880	21,231,000	$341,761,154	40,765,900	$90,230,537	34,034,100	$145,781,515	$1,576,917,556
1881	20,937,702	362,861,509	43,576,899	104,070,759	36,247,603	170,535,435	1,721,795,252
1882	23,280,238	463,069,499	45,016,224	106,594,954	44,122,200	263,543,195	1,906,459,250
1883	28,046,077	611,549,109	49,237,291	124,365,835	43,270,086	291,951,221	2,338,215,298
1884	29,046,101	683,229,054	50,626,626	119,902,706	44,200,893	246,301,139	2,467,868,924
1885	29,866,573	694,382,913	50,360,243	107,960,650	45,142,657	226,401,683	2,456,428,380
1886	31,275,242	661,956,274	48,322,331	92,443,867	46,092,043	196,569,894	2,365,159,862
1887	33,511,750	663,137,926	44,759,314	89,872,839	44,612,836	200,043,291	2,400,586,938.
1888	34,378,363	611,750,520	43,544,755	89,279,926	44,346,525	220,811,082	2,409,043,418
1889	35,032,417	597,236,812	42,599,079	90,640,369	50,301,592	291,307,193	2,507,050,058
1890	36,849,024	560,625,137	44,336,072	100,659,761	51,602,780	243,418,336	2,418,766,028
1891	36,875,648	544,127,908	43,431,136	108,397,447	50,625,106	210,193,923	2,329,787,770
1892	37,651,239	570,749,155	44,938,365	116,121,390	52,398,019	241,031,415	2,461,755,698
1893	35,954,196	547,882,204	47,273,553	125,909,264	46,094,807	295,426,492	2,483,506,681
1894	36,608,168	536,789,747	45,048,017	89,186,110	45,206,498	270,384,626	2,170,816,754
1895	34,364,216	482,999,129	42,294,064	66,685,767	44,165,716	219,501,267	1,819,446,306
1896	32,085,409	508,928,416	38,298,783	65,167,735	42,842,759	186,529,745	1,727,926,084
1897	30,508,408	507,929,421	36,818,643	67,020,942	40,600,276	166,272,770	1,655,414,612
1898	29,264,197	612,296,634	37,656,960	92,721,133	39,759,993	174,351,409	1,891,577,471
1899	27,994,225	637,931,135	39,114,453	107,697,530	38,651,631	170,109,743	1,997,010,407

Average value of farm animals in the United States on January 1, 1880 to 1899.

[From Division of Statistics.]

Years.	Horses.	Mules.	Milch cows.	Cattle, other than milch cows.	Sheep.	Swine.
1880	$54.75	$61.26	$23.27	$16.10	$2.21	$4.28
1881	58.44	69.79	23.95	17.33	2.39	4.70
1882	58.53	71.35	25.89	19.89	2.37	5.97
1883	70.59	79.49	30.21	21.81	2.53	6.75
1884	74.64	84.22	31.37	23.52	2.37	5.57
1885	73.70	82.38	29.70	23.25	2.14	5.02
1886	71.27	79.60	27.40	21.17	1.91	4.26
1887	72.15	78.91	26.08	19.79	2.01	4.48
1888	71.82	79.78	24.65	17.79	2.05	4.98
1889	71.89	79.49	23.94	17.05	2.13	5.79
1890	68.84	78.25	22.14	15.21	2.27	4.72
1891	67.00	77.88	21.62	14.76	2.50	4.15
1892	65.01	75.55	21.40	15.16	2.58	4.60
1893	61.22	70.68	21.75	15.24	2.66	6.41
1894	47.83	62.17	21.77	14.66	1.98	5.98
1895	36.29	47.55	21.97	14.06	1.58	4.97
1896	33.07	45.29	22.55	15.86	1.70	4.35
1897	31.51	41.66	23.16	16.65	1.82	4.10
1898	34.26	43.88	27.45	20.92	2.46	4.39
1899	37.40	44.96	29.66	22.79	2.75	4.40

Number, average price, and total value of farm animals in the United States on January 1, 1899, by States.

States and Territories.	Horses.			Mules.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	111,987	$52.29	$5,855,722			
New Hampshire	55,028	50.48	2,777,941			
Vermont	84,812	48.16	4,084,899			
Massachusetts	63,478	71.95	4,566,926			
Rhode Island	10,281	79.84	820,792			
Connecticut	43,682	71.01	3,101,932			
New York	596,738	58.04	34,634,083	4,421	$62.87	$277,960
New Jersey	79,180	67.10	5,313,023	7,269	82.95	602,968
Pennsylvania	548,747	53.56	29,390,858	37,053	66.99	2,482,216
Delaware	30,883	55.49	1,713,722	4,928	67.05	330,427
Maryland	129,662	48.50	6,289,047	12,638	64.06	809,577
Virginia	233,940	39.64	9,272,222	35,998	51.34	1,848,026

Number, average price, and total value of farm animals in the United States on January 1, 1899, by States—Continued.

States and Territories.	Horses.			Mules.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
North Carolina	146,697	$47.96	$7,035,577	111,398	$55.65	$6,198,903
South Carolina	66,979	51.45	3,446,020	97,357	60.28	5,[illegible],061
Georgia	110,266	46.09	5,082,393	158,594	61.01	9,676,063
Florida	37,673	39.54	1,489,735	8,354	57.07	476,792
Alabama	132,224	39.86	5,270,259	129,726	48.72	6,320,059
Mississippi	201,477	37.25	7,501,111	163,082	51.32	8,368,620
Louisiana	143,593	32.48	4,663,985	90,904	57.03	5,184,389
Texas	1,137,015	17.67	20,088,788	265,880	29.98	7,972,280
Arkansas	234,596	29.13	6,833,080	145,504	37.59	5,469,565
Tennessee	317,601	36.35	11,544,013	151,265	39.36	5,954,253
West Virginia	151,847	36.64	5,563,827	7,412	45.47	337,055
Kentucky	365,602	34.41	12,581,471	106,547	37.63	4,009,295
Ohio	653,499	45.59	29,791,046	17,228	47.72	822,196
Michigan	410,410	51.23	21,023,483	2,646	51.61	136,554
Indiana	601,271	39.77	23,909,557	41,950	44.44	1,851,093
Illinois	1,003,299	40.30	40,437,954	82,225	44.41	3,651,271
Wisconsin	409,822	49.96	20,473,290	4,754	49.79	236,713
Minnesota	455,122	44.75	20,366,015	8,416	49.03	412,663
Iowa	981,352	38.40	37,686,866	31,547	43.12	1,360,209
Missouri	762,734	28.02	21,371,427	183,362	36.03	6,606,802
Kansas	734,881	29.85	21,935,833	79,410	39.25	3,116,611
Nebraska	652,284	34.69	22,629,031	43,016	44.13	1,898,300
South Dakota	290,746	30.56	8,884,341	6,693	43.82	293,297
North Dakota	175,137	42.21	7,392,360	7,036	55.44	390,066
Montana	164,923	21.16	3,490,193	924	36.45	33,679
Wyoming	72,258	18.15	1,311,701	1,514	34.17	51,734
Colorado	148,687	24.77	3,682,538	8,667	44.30	383,941
New Mexico	83,351	15.55	1,296,524	3,472	30.59	106,198
Arizona	50,414	25.56	1,288,464	1,041	29.50	30,713
Utah	68,295	20.26	1,383,753	1,599	32.73	52,329
Nevada	44,305	11.94	529,107	1,394	23.22	32,368
Idaho	128,077	21.86	2,799,957	917	33.26	30,501
Washington	169,694	31.03	5,265,775	1,441	45.16	65,071
Oregon	185,844	26.51	4,927,567	5,699	29.86	167,488
California	342,265	27.54	9,426,483	52,915	34.15	1,807,174
Oklahoma	42,649	19.86	847,182	8,407	28.41	238,821
Total	13,665,307	37.40	511,074,813	2,134,213	44.96	95,963,261

States and Territories.	Milch cows.			All cattle, other than milch cows.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	197,878	$30.50	$6,035,279	109,440	$25.84	$2,827,762
New Hampshire	136,825	33.65	4,604,161	79,380	29.58	2,347,855
Vermont	271,602	30.85	8,378,922	133,788	24.41	3,265,629
Massachusetts	179,791	37.75	6,787,110	74,875	26.52	1,985,763
Rhode Island	25,511	39.90	1,017,889	10,356	32.74	339,038
Connecticut	143,098	35.55	5,087,134	66,588	32.09	2,137,078
New York	1,458,251	33.55	48,924,321	561,077	27.10	15,204,058
New Jersey	214,674	38.15	8,189,813	41,558	26.86	1,116,251
Pennsylvania	924,260	31.50	29,114,190	528,942	25.59	13,538,007
Delaware	35,376	28.95	1,024,135	22,995	23.63	543,340
Maryland	155,022	26.95	4,177,843	105,900	23.12	2,448,143
Virginia	244,937	22.25	5,449,848	338,542	22.25	7,531,714
North Carolina	248,263	15.90	3,947,382	295,530	10.86	3,210,640
South Carolina	126,762	16.75	2,123,264	141,509	9.45	1,337,399
Georgia	297,324	23.00	6,838,452	423,018	9.07	3,836,978
Florida	114,251	15.60	1,782,316	325,774	7.56	2,462,036
Alabama	254,727	15.45	3,935,532	336,479	8.92	3,001,561
Mississippi	256,951	18.90	4,856,374	304,118	11.38	3,459,645
Louisiana	125,747	19.10	2,401,768	182,690	12.07	2,205,892
Texas	700,802	23.75	16,644,048	4,533,897	16.91	76,665,937
Arkansas	196,808	19.40	3,818,075	250,528	13.50	3,381,378
Tennessee	254,675	22.05	5,615,584	322,293	16.43	5,295,279
West Virginia	163,895	27.50	4,507,112	243,460	23.33	5,678,952
Kentucky	248,208	25.40	6,304,483	341,181	23.18	7,908,920
Ohio	736,735	31.05	22,875,622	636,433	27.85	17,725,937
Michigan	459,107	31.30	14,370,049	341,535	24.45	8,352,225
Indiana	611,975	31.10	19,032,422	641,913	29.03	18,636,018
Illinois	1,001,212	33.60	33,640,723	1,265,066	29.34	37,118,503
Wisconsin	895,822	31.30	28,039,229	589,315	25.13	14,811,256
Minnesota	646,673	29.45	19,044,520	570,165	21.97	12,526,243
Iowa	1,250,775	34.40	43,026,660	2,163,584	31.02	67,120,886
Missouri	673,195	27.80	18,714,821	1,460,647	25.51	37,256,725
Kansas	680,457	31.05	21,128,190	2,076,489	27.10	56,280,123

Number, average price, and total value of farm animals in the United States on January 1, 1899, by States—Continued.

States and Territories.	Milch cows.			All cattle, other than milch cows.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Nebraska	628,750	$33.40	$21,000,250	1,395,829	$27.92	$38,974,337
South Dakota	372,321	29.20	10,871,773	449,362	26.69	11,994,588
North Dakota	171,073	28.60	4,892,688	252,640	25.84	6,528,852
Montana	43,994	34.40	1,513,394	952,598	25.48	24,272,206
Wyoming	18,140	38.10	691,134	694,973	26.10	18,137,398
Colorado	91,666	34.95	3,203,727	973,259	25.73	25,038,538
New Mexico	19,317	31.00	598,827	701,967	16.89	11,855,522
Arizona	18,404	29.60	544,758	381,812	16.90	6,453,200
Utah	57,787	27.60	1,594,921	303,116	19.33	5,860,137
Nevada	18,069	29.25	528,518	224,317	19.80	4,441,142
Idado	31,500	28.20	888,300	384,056	20.26	7,782,125
Washington	115,485	30.20	3,487,647	265,376	20.95	5,560,691
Oregon	116,581	25.85	3,013,619	573,646	19.83	11,377,117
California	318,425	28.00	8,915,900	664,704	18.01	11,970,981
Oklahoma	37,014	28.40	1,051,198	257,505	23.79	6,127,330
Total	15,990,115	29.66	474,233,925	27,994,225	22.79	637,931,135

States and Territories.	Sheep.			Swine.		
	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	246,628	$3.07	$758,381	75,306	$8.20	$617,509
New Hampshire	78,289	3.11	243,088	56,104	8.16	457,949
Vermont	165,940	3.48	576,808	76,208	7.50	571,864
Massachusetts	40,437	4.25	171,857	54,846	9.04	495,698
Rhode Island	10,715	3.49	37,368	13,722	8.42	115,537
Connecticut	31,745	3.77	119,552	54,165	10.09	546,525
New York	841,955	4.23	3,557,260	645,237	6.54	4,216,948
New Jersey	42,299	4.03	170,338	151,120	8.01	1,210,849
Pennsylvania	790,604	3.75	2,963,184	1,043,331	7.61	7,936,097
Delaware	12,981	3.69	47,874	50,556	5.87	296,762
Maryland	136,135	3.38	460,068	331,853	5.86	1,944,660
Virginia	369,527	2.87	1,059,803	917,550	3.73	3,422,462
North Carolina	261,400	1.52	396,021	1,369,703	3.29	4,503,583
South Carolina	66,540	1.50	99,810	1,041,462	3.44	3,578,463
Georgia	327,584	1.59	520,203	2,093,987	3.87	8,095,353
Florida	83,598	1.58	132,085	429,128	2.04	877,138
Alabama	193,033	1.39	269,281	1,866,640	2.84	5,291,925
Mississippi	239,720	1.49	355,985	1,957,399	2.90	5,672,543
Louisiana	119,163	1.44	172,190	796,498	2.94	2,341,704
Texas	2,543,917	1.75	4,448,039	2,684,987	3.47	9,316,906
Arkansas	119,733	1.59	189,777	1,280,120	2.33	2,982,680
Tennessee	286,063	2.02	577,418	1,570,154	3.29	5,168,947
West Virginia	440,014	3.04	1,339,402	331,563	3.92	1,298,732
Kentucky	597,643	2.78	1,660,850	1,357,765	3.35	4,548,513
Ohio	2,730,471	3.55	9,680,885	2,307,051	5.02	11,572,167
Michigan	1,396,053	3.58	4,997,869	735,035	5.20	3,824,387
Indiana	674,532	3.95	2,666,762	1,340,231	4.92	6,591,257
Illinois	613,191	3.72	2,281,377	2,008,265	5.52	11,077,589
Wisconsin	722,967	3.43	2,479,778	929,763	6.24	5,801,721
Minnesota	410,998	2.96	1,217,377	411,353	5.63	2,317,974
Iowa	613,343	3.70	2,269,369	3,408,281	5.75	19,590,800
Missouri	616,102	3.00	1,850,154	2,949,818	3.96	11,686,028
Kansas	231,192	2.87	663,522	1,591,341	5.04	8,021,950
Nebraska	292,779	3.17	928,256	1,333,671	5.32	7,201,529
South Dakota	363,697	3.11	1,129,643	145,469	5.67	824,083
North Dakota	359,721	2.82	1,014,413	111,959	6.08	680,712
Montana	3,377,547	2.72	9,186,928	42,265	7.22	305,156
Wyoming	2,328,025	3.08	7,172,645	22,345	5.98	133,555
Colorado	1,655,551	2.71	4,486,543	20,713	4.99	103,305
New Mexico	3,128,692	1.99	6,213,583	30,204	4.42	133,503
Arizona	1,014,287	2.27	2,299,896	23,286	3.84	89,418
Utah	2,116,949	2.43	5,139,952	47,808	6.96	332,598
Nevada	576,994	2.21	1,275,157	10,441	4.54	47,401
Idaho	2,311,880	2.65	6,132,262	75,718	5.83	441,438
Washington	759,824	2.74	2,084,957	156,748	5.65	886,252
Oregon	2,575,468	2.49	6,403,901	216,430	4.02	869,831
California	2,175,545	2.64	5,742,352	374,141	4.47	1,673,907
Oklahoma	22,982	2.32	53,307	89,891	4.27	383,835
Total	39,114,453	2.75	107,697,530	38,651,631	4.40	170,109,743

IMPORTS AND EXPORTS OF AGRICULTURAL PRODUCTS.

Agricultural imports of the United States during the five years ended June 30, 1898.

[From Section of Foreign Markets.]

Articles imported.	1894.		1895.		1896.		1897.		1898.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER.										
Animals, live:										
Cattle ..... number	1,592	$18,704	149,781	$765,853	217,826	$1,509,856	328,977	$2,589,857	291,589	$2,913,223
Horses ..... do	6,166	1,319,572	13,098	1,055,191	9,991	662,591	6,998	464,898	3,085	414,899
Sheep ..... do	242,568	788,181	291,461	682,618	322,692	853,530	405,633	1,019,668	392,314	1,106,322
All other, including fowls	.....	274,789	.....	233,416	.....	226,500	.....	211,122	.....	239,681
Total	.....	2,401,246	.....	2,737,078	.....	3,252,477	.....	4,285,455	.....	4,674,125
Animal products:										
Beeswax ..... pounds	318,660	80,024	288,001	78,776	273,464	75,970	174,017	43,339	272,097	72,473
Bones, hoofs, and horns—										
Bones, crude	.....	307,033	.....	306,049	.....	157,946	.....	224,039	.....	492,544
Hoofs and horns	.....	235,232	.....	268,800	.....	568,445	.....	150,134		
Total	.....	542,265	.....	574,849	.....	726,391	.....	374,173	.....	492,544
Bristles—										
Crude, not sorted, bunched or prepared ..... pounds	892,520	929,231	4,741	1,892	726	1,620	630	385	1,203	416
Sorted, bunched or prepared, pounds			1,296,753	1,242,259	1,571,804	1,433,728	1,347,270	1,216,794	1,333,887	1,248,703
Total ..... pounds	892,520	929,231	1,301,494	1,244,151	1,572,530	1,435,348	1,347,900	1,217,179	1,335,090	1,249,119
Dairy products—										
Butter ..... do	144,346	23,356	72,148	12,930	52,067	8,533	37,963	6,077	31,984	5,474
Cheese ..... do	8,742,851	1,247,198	10,276,236	1,450,657	10,728,397	1,491,338	12,319,122	1,668,796	10,012,188	1,345,153
Milk	.....	102,336	.....	80,491	.....	62,622	.....	58,467	.....	67,729
Total	.....	1,372,890	.....	1,544,078	.....	1,562,493	.....	1,733,340	.....	1,416,356
Eggs ..... dozens	1,791,430	199,536	2,705,502	224,136	947,132	88,682	580,681	47,709	166,319	8,078
Feathers and downs, crude	.....	263,849	.....	1,746,967	.....	2,386,801	.....	2,282,908	.....	2,238,955

Agricultural imports of the United States during the five years ended June 30, 1898—Continued.

Articles imported.	1894.		1895.		1896.		1897.		1898.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER—continued.										
Animal products—Continued.										
Fibers, animal—										
Silk—										
Cocoons ..... pounds	181,824	$112,385	320,621	$129,042	279,067	$112,900	.....	.....	10,492	$3,999
Raw, or as reeled from the cocoon ..... pounds	4,956,875	15,627,822	7,974,810	22,029,068	8,000,621	26,246,902	6,513,612	$18,496,944	10,315,162	31,456,800
Waste ..... do	763,786	493,975	1,021,029	457,946	1,084,299	403,626	1,479,832	421,339	1,762,297	659,267
Total ..... do	5,902,485	16,234,182	9,316,460	22,626,056	9,363,987	26,763,428	7,993,444	18,918,283	12,087,951	32,110,066
Wools, hair of the camel, goat, alpaca, and other like animals, unmanufactured—										
Class 1, clothing—										
In the grease ..... pounds	10,685,496	1,748,359	87,151,522	13,335,602	117,233,440	19,448,471	176,350,510	27,824,507	43,061,372	7,302,841
Scoured ..... do							24,408,569	6,457,149	2,381,615	666,770
Total ..... do	10,685,496	1,748,359	87,151,522	13,335,602	117,233,440	19,448,471	200,759,079	34,281,656	45,442,987	7,969,611
Class 2, combing—										
In the grease ..... do	1,548,505	399,875	13,476,735	2,637,581	15,756,318	3,509,736	37,627,967	7,119,201	4,305,563	856,381
Scoured ..... do							323,523	68,419	15,310	3,218
Total ..... do	1,548,505	399,875	13,476,735	2,637,581	15,756,318	3,509,736	37,951,490	7,187,620	4,320,873	859,599
Class 3, carpet—										
In the grease ..... do	42,918,584	3,959,204	105,405,649	9,583,238	97,921,715	9,493,035	110,665,432	11,599,886	83,027,666	7,954,159
Scoured ..... do							1,476,025	174,029	3,676	323
Total ..... do	42,918,584	3,959,204	105,405,649	9,583,238	97,921,715	9,493,035	112,141,457	11,773,915	83,031,342	7,954,482
Total wools ..... do	55,152,585	6,107,438	206,033,906	25,556,421	230,911,473	32,451,242	350,852,026	53,243,191	132,795,202	16,783,692
Total animal fibers	.....	22,341,620	.....	48,182,477	.....	59,214,670	.....	72,161,474	.....	48,893,758
Gelatin	.....	(a)	.....	(a)	.....	15,386	.....	5,748	.....	25,907
Glue ..... pounds	4,132,524	440,240	4,751,048	446,394	6,276,926	555,979	4,926,620	472,312	4,103,814	428,507
Grease and tallow	.....	420,059	.....	1,556,388	.....	1,232,001	.....	984,332	.....	593,239
Gut, unmanufactured	.....	188,111	.....	212,645	.....	195,362	.....	180,721	.....	42,879
Hair, unmanufactured	.....	839,972	.....	1,165,944	.....	1,244,077	.....	1,330,632	.....	1,839,668
Hide cuttings, raw, and other glue stock	.....	280,062	.....	263,175	.....	279,692	.....	289,686	.....	408,592

Hides and skins, other than furs—										
Goatskins ..... pounds..	(a)	8,583,166	54,240,492	10,954,827	46,747,029	10,304,395	49,868,020	11,328,162	64,923,487	15,776,601
Hides of cattle ..... do....	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	126,243,595	13,624,989
All other ..... do....	(a)	8,202,986	172,335,253	15,168,115	163,650,982	20,215,782	156,232,824	16,534,864	54,607,334	7,667,342
Total ..... do....	(a)	16,786,152	226,575,745	26,122,942	210,398,011	30,520,177	206,100,844	27,863,026	245,774,616	37,068,932
Honey ..... gallons..	152,643	56,156	67,444	22,993	79,985	30,609	66,432	27,599	26,604	38,158
Meat products—										
Meat and meat extracts	.....	412,656	.....	479,336	.....	493,393	.....	601,898	.....	345,108
All other	.....	12,291	.....	5,244	.....	39,129	.....	49,484	.....	80,031
Total	.....	424,957	.....	484,580	.....	532,522	.....	651,292	.....	425,139
Oils, animal, not elsewhere specified, except whale and fish ..... gallons..	3,597	1,232	1,464	469	37,330	12,213	38,334	6,066	14,163	5,715
Oleostearin ..... pounds..	.....	.....	.....	.....	523,341	37,020	.....	.....	.....	.....
Rennets, raw or prepared	.....	76,063	.....	84,415	.....	51,073	.....	60,026	.....	99,757
Sausage, Bologna ..... pounds..	(a)	102,610	(a)	93,188	359,260	80,887	328,080	76,303	(a)	82,546
Sausage skins	.....	495,118	.....	419,345	.....	588,657	.....	542,817	.....	537,871
Total animal products	.....	45,800,147	.....	84,317,912	.....	100,866,013	.....	110,300,733	.....	95,958,883
Total animal matter	.....	48,201,393	.....	87,054,990	.....	104,118,490	.....	114,586,188	.....	109,633,608
VEGETABLE MATTER.										
Argols, or wine lees ..... pounds..	22,373,180	1,504,200	27,911,122	1,893,730	28,481,665	2,724,709	23,457,576	1,967,042	19,202,629	1,591,027
Breadstuffs:										
Barley ..... bushels..	791,061	358,744	2,116,816	867,743	837,384	317,209	1,251,587	394,749	124,804	43,823
Corn (maize) ..... do....	2,199	1,508	16,575	7,552	4,338	1,877	6,284	2,070	3,417	1,479
Oats ..... do....	8,345	3,928	308,308	80,901	47,506	13,039	46,459	12,071	9,098	3,368
Oatmeal ..... pounds..	421,459	24,486	396,176	21,993	343,732	19,689	1,525,499	32,742	287,910	15,697
Rye ..... bushels..	50	37	12,918	6,272	154	291	72	170	32,938	14,324
Wheat ..... do....	1,181,030	769,177	1,429,993	868,965	2,110,030	1,386,161	1,534,117	1,176,437	2,046,599	1,948,289
Wheat flour ..... barrels.	401	1,946	1,868	8,295	1,394	6,848	2,250	9,944	2,744	12,299
All other, and preparations of, used as food	.....	1,042,064	.....	998,092	.....	1,035,700	.....	1,146,710	.....	1,113,818
Total	.....	2,201,887	.....	2,859,813	.....	2,780,814	.....	2,774,763	.....	3,152,067
Chocolate, other than confectionery and sweetened chocolate ..... pounds..	969,855	198,425	897,637	174,805	1,145,467	198,417	1,467,977	239,849	992,288	149,866
Cocoa or cacao:										
Crude, and leaves and shells of do..	17,654,779	2,402,382	29,307,048	3,195,811	23,276,597	2,387,078	31,406,612	2,997,836	25,717,404	3,492,033
Prepared or manufactured ..... do....	1,294,759	454,730	1,403,576	482,532	1,244,309	410,249	1,495,459	443,604	815,824	290,844
Total ..... do....	18,949,538	2,857,112	30,710,624	3,678,343	24,520,906	2,797,327	32,902,071	3,441,450	26,533,228	3,782,877
Coffee ..... do....	550,934,337	99,314,676	652,208,975	96,130,717	580,597,915	84,793,124	737,645,670	81,544,384	870,514,455	65,067,631

a Not stated.

Agricultural imports of the United States during the five years ended June 30, 1898—Continued.

Articles imported.	1894.		1895.		1896.		1897.		1898.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Coffee substitutes:										
Chicory root—										
Raw, unground ..... pounds..	7,951,042	$168,892	9,544,186	$158,142	15,841,955	$210,228	16,930,162	$232,494	315,707	$5,100
Roasted, ground, or otherwise prepared ..... pounds.	1,906,300	74,516	445,458	14,816	475,933	15,849	399,008	13,899	.....	.....
Total ..... do....	9,857,342	243,408	9,989,644	172,958	16,317,888	226,077	17,329,170	246,393	315,707	5,100
All other ..... do....	1,389,672	55,554	2,776,117	106,886	2,366,962	90,532	2,373,245	87,679	857,810	29,562
Total ..... do....	11,247,014	298,962	12,765,761	279,844	18,684,850	316,609	19,702,415	334,072	1,173,517	34,662
Fibers, vegetable:										
Cotton, unmanufactured ..... do....	27,705,949	3,003,888	49,332,022	4,714,375	55,350,520	6,578,212	51,898,926	5,884,262	52,660,363	5,019,503
Flax, and tow of ..... tons ..	4,352	1,336,845	5,008	1,008,743	6,538	1,171,663	7,480	1,256,717	5,529	1,193,597
Flax, hackled, etc ..... do....			2,225	1,050,548	1,295	632,765	1,710	641,259		
Hemp, and tow of ..... do ...	1,635	239,918	6,177	754,975	8,356	1,046,656	5,096	633,288	4,017	560,334
Hemp, hackled, etc ..... do....			777	127,786	94	22,847	24	6,569		
Istle or Tampico fiber ..... do ...	4,789	257,089	9,827	458,404	12,207	717,585	6,313	335,841	2,563	130,294
Jute and jute butts ..... do ...	50,037	1,716,298	110,671	2,752,966	88,992	2,091,206	68,550	1,640,484	112,306	2,543,198
Manila hemp ..... do....	35,233	4,013,255	50,278	4,060,517	47,244	3,604,585	46,260	3,408,322	50,270	3,239,341
Sisal grass ..... do....	48,168	3,742,073	47,596	2,743,396	52,130	3,412,760	63,266	3,834,732	69,322	5,169,900
All other ..... do....	10,207	858,003	6,152	324,746	6,336	260,627	8,734	579,206	9,791	609,222
Total	.....	15,167,369	.....	17,996,456	.....	19,448,906	.....	18,220,680	.....	18,465,689
Flowers, natural, dressed or undressed ..	.....	41,445	.....	10,014	.....	10,386	.....	10,334	.....	11,914
Fruit juices:										
Prune juice or prune wine .gallons..	31,792	27,406	39,011	28,826	34,422	28,566	34,546	24,222	26,174	23,285
All other, including cherry juice, gallons	(a)	17,452	(a)	26,470	(a)	47,285	(a)	56,767	52,968	25,879
Total ..... gallons..	(a)	44,858	(a)	55,296	(a)	75,851	(a)	80,989	79,142	49,164
Fruits and nuts:										
Fruits—										
Bananas	.....	5,122,503	.....	4,674,861	.....	4,502,746	.....	4,086,320	.....	4,236,418
Currants ..... pounds ..	52,664,843	774,802	16,450,706	258,659	33,040,846	551,072	29,265,761	596,084	25,186,210	837,987
Dates ..... do ...	12,408,192	387,586	15,186,789	316,592	13,680,302	273,456	11,847,279	284,056	13,561,434	371,992
Figs ..... do....	7,985,959	392,040	11,855,890	587,420	11,900,710	639,512	8,940,762	565,380	9,628,426	509,002
Lemons	.....	4,285,278	.....	3,917,326	.....	5,040,344	.....	4,043,822	.....	2,848,130
Oranges	.....	1,127,005	.....	1,997,266	.....	2,694,151	.....	2,324,907	.....	886,722

Plums and prunes.....pounds..	9,908,122	416,342	14,352,057	527,625	483,658	68,862	710,028	73,303	303,992	39,660
Raisins.....do....	13,751,050	554,081	15,921,278	651,420	10,826,094	460,200	12,650,598	567,039	6,593,833	381,889
Prepared or preserved fruits....	.....	526,561	.....	570,568	.....	598,928	.....	605,053	.....	922,357
All other fruits *b*.....	.....	2,980,584	.....	1,725,342	.....	2,128,056	.....	1,810,807	.....	1,294,855
Total fruits.....	.....	16,566,782	.....	15,227,079	.....	16,957,307	.....	14,926,771	.....	12,329,012
Nuts—										
Almonds.....pounds..	7,436,784	769,453	7,903,375	810,439	7,789,681	765,594	9,644,338	880,263	5,746,362	659,659
Cocoanuts.....	.....	786,777	.....	471,994	.....	442,739	.....	471,587	.....	575,935
All other nuts.....	.....	631,759	.....	730,411	.....	868,799	.....	848,511	.....	1,002,344
Total nuts.....	.....	2,187,989	.....	2,012,844	.....	2,075,132	.....	2,200,161	.....	2,237,938
Total fruits and nuts.....	.....	18,754,771	.....	17,239,923	.....	19,032,439	.....	17,126,932	.....	14,566,950
Ginger, preserved or pickled.....	.....	14,387	.....	15,395	.....	23,547	.....	7,123	.....	14,295
Hay.....tons..	86,784	761,940	201,900	1,433,716	302,652	2,773,535	119,942	1,030,497	3,887	34,659
Hops.....pounds..	828,022	484,415	3,133,664	599,744	2,772,045	600,419	3,017,821	629,987	2,375,922	648,155
Indigo.....do....	1,718,534	1,218,576	3,956,986	2,015,975	3,340,001	1,673,170	3,522,016	1,696,641	3,097,340	1,815,411
Malt, barley.....bushels..	5,010	5,676	11,069	7,495	5,579	4,774	11,084	9,384	4,769	4,412
Malt extract, fluid and solid.....	.....	28,253	.....	51,501	.....	23,889	.....	11,485	.....	6,917
Malt liquors:										
In bottles or jugs.....gallons..	931,172	885,537	943,939	900,037	1,038,641	1,007,146	1,048,994	1,025,867	733,535	695,102
In other receptacles.....do....	1,979,368	625,230	2,027,737	614,808	2,244,763	657,870	1,915,650	534,426	1,777,202	506,428
Total.....do....	2,910,540	1,510,767	2,971,676	1,514,845	3,283,404	1,665,016	2,964,644	1,560,293	2,510,737	1,201,530
Oil cake.....pounds..	7,600,871	37,588	6,794,531	47,774	7,473,016	45,725	3,098,364	20,313	2,159,809	8,799
Oils, vegetable:										
Fixed or expressed—										
Olive, salad.....gallons..	757,478	909,897	775,046	952,405	942,598	1,107,049	928,567	1,134,077	736,877	923,804
Other.....	.....	1,730,797	.....	2,570,035	.....	2,557,026	.....	2,353,084	.....	2,434,209
Volatile or essential.....pounds..	2,861,875	1,102,108	(*a*)	1,398,956	(*a*)	1,554,289	(*a*)	1,885,523	(*a*)	1,511,078
Total.....	.....	3,742,802	.....	4,921,396	.....	5,218,364	.....	5,372,684	.....	4,869,091
Opium:										
Crude or unmanufactured..pounds..	716,881	1,691,914	358,455	730,669	365,514	683,347	1,072,944	2,184,727	123,845	265,607
Prepared.....do....	50,102	310,771	139,765	920,006	98,745	735,134	157,061	1,132,861	100,258	652,341
Total.....do....	766,983	2,002,685	498,220	1,650,675	464,259	1,418,481	1,229,975	3,317,588	224,103	917,948
Plants, trees, shrubs, vines, etc.....	.....	124,143	.....	632,523	.....	955,307	.....	963,977	.....	762,158

a Not stated.

b Including nuts free of duty, except cocoanuts.

Agricultural imports of the United States during the five years ended June 30, 1898—Continued.

Articles imported.	1894.		1895.		1896.		1897.		1898.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Rice and rice meal:										
Rice ..... pounds	86,810,536	$1,540,992	141,301,411	$2,353,974	78,190,334	$1,274,574	133,939,939	$2,555,960	129,810,630	$2,793,111
Rice flour, rice meal, and broken rice, pounds	55,351,281	833,843	78,262,909	1,091,538	68,534,273	911,005	63,876,204	961,200	60,474,685	953,722
Total ..... pounds	142,161,817	2,374,835	219,564,320	3,445,512	146,724,607	2,185,579	197,816,134	3,517,160	190,285,315	3,746,833
Sauerkraut	.....	16,652	.....	25,898	.....	7,895	.....	1,831	.....	.....
Seeds:										
Linseed or flaxseed ..... bushels	592,820	701,866	4,166,222	4,554,484	754,507	812,940	105,222	108,871	136,098	150,515
All other	.....	1,693,737	.....	1,981,096	.....	1,870,214	.....	1,315,055	.....	1,081,251
Total	.....	2,395,603	.....	6,535,580	.....	2,683,154	.....	1,423,926	.....	1,231,766
Spices:										
Unground—										
Nutmegs ..... pounds	1,140,878	395,977	1,652,613	513,801	1,355,420	433,436	1,669,740	451,614	1,213,904	331,235
Pepper, black or white ..... do	12,564,215	665,576	20,501,837	791,346	16,644,763	650,861	15,033,452	711,453	14,080,136	909,711
Other ..... do	14,857,688	943,155	17,879,564	1,052,868	19,193,589	999,226	20,411,490	1,076,963	13,784,689	898,992
All other, ground, etc ..... do	1,064,246	257,845	2,058,782	272,223	2,618,214	294,996	3,030,031	336,686	2,658,706	264,691
Total ..... do	30,427,027	2,262,553	42,092,796	2,640,235	39,811,986	2,378,519	40,144,713	2,576,716	31,737,525	2,404,629
Spirits, distilled:										
Of domestic manufacture, returned, proof gallons	1,089,627	910,526	770,124	670,292	1,029,653	940,060	956,760	863,558	854,586	734,901
Brandy ..... proof gallons	391,433	568,458	313,327	813,882	259,704	690,761	337,595	911,521	137,902	395,758
All other ..... do	893,131	961,146	1,139,710	1,246,567	1,249,895	1,446,873	1,727,110	2,074,835	770,850	1,004,135
Total ..... do	2,155,191	2,410,130	2,223,161	2,730,741	2,539,252	3,077,694	3,021,465	3,850,114	1,763,318	2,134,794
Starch ..... pounds	2,045,216	42,606	4,265,650	82,150	3,467,399	62,756	2,941,253	51,812	6,120,924	103,780
Straw ..... tons	8,313	27,300	7,745	24,544	7,879	31,140	9,386	31,768	1,448	4,463
Sugar and molasses:										
Molasses ..... gallons	19,650,063	1,984,778	15,075,879	1,295,146	4,687,664	737,265	3,702,471	586,513	3,603,547	544,016
Sugar—										
Not above No. 16 Dutch standard—										
Beet sugar ..... pounds	510,359,276	15,793,041	347,356,732	6,993,282	604,686,985	14,048,914	1,865,577,495	33,689,158	140,641,485	2,717,955
Other ..... do	3,775,878,029	108,842,016	3,168,781,436	67,836,512	3,104,187,781	69,817,286	2,854,192,069	60,448,873	2,448,190,703	55,319,873

Above No. 16 Dutch standard, pounds	58,965,576	2,236,832	58,352,286	1,633,042	187,463,791	5,353,573	199,136,169	4,928,150	101,088,663	2,434,921
Total sugar.....pounds	4,345,193,881	126,871,889	3,574,510,454	76,462,836	3,896,338,557	89,219,773	4,918,905,733	99,666,181	2,689,920,851	60,472,749
Total sugar and molasses		128,856,667		77,757,982		89,957,038		99,652,694		61,016,765
Tea .....pounds	93,518,717	14,144,243	97,253,458	13,171,379	93,998,372	12,704,440	113,347,175	14,835,862	71,957,715	10,054,283
Tobacco, leaf:										
Suitable for cigar wrappers....do	4,447,308	5,098,461	5,679,252	7,219,877	5,211,852	5,596,778	6,057,268	5,663,214	3,988,561	3,913,294
Other .....do	15,215,951	5,886,925	20,989,009	7,525,843	27,713,114	10,906,352	7,747,959	3,920,941	6,488,547	3,575,314
Total .....do	19,663,259	10,985,386	26,668,261	14,745,720	32,924,966	16,503,130	13,805,227	9,584,155	10,477,108	7,488,608
Vanilla beans .....do	171,556	727,853	137,296	495,273	235,763	1,013,608	165,001	884,865	63,997	279,755
Vegetables:										
Beans and peas.....bushels	1,184,081	1,117,969	1,535,960	1,548,767	613,801	658,320	482,984	489,274	163,560	149,237
Cabbages .....number	(a)	(a)	(a)	(a)	1,261,696	55,644	711,033	38,906	.....	.....
Onions.....bushels	(a)	(a)	(a)	(a)	(a)	(a)	560,138	627,273	488,853	429,173
Potatoes .....do	3,002,578	1,277,194	1,341,533	603,554	175,240	127,595	246,178	145,584	1,171,378	473,154
Pickles and sauces	.....	341,135	.....	321,632	.....	324,377	.....	332,243	.....	243,354
All other—										
In their natural state	.....	653,259	.....	679,894	.....	683,117	.....	256,752	.....	239,793
Prepared or preserved	.....	505,510	.....	817,689	.....	727,797	.....	720,822	.....	492,959
Total vegetables	.....	3,895,067	.....	3,971,536	.....	2,576,850	.....	2,610,854	.....	2,034,600
Vinegar.....gallons	68,542	18,501	75,108	19,823	81,075	24,552	76,123	20,519	85,556	22,313
Waters, unmedicated	.....	20,423	.....	21,105	.....	16,748	.....	20,082	.....	11,797
Wines:										
Champagne and other sparkling, dozen bottles	237,360	3,498,522	257,757	3,807,961	246,593	3,628,319	228,628	3,348,004	223,827	3,264,333
Still wines—										
In bottles.....dozens	296,697	1,423,143	296,779	1,430,229	314,190	1,527,916	309,281	1,475,211	268,921	1,312,147
In casks.....gallons	2,599,693	1,817,813	2,789,153	1,945,347	2,834,898	1,950,770	2,997,952	2,039,250	1,930,870	1,392,710
Total	.....	6,739,478	.....	7,183,537	.....	7,107,005	.....	6,862,465	.....	5,969,180
Total vegetable matter	.....	316,232,234	.....	286,060,995	.....	286,910,917	.....	296,285,290	.....	243,658,788
Total agricultural imports	.....	364,425,627	.....	353,115,985	.....	391,029,407	.....	349,871,468	.....	314,291,736

a Not stated.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1898.

[From Section of Foreign Markets.]

Articles exported.	1894.		1895.		1896.		1897.		1898.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER.										
Animals, live:										
Cattle ..... number	359,278	$33,461,922	331,722	$30,603,796	372,461	$34,560,672	392,190	$36,357,451	639,255	$37,827,500
Hogs ..... do	1,556	14,753	7,130	72,424	21,049	227,297	28,751	295,998	14,411	110,487
Horses ..... do	5,246	1,108,995	13,984	2,209,298	25,126	3,530,703	39,532	4,769,265	51,150	6,176,569
Mules ..... do	2,063	240,961	2,515	186,452	5,918	406,161	7,473	545,331	8,098	664,789
Sheep ..... do	132,370	832,763	405,748	2,630,686	491,565	3,076,384	244,120	1,531,615	199,690	1,213,886
All other, including fowls		53,247		51,389		39,752		68,771		250,175
Total		35,712,641		35,754,045		41,840,969		43,568,461		46,243,406
Animal products:										
Beeswax ..... pounds	469,763	118,093	309,212	90,875	222,612	65,844	195,048	56,462	151,004	41,827
Bones, hoofs, horns and horn tips, strips, and waste		260,675		288,084		321,680		280,140		174,861
Bristles		1,844		3,901				415		
Dairy products—										
Butter ..... pounds	11,812,092	2,077,608	5,598,812	915,533	19,373,913	2,937,203	31,345,224	4,493,364	25,690,025	3,864,765
Cheese ..... do	73,852,134	7,180,331	60,448,421	5,497,539	36,777,291	3,091,914	50,944,617	4,636,063	53,167,280	4,559,324
Milk		322,288		219,785		270,453		524,968		671,670
Total		9,580,227		6,632,857		6,299,570		9,654,395		9,095,759
Eggs ..... dozens	163,061	27,497	151,007	25,317	328,485	48,339	1,300,183	180,954	2,754,810	448,370
Egg yolks		2,928		2,255		556				
Feathers—										
Ostrich		6,500		9		250		5,679		
Other, crude and prepared, except egret ..... pounds	1,012,173	155,795	1,284,895	215,681	1,165,658	193,046	1,142,632	112,714	(a)	157,553
Total		162,295		215,690		193,296		118,393		157,553
Glue ..... pounds	999,052	101,372	1,178,328	114,493	1,760,470	166,930	1,400,863	132,581	2,318,741	209,441
Grease, grease scraps, and all soap stock		1,380,299		904,071		1,516,763		2,070,111		1,964,565
Hair, and manufactures of		353,729		505,029		455,880		517,469		635,716
Hides and skins, other than furs, pounds		3,972,494	36,002,859	2,310,323	39,545,324	3,858,946	31,119,166	2,388,530	11,536,073	1,015,032
Honey		127,282		118,873		90,969		22,368		98,504

Meat products—											
Beef products—											
Beef, canned ..... pounds..	55,974,910	5,120,851	64,102,263	5,720,933	63,698,180	5,636,953	54,019,772	4,656,308	37,109,570	3,279,657
Beef, fresh ..... do....	193,891,824	16,700,163	191,338,487	16,832,860	224,783,225	18,974,107	290,305,930	22,653,742	274,768,074	22,966,556
Beef, salted or pickled.. do....	62,682,667	3,572,054	62,473,325	3,558,230	70,709,209	3,975,113	67,712,940	3,514,126	44,314,479	2,368,467
Beef, other cured ..... do....	1,218,334	100,631	821,673	73,569	514,303	59,371	939,448	83,701	1,589,052	150,051
Tallow ..... do....	54,661,524	2,766,164	25,864,300	1,293,059	52,759,212	2,323,764	75,158,834	2,782,595	81,744,809	3,141,653
Total ..... do....	368,429,259	28,259,863	344,600,048	27,478,651	412,464,129	30,969,308	488,176,924	33,690,472	439,525,984	31,906,384
Hog products—											
Bacon ..... do....	416,657,577	38,338,843	452,549,976	37,776,293	425,352,187	33,442,847	500,399,448	34,187,147	650,108,933	46,380,918
Hams ..... do....	86,970,571	9,845,062	105,494,123	10,960,567	129,036,351	12,669,763	165,247,302	15,970,021	200,185,861	18,987,525
Pork, fresh ..... do....	1,168,647	92,095	818,581	60,630	744,656	43,739	1,306,424	94,816	12,224,285	815,075
Pork, pickled ..... do....	63,575,881	5,067,773	58,266,893	4,138,400	69,498,373	3,973,461	66,768,920	3,297,214	88,133,078	4,906,961
Lard ..... do....	447,566,867	40,089,809	474,895,274	36,821,508	509,534,256	33,589,851	568,315,640	29,126,185	709,344,045	39,710,672
Total ..... do....	1,015,939,543	93,433,582	1,092,024,847	89,757,428	1,134,165,823	83,719,661	1,302,037,734	82,675,683	1,659,996,202	110,801,151
Mutton ..... do....	2,197,900	174,404	591,449	47,832	422,950	31,793	361,955	28,341	320,169	27,961
Oleo and oleomargarin—											
Oleo, the oil ..... do....	123,295,895	11,942,842	78,098,878	7,107,018	103,276,756	8,087,905	113,506,152	6,742,061	132,579,277	7,904,413
Oleomargarin, or imitation butter ..... pounds..	3,898,950	475,003	10,100,897	992,464	6,063,699	587,269	4,864,351	472,856	4,328,556	386,297
Total ..... do....	127,194,845	12,417,845	88,199,775	8,099,482	109,340,455	8,675,174	118,370,503	7,214,917	136,907,813	8,290,710
Poultry and game	.....	18,633	.....	17,898	.....	40,647	.....	42,082	.....	85,739
All other meat products	.....	1,386,089	.....	1,600,231	.....	1,767,437	.....	2,944,486	.....	4,196,078
Total meat products	.....	135,690,416	.....	127,001,522	.....	125,204,020	.....	126,625,981	.....	155,305,023
Oils, animal, not elsewhere specified—											
Lard oil ..... gallons	681,081	449,571	553,421	304,023	833,935	426,401	951,407	419,863	775,102	345,825
Other, except whale and fish, gallons	270,835	149,801	144,556	75,585	100,934	50,839	112,555	47,836	123,711	50,587
Total ..... gallons..	951,916	599,372	697,977	379,678	934,869	477,240	1,073,962	467,699	898,813	396,412
Quills	.....	15,440	.....	13,653	.....	27,930	.....	19,264	.....	14,413
Rennets, prepared	.....	1,320	.....	1,801	.....	815	.....	735	.....	....
Sausage skins	.....	1,280,544	.....	1,581,891	.....	1,771,680	.....	1,514,651	.....	1,821,519
Silk noils	.....	.....	.....	.....	.....	1,958	.....	.....	.....	.....
Silk waste ..... pounds	97,787	28,813	65,673	23,391	102,624	31,163	54,060	13,181	153,886	19,002
Silkworm eggs	.....	683	.....	2,850	.....	25	.....	23	.....	....
Stearin ..... pounds	321,898	17,938	36,429	2,157	668,585	34,289	1,388,535	70,534	3,987,258	188,579
Wool, raw ..... do....	520,247	90,676	4,279,109	484,463	6,945,981	855,950	5,271,585	619,952	121,139	18,071
Total animal products	.....	153,813,907	.....	140,703,174	.....	141,423,843	.....	144,753,760	.....	171,564,647
Total animal matter	.....	189,526,548	.....	176,457,219	.....	183,264,812	.....	188,322,221	.....	217,808,053

a Not stated.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1898—Continued.

Articles exported.	1894.		1895.		1896.		1897.		1898.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER.										
Breadstuffs:										
Barley ..... bushels	5,219,405	$2,379,714	1,563,754	$767,228	7,680,331	$3,109,311	20,030,301	$7,646,384	11,237,077	$5,542,040
Bran, middlings, and mill feed ..... tons	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	91,189	1,329,519
Bread and biscuit ..... pounds	15,185,175	723,873	14,206,314	634,600	15,426,601	694,326	15,214,619	697,695	15,990,558	788,264
Buckwheat ..... bushels	(a)	(a)	(a)	(a)	(a)	(a)	1,677,102	678,959	1,370,406	589,285
Corn (maize) ..... do	65,324,841	30,211,154	27,691,137	14,650,767	99,992,835	37,826,862	176,916,365	54,087,152	208,744,969	74,196,850
Corn meal ..... barrels	291,172	770,526	255,567	648,844	276,885	654,121	475,263	902,061	827,651	1,766,048
Oats ..... bushels	5,750,266	2,027,961	569,977	200,793	13,012,590	3,497,611	35,696,736	8,756,207	69,130,288	20,632,944
Oatmeal ..... pounds	9,719,357	238,528	20,499,253	566,321	38,592,504	969,502	47,310,251	1,071,340	85,509,350	1,757,978
Rye ..... bushels	230,822	126,532	9,437	5,340	988,466	445,075	8,560,271	3,667,305	15,541,575	8,825,769
Rye flour ..... barrels	3,055	9,273	3,768	12,002	3,777	11,163	2,566	7,366	3,410	11,815
Wheat ..... bushels	88,415,230	59,407,041	76,102,704	43,865,663	60,650,080	39,709,868	79,562,020	59,920,178	148,231,261	145,684,659
Wheat flour ..... barrels	16,859,533	69,271,770	15,268,892	51,651,928	14,620,864	52,025,217	14,569,545	55,914,347	15,349,943	69,263,718
All other breadstuffs, and preparations of, used as food	.....	1,610,884	.....	1,661,234	.....	2,442,940	.....	4,508,025	.....	3,508,240
Total	.....	166,777,229	.....	114,694,780	.....	141,356,993	.....	197,857,219	.....	333,897,119
Broom corn	.....	210,742	.....	169,503	.....	181,853	.....	136,007	.....	163,066
Cider ..... gallons	460,690	65,686	669,745	85,675	372,986	47,670	637,672	77,695	465,873	69,063
Coffee and cocoa, ground or prepared, and chocolate	.....	137,777	.....	104,317	.....	107,740	.....	128,078	.....	137,369
Cotton, unmanufactured:										
Sea-Island ..... bales	37,191	2,904,905	39,333	2,782,639	49,651	3,816,216	55,347	4,078,044	40,037	2,767,291
..... pounds	14,255,439		15,261,322		19,159,469		21,585,360		15,610,302	
Other ..... bales	5,360,318	207,964,384	6,926,025	202,118,351	4,610,114	186,240,244	6,121,018	226,812,927	7,540,967	227,674,924
..... pounds	2,669,026,886		3,502,171,787		2,316,066,946		3,082,169,589		3,834,653,993	
Total ..... bales	5,397,509	210,869,289	6,965,358	204,900,990	4,659,765	190,056,460	6,176,365	230,890,971	7,581,004	230,442,215
..... pounds	2,683,282,325		3,517,433,109		2,335,226,385		3,103,754,949		3,850,264,295	
Cotton-seed hulls	.....	1,747	.....	235	.....	.....	.....	.....	.....	.....
Cotton-seed meats	.....	.....	.....	.....	.....	.....	.....	37,970	.....	.....
Flax, raw	.....	900	.....	906	.....	.....	.....	.....	.....	.....
Flowers, cut	.....	1,588	.....	2,521	.....	798	.....	1,429	.....	2,967
Fruits and nuts:										
Fruits—										
Apples, dried ..... pounds	2,846,645	168,054	7,085,946	461,214	26,691,963	1,310,507	30,775,401	1,340,159	31,031,254	1,897,725
Apples, green or ripe ..... barrels	78,580	242,617	818,711	1,954,318	360,002	930,389	1,503,981	2,371,143	605,390	1,684,717
Oranges	.....	(a)	.....	(a)	.....	(a)	.....	(a)	.....	339,396
Prunes ..... pounds	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	15,940,791	1,021,888
Raisins ..... do	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	3,109,639	167,062

Fruits, preserved—										
Canned		660,723		871,465		1,376,281		1,686,723		1,624,741
Other		211,215		47,420		70,353		43,276		82,504
All other green, ripe, or dried fruits		1,016,397		1,522,100		1,868,353		2,172,199		2,033,845
Total fruits		2,239,006		4,856,517		5,585,783		7,613,500		8,851,878
Nuts		125,233		115,274		93,283		125,805		161,432
Total fruits and nuts		2,424,239		4,971,791		5,679,066		7,739,305		9,013,310
Ginseng ... pounds	194,564	619,114	233,236	826,713	199,436	770,673	179,573	840,686	174,063	638,446
Glucose or grape sugar ... do	124,796,288	2,328,707	133,808,329	2,567,784	171,231,650	2,772,335	194,419,250	2,736,674	196,864,605	2,871,839
Grasses, dried		36,205		19,781		44,583		17,766		26,499
Hay ... tons	54,446	890,654	47,117	699,029	59,052	874,048	61,658	845,599	81,827	1,151,273
Hops ... pounds	17,472,975	3,844,232	17,523,388	1,872,597	16,765,254	1,478,919	11,426,241	1,204,183	17,161,669	2,642,779
Lard substitutes, not elsewhere specified (cottolene, lardine, etc.) ... pounds	1,022,046	77,984	503,859	38,122	1,709,923	102,279	16,261,991	857,708	21,343,025	1,118,659
Malt ... bushels	89,897	61,186	162,006	110,326	200,042	126,942	289,543	177,292	406,702	287,473
Malt sprouts		(a)		(a)		(a)		(a)		15,124
Malt liquors:										
In bottles ... dozens	351,625	471,589	426,777	492,448	492,055	590,116	549,910	636,837	406,231	497,031
In other receptacles ... gallons	307,077	77,390	258,620	66,322	290,383	69,759	390,048	87,112	391,802	88,548
Total		548,979		558,770		659,875		723,949		585,579
Must		51,308		16,000		18,560				
Oil cake and oil-cake meal:										
Corn ... pounds									2,202,680	20,286
Cotton-seed ... do	744,603,229	8,807,256	489,716,053	4,310,128	404,937,291	3,740,232	623,386,638	5,515,860	919,727,701	8,040,710
Flaxseed or linseed ... do			243,936,442	2,855,459	393,429,432	4,209,415	433,106,448	4,095,244	436,206,321	4,549,824
Total ... do	744,603,229	8,807,256	733,652,495	7,165,587	798,366,723	7,949,647	1,056,493,086	9,611,044	1,358,156,702	12,601,820
Oils, vegetable:										
Corn oil ... gallons									2,646,560	575,646
Cotton-seed ... do	14,958,300	6,008,405	21,187,728	6,813,313	19,445,848	5,476,510	27,198,882	6,807,361	40,320,784	10,137,619
Linseed ... do	92,861	48,550	62,718	37,363	67,159	36,260	111,262	42,709	99,074	38,429
Volatile or essential—										
Peppermint ... pounds	80,225	209,722	87,633	194,616	85,290	174,810	162,432	257,484	145,375	189,811
Other		64,907		190,798		102,487		146,569		291,426
All other		129,041		106,022		309,955		1,167,504		885,057
Total		6,460,625		7,342,112		6,097,022		8,511,618		12,019,069
Plants, trees, and shrubs		140,415		129,551		133,775		135,047		99,359
Rice ... pounds	763,425	19,484	124,296	4,687	1,346,876	14,117	387,288	11,617	637,146	27,501
Rice bran, meal, and polish ... do	10,002,221	92,255	1,499,040	11,767	15,684,678	79,637	3,518,466	29,113	5,363,844	25,498
Roots, herbs, and barks, n. e. s.		241,738		232,095		153,896		154,347		147,839

a Not stated.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1898—Continued.

Articles exported.	1894.		1895.		1896.		1897.		1898.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Seeds:										
Cotton ..... pounds	5,419,056	$41,866	11,051,812	$86,695	26,980,110	$179,621	26,566,024	$170,604	32,764,781	$197,258
Flaxseed or linseed ..... bushels	2,047,836	2,426,284	1,224	1,433	80,453	73,207	4,713,747	3,850,835	257,228	231,237
Grass seed—										
Clover ..... pounds	45,418,663	4,540,851	22,900,672	2,124,997	5,539,787	437,493	13,042,994	1,003,157	31,155,381	1,892,101
Timothy ..... do	10,155,867	449,207	4,939,237	277,160	11,894,536	518,755	16,733,993	574,457	10,238,780	317,173
Other grass seed	.....	(a)	.....	(a)	.....	(a)	.....	(a)	.....	167,109
Total	.....	(a)	.....	(a)	.....	(a)	.....	(a)	.....	2,376,383
All other seeds	.....	484,013	.....	358,860	.....	382,941	.....	429,379	.....	149,845
Total seeds	.....	7,942,221	.....	2,849,145	.....	1,592,017	.....	6,028,432	.....	2,954,723
Spices	.....	1,205	.....	871	.....	1,367	.....	772	.....	3,841
Spirits, distilled:										
Alcohol, including pure, neutral, or cologne spirits ..... proof gallons	173,527	62,166	676,832	181,393	331,407	85,292	416,725	140,046	b 1,619,230	b 463,616
Brandy ..... do	361,653	291,022	100,719	94,924	89,259	87,294	11,815	12,646	24,886	39,455
Rum ..... do	977,994	1,081,716	879,153	1,134,965	865,643	1,174,093	808,393	1,102,267	607,634	845,673
Whisky—										
Bourbon ..... do	4,105,639	3,720,562	1,442,685	1,485,525	139,866	187,336	569,413	422,451	286,599	241,066
Rye ..... do	256,816	266,293	17,672	34,755	26,630	45,268	21,282	38,402	17,495	31,164
All other ..... do	592,387	255,177	154,703	60,124	336,424	151,521	500,338	225,897	36,869	30,149
Total ..... do	6,468,016	5,676,936	3,271,764	2,991,686	1,789,229	1,730,804	2,327,966	1,941,703	2,592,713	1,651,123
Starch ..... pounds	22,888,016	727,011	11,788,990	366,800	31,829,435	885,198	79,088,876	1,665,926	72,806,313	1,371,549
Straw	.....	121	.....	3,639	.....	5,293	.....	5,659	.....	5,907
Sugar and molasses:										
Molasses and sirup ..... gallons	9,385,359	1,038,680	9,148,711	850,400	6,953,307	737,870	8,913,830	788,323	11,391,370	1,061,929
Sugar—										
Brown ..... pounds	690,080	25,931	695,486	22,052	296,265	10,389	1,107,864	35,367	460,682	17,333
Refined ..... do	14,778,416	653,052	8,833,522	406,924	9,106,259	450,753	7,197,355	341,641	6,047,608	301,511
Total ..... do	15,468,496	678,983	9,529,008	428,976	9,402,524	461,142	8,305,219	377,008	6,508,290	318,864
Total sugar and molasses	.....	1,717,663	.....	1,279,376	.....	1,199,012	.....	1,165,331	.....	1,380,793

Sugar meal ..... pounds..	.....	.....	.....	.....	3,930,412	66,935	.....	.....	.....	.....
Teazels	.....	3,487	.....	1,281	.....	6,287	.....	3,336	.....	13,290
Tobacco, unmanufactured:										
Leaf ..... pounds..	268,791,312	22,939,356	293,805,855	25,622,776	287,700,301	24,405,245	305,978,292	24,513,567	252,258,902	21,924,357
Stems and trimmings ..... do....	21,893,680	1,145,878	7,186,075	176,192	7,839,011	166,117	8,953,399	197,879	10,761,312	247,223
Total ..... do....	290,684,992	24,085,234	300,991,930	25,798,968	295,539,312	24,571,362	314,931,691	24,711,446	263,020,214	22,171,580
Vegetables:										
Beans and peas ..... bushels..	326,748	576,657	242,680	429,002	473,975	632,073	900,219	1,110,387	854,284	1,094,094
Onions ..... do....	68,865	69,823	53,335	46,703	82,916	61,181	73,511	60,088	100,148	90,832
Potatoes ..... do....	803,111	651,877	572,957	418,221	680,049	371,485	926,646	515,067	605,187	469,666
Vegetables, canned	.....	255,857	.....	441,388	.....	407,506	.....	408,840	.....	386,039
All other, including pickles and sauces	.....	190,248	.....	208,144	.....	182,805	.....	243,542	.....	350,157
Total	.....	1,744,462	.....	1,543,458	.....	1,655,050	.....	2,337,924	.....	2,381,788
Vinegar ..... gallons..	68,282	9,537	80,234	11,273	123,163	16,975	93,969	11,572	108,657	12,939
Wine:										
In bottles ..... dozens..	13,813	63,860	13,919	56,202	17,147	69,460	16,794	69,444	9,672	46,721
In other receptacles ..... gallons..	802,192	380,588	1,125,297	545,708	1,339,090	581,827	1,389,375	629,270	1,623,103	682,028
Total	.....	444,448	.....	601,910	.....	651,287	.....	698,714	.....	728,749
Yeast	.....	42,435	.....	44,599	.....	45,017	.....	42,849	.....	41,770
Total vegetable matter	.....	447,107,199	.....	381,928,642	.....	391,133,452	.....	501,432,972	.....	640,699,889
Total agricultural exports	.....	636,633,747	.....	558,385,861	.....	571,398,264	.....	689,755,195	.....	858,507,942

a Not stated.

b Not including wood alcohol.

AVERAGE PRICES FOR IMPORTS AND EXPORTS.

[From Section of Foreign Markets.]

Average import price of agricultural products imported into the United States during each of the five fiscal years 1894–1898.

[The import prices of merchandise here given represent "the actual market value or wholesale price of such merchandise as bought and sold in usual wholesale quantities, at the time of exportation to the United States, in the principal markets of the country from whence imported, and in the condition in which such merchandise is there bought and sold for exportation to the United States, or consigned to the United States for sale, including the value of all cartons, cases, crates, boxes, sacks, and coverings of any kind, and all costs, charges, and expenses incident to placing the merchandise in condition, packed ready for shipment to the United States" (Act of June 10, 1890.)

The export prices are the actual market values in the port of shipment.]

Articles imported.	Years ended June 30—				
	1894.	1895.	1896.	1897.	1898.
ANIMAL MATTER.					
Cattle, free of duty ..... head	$17.14	$6.63	$20.56	$119.41	$132.81
Cattle, dutiable ..... do	10.43	4.95	6.89	7.89	9.75
Total cattle ..... do	11.75	5.11	6.93	7.87	9.99
Horses, free of duty ..... do	551.55	330.17	196.34	138.85	181.82
Horses, dutiable ..... do	103.96	53.88	50.72	58.38	117.92
Total horses ..... do	214.01	80.56	66.32	66.42	134.49
Sheep, free of duty ..... do	24.84	15.90	10.85	13.70	14.05
Sheep, dutiable ..... do	3.02	2.25	2.54	2.45	2.73
Total sheep ..... do	3.25	2.34	2.65	2.51	2.82
Beeswax ..... pound	.251	.274	.278	.249	.266
Bristles, crude, not sorted, bunched, or prepared ..... pound	.....	.399	2.231	.611	.346
Bristles, sorted, bunched, or prepared ..... do	.....	.958	.912	.903	.814
Total bristles ..... do	1.041	.956	.913	.903	.814
Butter ..... do	.162	.179	.164	.160	.171
Cheese ..... do	.143	.141	.139	.135	.134
Eggs ..... dozen	.111	.120	.090	.082	.049
Silk:					
Cocoons ..... pound	.618	.434	.405	.....	.381
Raw, or as reeled from the cocoon ..... do	3.15	2.76	3.28	2.84	3.05
Waste ..... do	.647	.449	.372	.285	.374
Total silk ..... do	2.75	2.43	2.86	2.37	2.66
Wool, class 1, clothing:					
In the grease ..... do	.....	.....	.....	.158	.170
Scoured ..... do	.....	.....	.....	.265	.280
Total wool, class 1 ..... do	.164	.153	.166	.171	.175
Wool, class 2, combing:					
In the grease ..... do	.....	.....	.....	.189	.199
Scoured ..... do	.....	.....	.....	.211	.210
Total wool, class 2 ..... do	.258	.196	.223	.189	.199
Wool, class 3, carpet:					
In the grease ..... do	.....	.....	.....	.105	.096
Scoured ..... do	.....	.....	.....	.118	.088
Total wool, class 3 ..... do	.092	.091	.097	.105	.096
Total wools ..... do	.111	.124	.141	.152	.126
Glue ..... do	.097	.088	.089	.096	.104
Hides and skins, other than furs:					
Goatskins ..... do	.....	.202	.220	.227	.243
Hides of cattle ..... do	}	.088	.124	.106	{ .108
All other ..... do					{ .140
Total hides and skins ..... do	.....	.115	.145	.135	.151
Honey ..... gallon	.368	.341	.383	.415	.395
Oils, animal, n. e. s., except whale and fish, gallon	.343	.320	.327	.158	.404
Oleomargarin ..... pound	.....	.....	.071	.....	.....
Sausage, Bologna ..... do	.....	.....	.225	.233	.....
VEGETABLE MATTER.					
Argols, or wine lees ..... pound	.067	.068	.096	.084	.083
Barley ..... bushel	.435	.410	.379	.310	.351
Corn (maize) ..... do	.686	.456	.433	.329	.433
Oats ..... do	.471	.262	.274	.260	.370
Oatmeal ..... pound	.058	.056	.057	.021	.035
Rye ..... bushel	.740	.486	1.89	2.36	.404
Wheat ..... do	.651	.608	.657	.767	.952
Wheat flour ..... barrel	4.85	4.44	4.91	4.41	4.46
Chocolate, other than confectionery and sweetened chocolate ..... pound	.206	.195	.173	.168	.151
Cocoa, or cacao, crude, and leaves and shells of ..... pound	.136	.109	.103	.095	.136
Cocoa, or cacao, prepared or manufactured, pound	.351	.337	.330	.297	.357
Total cocoa or cacao ..... pound	.151	.120	.114	.105	.143
Coffee ..... do	.164	.147	.146	.111	.075
Chicory root, raw, unground ..... do	.021	.017	.013	.014	.016
Chicory root, roasted, ground, or otherwise prepared ..... pound	.039	.033	.033	.035	.....

Average import price of agricultural products imported into the United States during each of the five fiscal years 1894–1898—Continued.

Articles imported.	Years ended June 30—				
	1894.	1895.	1896.	1897.	1898.
VEGETABLE MATTER—continued.					
Total chicory root ..... pound	$0.025	$0.017	$0.014	$0.014	$0.016
Coffee substitutes, n. e. s. ..... do	.040	.039	.038	.037	.034
Total coffee substitutes ..... do	.027	.022	.017	.017	.030
Cotton, unmanufactured ..... do	.108	.096	.119	.113	.095
Flax, and tow of ..... ton	397.18	291.43	179.21	168.01	215.88
Flax, hackled, etc ..... do		472.16	488.62	375.01	
Hemp, and tow of ..... do	146.74	122.22	125.36	124.27	139.49
Hemp, hackled, etc ..... do		164.46	243.05	273.71	
Istle or Tampico fiber ..... do	53.68	46.65	58.78	53.20	50.84
Jute and jute butts ..... do	34.30	24.88	22.49	23.93	22.65
Manila hemp ..... do	113.91	80.76	76.30	73.68	64.44
Sisal grass ..... do	77.21	57.64	65.47	60.61	74.58
Fibers, n. e. s ..... do	84.06	52.79	41.13	66.32	62.22
Fruit juices:					
Prune juice or prune wine ..... gallon	.862	.739	.830	.701	.890
All other, including cherry juice ..... do	.....	.....	.....	.....	.489
Total fruit juices ..... do	.....	.....	.....	.....	.621
Currants ..... pound	.015	.016	.017	.020	.033
Dates ..... do	.031	.021	.020	.024	.027
Figs ..... do	.049	.050	.054	.060	.053
Plums and prunes ..... do	.012	.037	.142	.103	.130
Raisins ..... do	.040	.041	.043	.045	.058
Almonds ..... do	.103	.103	.098	.091	.115
Hay ..... ton	8.78	7.10	9.16	8.59	8.92
Hops ..... pound	.585	.191	.217	.209	.274
Indigo ..... do	.709	.509	.501	.482	.586
Malt, barley ..... bushel	1.13	.677	.856	.847	.925
Malt liquors in bottles or jugs ..... gallon	.951	.953	.970	.978	.948
Malt liquors in other receptacles ..... do	.316	.303	.293	.279	.285
Total malt liquors ..... do	.519	.510	.507	.526	.479
Oil cake ..... pound	.005	.007	.006	.007	.004
Olive oil ..... gallon	1.20	1.23	1.17	1.22	1.25
Volatile or essential oil ..... pound	.385	.....	.....	.....	.....
Opium, crude or unmanufactured ..... do	2.36	2.04	1.87	2.04	2.14
Opium, prepared ..... do	6.20	6.58	7.44	7.21	6.51
Total opium ..... do	2.61	3.31	3.06	2.70	4.10
Rice ..... do	.018	.017	.016	.019	.022
Rice flour, rice meal, and broken rice ..... do	.015	.014	.013	.015	.016
Total rice and rice meal ..... do	.017	.016	.015	.018	.020
Linseed, or flaxseed ..... bushel	1.18	1.09	1.08	1.03	1.11
Spices, unground:					
Nutmegs ..... pound	.347	.311	.320	.270	.273
Pepper, black and white ..... do	.052	.039	.039	.047	.065
Other ..... do	.063	.059	.052	.053	.065
Spices, ground, etc ..... do	.155	.132	.113	.111	.100
Total spices ..... do	.074	.063	.060	.064	.076
Spirits, distilled:					
Of domestic manufacture, returned, proof gallon	.858	.870	.913	.903	.860
Brandy ..... proof gallon	2.82	2.60	2.66	2.70	2.87
All other ..... do	1.04	1.09	1.16	1.20	1.30
Total distilled spirits ..... do	1.12	1.23	1.21	1.27	1.21
Starch ..... pound	.021	.019	.018	.018	.017
Straw ..... ton	3.28	3.17	3.95	3.38	3.08
Molasses ..... gallon	.101	.086	.157	.158	.151
Beet sugar, not above No. 16 Dutch standard, pound	.031	.020	.023	.018	.019
Sugar, other than beet, not above No. 16 Dutch standard ..... pound	.029	.021	.022	.021	.023
Sugar, above No. 16 Dutch standard ..... do	.038	.028	.029	.025	.024
Total sugar ..... do	.029	.021	.023	.020	.022
Tea ..... do	.151	.135	.135	.131	.140
Tobacco, leaf:					
Suitable for cigar wrappers ..... do	1.15	1.27	1.07	.935	.981
Other ..... do	.387	.359	.394	.506	.551
Total leaf tobacco ..... do	.559	.553	.501	.694	.715
Vanilla beans ..... do	4.24	3.61	4.30	5.36	4.37
Beans and peas ..... bushel	.944	1.01	1.07	1.01	.912
Cabbages ..... number	.....	.....	.044	.055	.....
Onions ..... bushel	.....	.....	.....	1.12	.878
Potatoes ..... do	.425	.450	.728	.591	.404
Vinegar ..... gallon	.270	.264	.303	.270	.261
Champagne and other sparkling wines, dozen bottles	14.74	14.77	14.73	14.64	14.58
Still wines:					
In bottles ..... dozen	4.81	4.82	4.86	4.77	4.88
In casks ..... gallon	.699	.697	.688	.680	.721

Average export price of agricultural products exported from the United States during each of the five fiscal years 1894–1898.

Articles exported.	Years ended June 30—				
	1894.	1895.	1896.	1897.	1898.
ANIMAL MATTER.					
Cattle ..... head	$93.14	$92.26	$92.79	$92.70	$86.12
Hogs ..... do	9.50	10.16	10.80	10.30	7.67
Horses ..... do	211.40	157.99	140.52	120.64	120.75
Mules ..... do	116.80	74.14	68.63	72.97	82.09
Sheep ..... do	6.29	6.48	6.26	6.27	6.08
Beeswax ..... pound	.251	.294	.296	.289	.277
Butter ..... do	.176	.164	.152	.143	.150
Cheese ..... do	.097	.091	.084	.091	.086
Eggs ..... dozen	.169	.168	.147	.139	.163
Feathers, crude and prepared, other than ostrich and egret ..... pound	.154	.168	.166	.099	.....
Glue ..... do	.101	.097	.095	.095	.090
Hides and skins, other than furs ..... do	.....	.064	.098	.077	.088
Beef, canned ..... do	.091	.089	.088	.086	.088
Beef, fresh ..... do	.086	.088	.084	.078	.084
Beef, salted or pickled ..... do	.057	.057	.056	.052	.053
Beef, other cured ..... do	.083	.090	.115	.089	.094
Tallow ..... do	.051	.050	.044	.037	.038
Bacon ..... do	.092	.083	.079	.068	.071
Hams ..... do	.113	.104	.098	.097	.095
Pork, fresh ..... do	.079	.074	.059	.073	.067
Pork, pickled ..... do	.080	.071	.057	.049	.056
Lard ..... do	.090	.078	.066	.051	.056
Mutton ..... do	.079	.081	.075	.078	.085
Oleo-oil ..... do	.097	.091	.078	.059	.060
Oleomargarin (imitation butter) ..... do	.122	.098	.097	.097	.089
Lard oil ..... gallon	.660	.549	.511	.437	.395
Other animal oils, except whale and fish ..... do	.553	.523	.504	.425	.409
Total animal oils, except whale and fish ..... do	.630	.544	.510	.435	.397
Silk waste ..... pound	.295	.356	.304	.244	.123
Stearin ..... do	.056	.059	.051	.051	.047
Wool, raw ..... do	.174	.113	.123	.118	.149
VEGETABLE MATTER.					
Barley ..... bushel	.456	.491	.404	.382	.493
Bran, middlings and mill feed ..... ton	.....	.....	.....	.....	14.78
Bread and biscuit ..... pound	.048	.045	.045	.046	.049
Buckwheat ..... bushel	.....	.....	.....	.405	.430
Corn (maize) ..... do	.462	.529	.378	.306	.355
Corn meal ..... barrel	2.65	2.90	2.36	1.90	2.13
Oats ..... bushel	.353	.352	.260	.249	.298
Oatmeal ..... pound	.025	.028	.024	.023	.021
Rye ..... bushel	.548	.566	.450	.428	.568
Rye flour ..... barrel	3.04	3.20	2.96	2.87	3.46
Wheat ..... bushel	.672	.576	.655	.753	.983
Wheat flour ..... barrel	4.11	3.38	3.56	3.84	4.51
Cider ..... gallon	.143	.128	.128	.122	.129
Cotton, sea-island ..... pound	.204	.182	.199	.189	.177
Cotton, other ..... do	.078	.058	.080	.074	.059
Total cotton ..... do	.079	.058	.081	.074	.060
Apples, dried ..... do	.059	.065	.050	.044	.061
Apples, green or ripe ..... barrel	3.09	2.39	2.58	1.58	2.78
Prunes ..... pound	.....	.....	.....	.....	.064
Raisins ..... do	.....	.....	.....	.....	.054
Ginseng ..... do	3.18	3.54	3.86	4.68	3.67
Glucose ..... do	.019	.019	.016	.014	.015
Hay ..... ton	16.36	14.84	14.80	13.71	14.07
Hops ..... pound	.220	.107	.088	.114	.154
Lard substitutes, n. e. s ..... do	.076	.076	.060	.053	.052
Malt ..... bushel	.681	.681	.635	.612	.707
Malt liquors in bottles ..... dozen	1.34	1.15	1.20	1.16	1.22
Malt liquors in other receptacles ..... gallon	.252	.256	.240	.223	.226
Corn-oil cake ..... pound	.....	.....	.....	.....	.009
Oil cake and oil cake meal, cotton seed ..... do	.....	.009	.009	.009	.009
Oil cake and oil-cake meal, flaxseed ..... do	.....	.012	.011	.009	.010
Total oil cake and oil-cake meal ..... do	.012	.010	.010	.009	.009
Corn oil ..... gallon	.....	.....	.....	.....	.218
Cotton-seed oil ..... do	.402	.322	.282	.254	.252
Linseed oil ..... do	.523	.596	.495	.384	.427
Peppermint oil ..... pound	2.61	2.22	2.05	1.58	1.24
Rice ..... do	.026	.038	.010	.038	.043
Rice bran, meal, and polish ..... do	.009	.008	.006	.006	.006
Clover seed ..... do	.100	.093	.079	.077	.061
Cotton seed ..... do	.008	.008	.007	.006	.006
Flaxseed ..... bushel	1.18	1.17	.910	.820	.899
Timothy seed ..... pound	.044	.056	.044	.034	.031
Alcohol, including pure, neutral, etc., proof gallon	.358	.268	.257	.336	.286

Average export price of agricultural products exported from the United States during each of the five fiscal years 1894–1898—Continued.

Articles exported.		Years ended June 30—				
		1894.	1895.	1896.	1897.	1898.
VEGETABLE MATTER—continued.						
Brandy	proof gallon	$0.805	$0.942	$0.978	$1.07	$1.39
Rum	do	1.11	1.29	1.36	1.36	1.39
Bourbon whisky	do	.966	1.03	1.34	.742	.811
Rye whisky	do	1.04	1.97	1.70	1.80	1.78
Distilled spirits, n. e. s.	do	.431	.389	.450	.451	.818
Total distilled spirits	do	.878	.914	.967	.834	.637
Starch	pound	.032	.031	.028	.021	.019
Molasses and sirup	gallon	.111	.093	.106	.088	.093
Sugar, brown	pound	.038	.032	.035	.032	.038
Sugar, refined	do	.044	.046	.049	.047	.050
Total sugar	do	.044	.045	.049	.045	.049
Sugar meal	do			.047		
Tobacco, leaf	do	.085	.087	.085	.080	.087
Tobacco, stems and trimmings	do	.052	.025	.021	.022	.023
Total tobacco, unmanufactured	do	.083	.086	.083	.078	.084
Beans and peas	bushel	1.76	1.77	1.33	1.23	1.28
Onions	do	1.01	.876	.738	.817	.907
Potatoes	do	.812	.730	.546	.556	.761
Vinegar	gallon	.140	.141	.138	.123	.119
Wine, in bottles	dozen	4.62	4.04	4.05	4.14	4.83
Wine in other receptacles	gallon	.474	.485	.434	.453	.420

SUGAR STATISTICS.

Quantity of sugar imported into the United States from the principal countries of supply during each fiscal year from 1894 to 1898, inclusive.

[From Section of Foreign Markets.]

Countries from which imported.	Years ended June 30—					Annual average, 1894–1898.	
	1894.	1895.	1896.	1897.	1898.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
Cuba	2,127,502,319	1,845,763,398	1,093,171,212	577,790,173	440,225,111	1,216,890,163	31.32
Germany	358,649,535	311,182,968	525,991,657	1,604,233,071	175,275,440	595,066,534	15.32
Dutch East Indies	288,013,620	280,464,270	567,670,780	634,171,629	621,731,462	478,410,352	12.31
Hawaii	326,574,584	274,385,228	352,175,269	431,217,116	499,776,895	376,825,819	9.70
British West Indies	256,821,752	193,498,237	217,421,118	322,103,866	231,401,746	244,249,344	6.29
Brazil	258,447,122	180,262,039	191,457,878	140,773,692	139,426,285	182,073,403	4.69
British Guiana	134,455,359	110,848,960	146,433,256	175,639,179	139,145,529	141,304,457	3.64
Santo Domingo	89,421,821	66,492,169	116,972,841	131,279,582	94,336,444	99,700,572	2.57
Philippine Islands	124,052,343	68,770,492	145,075,344	72,463,577	29,489,600	87,970,271	2.26
Porto Rico	75,546,030	56,352,954	81,582,810	86,607,317	98,452,421	79,708,306	2.05
Belgium	80,479,170	24,338,139	72,721,186	130,423,987	1,366,370	61,865,770	1.59
Egypt	----------	23,250,815	100,335,317	124,055,211	52,354,144	59,999,097	1.54
United Kingdom	58,241,416	40,610,295	56,992,162	68,250,019	21,106,706	49,040,120	1.26
Austria-Hungary	44,536,822	7,411,234	40,703,929	105,138,128	2,788,767	40,115,776	1.03
Netherlands	25,829,548	12,600,203	40,965,863	82,248,064	38,659,827	39,660,824	1.02
France	13,909,622	35,832	34,810,370	92,169,241	17,781	28,188,569	.73
China	21,189,075	23,696,925	31,827,859	11,437,760	7,161,664	19,062,656	.49
Dutch Guiana	12,787,452	8,794,544	12,299,609	18,043,833	25,636,311	15,512,356	.40
British Africa	8,595,345	3,776,030	26,564,115	25,895,469	12,081,142	15,382,418	.40
Danish West Indies	15,558,546	9,131,589	12,202,619	16,999,347	14,832,991	13,745,018	.35
Hongkong	11,203,629	8,351,495	12,046,973	3,243,630	4,183,246	7,805,795	.20
Canada	3,846,249	8,329,961	1,304,887	1,098,330	717,532	3,059,392	.08
Other countries	11,532,522	16,162,679	15,611,403	63,622,921	39,753,407	29,336,586	.76
Total	4,345,193,881	3,574,510,454	3,896,338,557	4,918,905,733	2,689,920,851	3,884,973,895	100.00

Value of sugar imported into the United States from the principal countries of supply during each fiscal year from 1894 to 1898, inclusive.

[From Section of Foreign Markets.]

Countries from which imported.	Years ended June 30—					Annual average, 1894-1898.	
	1894.	1895.	1896.	1897.	1898.		
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per ct.*
Cuba	63,147,745	40,100,204	24,102,835	11,982,473	9,828,607	29,832,373	32.99
Germany	11,198,222	6,332,916	12,528,755	29,844,019	3,520,796	12,684,942	14.03
Hawaii	9,461,857	7,403,658	11,336,796	13,165,084	16,660,412	11,605,562	12.84
Dutch East Indies	7,808,871	5,759,436	11,388,487	13,090,323	11,250,181	9,859,460	10.90
British West Indies	6,890,949	3,989,614	4,700,527	5,893,877	4,552,454	5,205,484	5.76
British Guiana	4,216,414	2,517,726	3,414,368	3,657,025	3,045,666	3,370,240	3.73
Brazil	5,688,714	2,701,287	3,776,486	2,136,989	2,317,990	3,324,293	3.68
Santo Domingo	2,875,810	1,188,951	2,459,302	2,059,169	2,030,239	2,122,694	2.35
Philippine Islands	3,655,627	1,111,006	2,270,902	1,199,202	381,279	1,723,603	1.91
Porto Rico	2,394,051	994,084	1,707,308	1,577,911	1,913,742	1,717,419	1.90
Egypt	----------	596,277	2,657,425	2,616,423	1,230,071	1,420,039	1.57
Belgium	2,357,534	458,779	1,771,980	2,311,309	31,909	1,386,346	1.53
United Kingdom	1,824,072	976,266	1,402,694	1,452,004	504,714	1,231,950	1.36
Netherlands	789,668	296,761	1,182,605	1,916,933	957,908	1,028,775	1.14
Austria-Hungary	1,423,083	178,472	958,402	1,957,027	67,831	916,963	1.01
China	800,218	668,287	920,301	313,803	176,751	575,872	.64
France	428,506	1,412	859,359	1,421,317	480	542,215	.60
Dutch Guiana	426,541	195,589	289,243	380,959	585,326	375,332	.41
Danish West Indies	473,153	205,323	261,728	316,781	312,446	313,888	.35
Hongkong	435,738	236,292	353,610	87,465	107,295	244,080	.27
British Africa	134,514	49,725	461,054	417,850	131,469	238,922	.26
Canada	193,476	289,060	92,692	74,191	32,589	136,402	.15
Other countries	246,906	211,701	322,914	1,194,047	832,594	561,632	.62
Total	126,871,889	76,462,836	89,219,773	99,066,181	60,472,749	90,418,686	100.00

Average price per pound of "Standard A" sugar in the New York market and average consumption of sugar of all grades, per capita of population, in the United States from 1878 to 1898.

[From Bureau of Statistics, Treasury Department.]

Calendar year—	Average price per pound.	Consumption per capita of population.	Calendar year—	Average price per pound.	Consumption per capita of population.
	Cents.	*Pounds.*		*Cents.*	*Pounds.*
1878	8.94	34.3	1889	7.59	51.8
1879	8.53	40.7	1890	6.00	52.8
1880	9.48	42.9	1891	4.47	66.1
1881	9.84	44.2	1892	4.21	63.5
1882	8.87	48.4	1893	4.72	63.9
1883	8.14	51.1	1894	4.00	66.0
1884	6.37	53.4	1895	4.00	62.6
1885	6.06	51.8	1896	4.41	61.6
1886	5.81	56.9	1897	4.38	64.5
1887	5.66	52.7	1898	4.84	61.1
1888	6.69	56.7			

TEA, COFFEE, AND LIQUORS.

Consumption of tea, coffee, wines, distilled spirits, and malt liquors in the United States, per capita of population, 1870 to 1898.

[From Bureau of Statistics, Treasury Department.]

Year ending June 30—	Tea.	Coffee.	Wines.	Distilled spirits.	Malt liquors.
	Pounds.	*Pounds.*	*Gallons.*	*Proof gals.*	*Gallons.*
1870	1.10	6.00	0.32	2.07	5.31
1871	1.14	7.91	.40	1.62	6.10
1872	1.46	7.28	.41	1.68	6.66
1873	1.53	6.87	.45	1.63	7.21
1874	1.27	6.59	.48	1.51	7.00
1875	1.44	7.08	.45	1.50	6.71
1876	1.35	7.33	.45	1.33	6.83
1877	1.23	6.94	.47	1.28	6.58
1878	1.33	6.24	.47	1.09	6.68
1879	1.21	7.42	.50	1.11	7.05
1880	1.39	8.78	.56	1.27	8.26
1881	1.54	8.25	.47	1.38	8.65
1882	1.47	8.30	.49	1.40	10.03
1883	1.30	8.91	.48	1.46	10.27
1884	1.09	9.26	.37	1.48	10.74
1885	1.18	9.60	.39	1.26	10.62
1886	1.37	9.36	.45	1.26	11.20
1887	1.49	8.53	.55	1.21	11.23
1888	1.40	6.81	.61	1.26	12.80
1889	1.29	9.16	.56	1.32	12.72
1890	1.33	7.83	.46	1.40	13.67
1891	1.29	7.99	.45	1.42	15.28
1892	1.37	9.61	.44	1.50	15.10
1893	1.32	8.24	.48	1.51	16.08
1894	1.34	8.01	.31	1.33	15.18
1895	1.38	9.22	.28	1.12	14.95
1896	1.31	8.04	.26	1.00	15.16
1897	1.55	9.95	.53	1.01	14.69
1898	.91	11.45	.28	1.10	15.64

TRANSPORTATION RATES.

Grain in sacks by steamers.

[Rates, in cents, per 100 pounds.]

[Compiled for Bulletin No. 14, Miscellaneous Series, of the Division of Statistics from reports of the St. Louis Merchants' Exchange.]

Year.	From St. Louis, Mo., to—								
	Memphis, Tenn.			Vicksburg, Miss.			New Orleans, La.		
	Highest.	Lowest.	Longest in effect.	Highest.	Lowest.	Longest in effect.	Highest.	Lowest.	Longest in effect.
1877	24	11.9	14.3	33	19	19	33	14	19
1878	50	7.4	7.4	50	10	10	35	10	10
1879	20	10	12.5	35	15	17.5	30	10	12.5
1880	51	12.5	20	30	20	20	25	15	20
1881	22.5	15	15	30	20	30	25	15	22.5
1882	17.5	12.5	12.5	30	20	20	25	20	20
1883	17.5	12.5	17.5	25	20	25	22.5	12.5	20
1884	15	13	15	22.5	20	20	17.5	12.5	12.5
1885	15	15	15	22.5	22.5	22.5	17.5	15	17.5
1886	15	10	10	20	17.5	17.5	17.5	15	17.5
1887	20	10	10	20	17.5	20	20	15	17.5
1888	15	10	10	20	17.5	17.5	17.5	12.5	12.5
1889	17.5	10	11	25	17.5	17.5	20	17.5	17.5
1890	12.5	10	10	17.5	15	17.5	17.5	15	15
1891	20	10	10	25	17.5	17.5	20	15	15
1892	20	10	10	25.5	17.5	17.5	20	15	17.5
1893	12	12	12	17.5	17.5	17.5	17.5	15	17.5
1894	15	12	12	20	17.5	17.5	20	12.5	20
1895	15	10	10	20	12.5	15	20	10	10
1896	12.5	10	10	17.5	15	15	15	10	15
1897	8	8	8	15	15	15	15	15	15
1898	10	10	10	15	15	15	10	10	10

Miscellaneous commodities, New York to Chicago by rail.

AVERAGE RATES FOR LESS THAN CARLOAD QUANTITIES, IN CENTS, PER 100 POUNDS.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Statistics.]

Year.	Furniture.	Agricultural implements.	Lead.	Bagging.	Crockery and earthenware.	Coffee.	Starch.	Sugar.	Molasses.	Rice.	Soap.	
											Castile and fancy.	Common.
1867	137	137	60	117	117	117	117	60	60	60	117	93
1868	122	122	56	103	103	.....	87	.....	.....	56	103	56
1869	99	99	54	92	.....	.....	75	.....	.....	54	92	54
1870	113	113	61	98	.....	.....	78	.....	.....	.....	98	60
1871	81	81	39	71	49	36	58	36	46	46	71	46
1872	105	105	43	93	81	43	72	43	55	51	93	55
1873	69	.....	31	62	31	31	50	31	40	31	62	40
1874	81	.....	37	74	37	37	62	37	49	37	74	49
1875	53	.....	25	48	29	24	40	24	41	25	48	33
1876	39	.....	20	37	20	20	32	20	23	20	37	23
1877	72	.....	33	56	33	33	50	33	40	33	65	40
1878	77	.....	41	41	41	41	41	41	41	41	62	41
1879	75	.....	40	40	40	40	40	40	40	40	60	40
1880	75	.....	40	40	40	40	40	40	40	40	60	40
1881	65	.....	33	33	33	33	33	33	33	33	51	33
1882	56	.....	26	26	26	26	26	24	24	26	44	26
1883	75	.....	35	35	35	35	35	30	30	35	60	35
1884	75	.....	35	35	35	35	35	25	25	35	60	35
1885	56	.....	27	27	27	27	27	20	29	27	45	27
1886	75	.....	35	35	35	35	35	25	25	35	60	35
1887	75	.....	35	46	35	35	35	33	33	35	64	35
1888	73	49	35	49	35	35	35	35	35	35	63	35
1889	75	50	35	50	35	35	35	35	35	35	65	35
1890	75	50	35	50	35	35	35	35	35	35	65	35
1891	75	50	35	50	35	35	35	35	35	35	49	35
1892	75	50	35	50	35	35	35	35	35	35	35	35
1893	75	50	35	50	35	35	35	35	35	35	35	35
1894	75	50	35	50	35	35	35	35	35	35	35	35
1895	75	50	35	50	35	35	35	35	35	35	35	35
1896	75	50	35	50	35	35	35	35	35	35	35	35
1897	75	50	35	50	35	35	35	35	35	35	35	35
1898	75	50	35	50	35	35	35	35	35	35	35	35

AVERAGE RATES FOR CARLOADS, IN CENTS, PER 100 POUNDS.

Year.	Furniture.	Agricultural implements.	Lead.	Bagging.	Crockery and earthenware.	Coffee.	Starch.	Sugar.	Molasses.	Rice.	Soap.	
											Castile and fancy.	Common.
1867	137	137	60	117	117	117	117	60	60	60	117	93
1868	122	122	56	103	103	.....	87	.....	.....	56	103	56
1869	99	99	54	92	.....	.....	75	.....	.....	54	92	54
1870	113	113	61	98	.....	.....	78	.....	.....	.....	98	60
1871	81	81	39	71	49	36	58	36	46	46	71	46
1872	105	105	93	93	81	43	72	43	55	51	93	55
1873	69	54	31	62	31	31	50	31	40	31	62	40
1874	81	49	37	74	37	37	62	37	49	37	74	49
1875	53	33	25	48	29	24	40	24	41	25	48	33
1876	39	23	20	37	20	20	32	20	23	20	37	23
1877	72	39	33	56	33	33	50	33	40	33	65	40
1878	77	41	41	41	41	41	41	41	41	41	62	41
1879	75	40	40	40	40	40	40	40	40	40	60	40
1880	75	40	40	40	40	40	40	40	40	40	60	40
1881	65	33	33	33	33	33	33	33	33	33	51	33
1882	56	26	26	26	26	26	26	24	24	26	44	26
1883	75	36	35	35	35	35	35	30	30	35	60	35
1884	75	36	35	35	35	35	35	25	25	35	60	35
1885	56	25	27	27	27	27	27	20	20	27	45	27
1886	75	35	35	35	35	35	35	25	25	35	60	35
1887	67	31	27	35	31	27	27	25	29	35	64	31
1888	63	30	25	35	30	25	25	25	30	25	63	30
1889	65	30	25	35	30	25	25	25	30	25	65	30
1890	65	30	25	35	30	25	25	25	30	25	65	30
1891	65	30	25	35	30	25	25	25	30	25	44	26
1892	65	30	25	35	30	25	25	24	30	25	25	25
1893	65	30	25	35	30	25	25	24	30	25	25	25
1894	65	30	25	35	30	25	25	24	30	25	25	25
1895	65	30	25	35	30	25	25	24	30	25	25	25
1896	65	30	25	35	30	25	25	24	30	25	25	25
1897	65	30	25	35	30	25	25	24	30	25	25	25
1898	65	30	25	35	30	25	25	24	30	25	25	25

Miscellaneous commodities, New York to Chicago by rail—Continued.

AVERAGE RATES, REGARDLESS OF QUANTITY SHIPPED, IN CENTS, PER 100 POUNDS.

Year.	Dry goods.	Cotton piece goods.	Boots and shoes.	Tea.	Drugs.
1867	137	137	137	137	137
1868	122	122	122	122	122
1869	99	99	99	99	99
1870	113	113	113	113	113
1871	81	81	81	81	81
1872	105	105	105	105	105
1873	69	69	69	69	69
1874	81	81	81	81	81
1875	53	53	53	53	53
1876	39	39	39	39	39
1877	72	72	72	72	72
1878	77	77	77	77	77
1879	75	75	75	75	75
1880	75	75	75	75	75
1881	65	65	65	65	65
1882	56	56	56	56	56
1883	75	75	75	75	75
1884	75	75	75	75	75
1885	56	56	56	56	56
1886	75	66	75	75	75
1887	75	50	75	75	75
1888	73	49	73	73	73
1889	75	50	75	75	75
1890	75	50	75	75	75
1891	75	50	75	75	75
1892	75	50	75	75	75
1893	75	50	75	75	75
1894	75	50	75	75	75
1895	75	50	75	75	75
1896	75	50	75	75	75
1897	75	50	75	75	75
1898	75	50	75	75	75

Live stock and dressed meats, Chicago to New York.

AVERAGE RATES, IN CENTS, PER 100 POUNDS.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Statistics.]

Year.	Cattle.	Hogs.	Sheep.	Horses and mules.	Dressed beef.	Dressed hogs.	
						Refrigerator cars.	Common cars.
1872					81		
1873					83		
1874					85		
1875					72		
1876					62		
1877					72		
1878					79		
1879	47	45	61	60	82		
1880	55	43	65	60	88		
1881	35	31	61	60	56		
1882	36	29	53	60	57		
1883	40	32	50	60	64		
1884	31	28	44	60	51		
1885	31	26	43	60	54		
1886	33	30	42	60	61	53	48
1887	33	32	40	60	62	59	54
1888	22	26	31	60	46	46	44
1889	25	30	30	60	47	47	45
1890	23	28	30	60	39	39	39
1891	27	30	30	60	45	45	45
1892	28	28	30	60	45	45	45
1893	28	20	30	60	45	45	45
1894	28	30	30	60	45	45	45
1895	28	30	30	60	45	45	45
1896	28	30	30	60	45	45	45
1897	28	30	30	60	45	45	45
1898	28	30	30	60	45	45	45

Grain, Chicago to New York.

AVERAGE RATES, IN CENTS, PER BUSHEL.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Statistics.]

Year.	Wheat.				Corn.	
	Via lake and rail.		Via all rail.		Via lake and rail.	Via all rail.
	As reported by New York Produce Exchange.	As reported by Chicago Board of Trade.	As reported by New York Produce Exchange.	As reported by Chicago Board of Trade.	As reported by Chicago Board of Trade.	As reported by Chicago Board of Trade.
1858				38.61		36.19
1859				34.80		32.48
1860				34.80		32.48
1861				41.58		38.81
1862				42.37		39.54
1863				33.88		31.63
1864				29.51		27.55
1865				28.53		26.62
1866				32.79		30.60
1867				32.38		30.22
1868	20.76		30.49	27.09		25.28
1869	18.80	18.80	26.39	26.74	17.71	24.96
1870	19.15	19.58	28.98	26.11	19.32	24.37
1871	22.38	22.76	27.75	28.47	21.24	26.57
1872	24.91	26.25	29.80	31.13	23.67	29.06
1873	23.64	21.63	29.17	27.26	20.19	25.42
1874	15.20	15.37	25.81	23.61	12.48	22.03
1875	12.71	12.09	20.97	20.89	11.34	19.50
1876	10.58	10.19	14.80	15.12	9.68	14.12
1877	15.08	14.75	19.37	19.56	13.42	18.03
1878	11.31	11.99	17.56	17.56	10.45	16.39
1879	13.30	13.13	17.30	17.74	12.20	14.56
1880	15.70	15.80	19.90	19.80	14.43	17.48
1881	10.40	10.49	14.40	14.40	9.42	13.40
1882	10.90	10.91	14.60	14.47	10.28	13.50
1883	11.5	11.63	16.5	16.20	11	15.12
1884	9.55	10	13.12	13.20	8.50	12.32
1885	9.02	9.02	14	13.20	8.01	12.32
1886	12	12	16.50	15	11.20	14
1887	12	12	16.33	15.75	11.20	14.70
1888	11	11.14	14.50	14.50	10.26	13.54
1889	8.70	8.97	15	15	8.19	12.6
1890	8.50	8.52	14.31	14.30	7.32	11.36
1891	8.53	8.57	15	15	7.53	14
1892	7.55	7.59	14.23	13.80	7.21	12.96
1893	8.44	8.48	14.70	14.63	7.97	13.65
1894	7	7	12.88	13.20	6.50	12.32
1895	6.95	6.96	12.17	11.89	6.40	10.29
1896	7.32	6.61	12	12	6.15	10.50
1897	7.37	7.42	12.32	12.50	6.92	11.43
1898		4.91	11.55	12	4.41	9.80

Average freight rates, in cents, per ton per mile.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Statistics.]

Year.	Fitchburg R. R.	Boston and Albany R. R.	New York Central and Hudson River R. R.	Erie R. R.	Lake Shore and Michigan Southern Rwy.	Pennsylvania R. R.	Pittsburg, Fort Wayne and Chicago Rwy.	Chesapeake and Ohio Rwy.	Illinois Central R. R.	Chicago, Rock Island and Pacific Rwy.	Chicago, Milwaukee and St. Paul Rwy.	Chicago and Alton R. R.	Union Pacific Rwy.	Louisville and Nashville R. R.	All railways in the United States.
1867	3.023	2.201	1.986	1.465	1.745	1.497	1.403	3.753	2.085	2.185	2.834	2.055	.....	3.006	1.925
1868	2.905	1.999	1.951	1.287	1.661	1.322	1.211	3.179	1.751	2.385	2.528	2.101	.....	2.949	1.810
1869	3.242	1.798	1.763	1.157	1.266	1.229	1.198	3.752	1.840	2.202	2.298	1.856	.....	2.456	1.769
1870	3.635	1.851	1.590	1.125	1.269	1.268	1.229	4.101	1.955	2.316	2.380	1.937	3.596	2.514	1.859
1871	.....	1.869	1.457	1.282	1.244	1.211	1.276	4.445	2.077	2.369	2.289	1.968	2.419	2.298	1.780
1872	3.501	1.800	1.422	1.362	1.227	1.304	1.264	3.643	1.923	2.229	2.177	1.789	2.390	2.055	1.846
1873	3.289	1.707	1.371	1.267	1.164	1.258	1.220	1.909	1.916	2.062	2.173	1.864	2.156	1.926	1.613
1874	3.903	1.641	1.319	1.184	1.065	1.164	1.134	1.354	1.881	1.871	2.137	1.916	1.949	1.946	1.520
1875	3.624	1.346	1.119	1.061	.887	.989	.970	1.299	1.692	1.688	1.823	1.649	2.164	1.687	1.421
1876	2.218	1.139	.929	.972	.722	.841	.827	1.061	1.587	1.693	1.798	1.438	2.211	1.638	1.217
1877	1.955	1.136	.954	.898	.813	.954	1.024	1.035	1.719	1.563	1.949	1.361	2.135	1.382	1.286
1878	1.582	1.113	.919	.960	.724	.914	.867	.985	1.616	1.539	1.762	1.354	2.236	1.635	1.296
1879	1.299	1.100	.793	.779	.641	.823	.754	.869	1.523	1.429	1.704	1.054	1.991	1.528	1.153
1880	1.36	1.207	.879	.836	.750	.918	.....	.866	1.543	1.209	1.749	1.206	.....	1.594	1.252
1881	1.26	1.038	.783	.805	.617	.857	.745	.892	1.522	1.220	1.702	1.241	2.178	1.566	1.188
1882	1.17	1.064	.738	.749	.628	.874	.752	.753	1.417	1.281	1.481	1.253	2.102	1.349	1.102
1883	1.19	1.197	.915	.786	.728	.881	.787	.722	1.433	1.170	1.391	1.128	1.913	1.326	1.205
1884	1.09	1.093	.831	.719	.652	.804	.673	.672	1.368	1.097	1.293	1.008	1.557	1.344	1.136
1885	1.06	.944	.688	.656	.553	.695	.577	.550	1.307	1.043	1.278	1.009	1.420	1.158	1.011
1886	1.07	1.101	.765	.659	.639	.755	.692	.541	1.157	1.071	1.168	.961	1.266	1.079	.999
1887	1.13	1.107	.782	.687	.670	.730	.717	.537	1.087	1.012	1.089	.946	1.213	1.075	.984
1888	1.116	1.099	.753	.716	.861	.723	.660	.541	1.068	.964	1.020	.973	1.170	1.049	1.001
1889	1.015	1.030	.712	.644	.632	.685	.69	.538	.839	.971	1.057	.525	1.166	.998	.922
1890	.995	1.105	.730	.665	.644	.661	.69	.561	.942	.995	.995	.898	1.138	.972	.941
1891	.991	1.089	.740	.636	.630	.656	.70	.525	.934	1.039	1.063	.980	1.131	.968	.895
1892	.925	1.057	.699	.614	.602	.647	.67	.518	.908	1.055	1.026	.973	1.080	.948	.898
1893	.923	1.006	.701	.631	.599	.620	.68	.511	.845	1.039	1.026	.949	1.036	.917	.878
1894	.895	.944	.733	.621	.587	.606	.65	.478	.839	.989	1.037	.974	.970	.876	.830
1895	.878	.969	.726	.604	.567	.565	.64	.425	.808	1.084	1.075	.994	.971	.884	.839
1896	.864	.942	.668	.606	.551	.563	.66	.425	.745	1.017	1.005	.925	.957	.866	.803
1897	.870	.918	.679	.610	.538	.561	.69	.419	.671	.958	1.008	.891	.932	.791	.798

Average rates, in cents, per passenger per mile.

[From Bulletin No. 14, Miscellaneous Series, of the Division of Stat.stics.]

Year.	Fitchburg R. R.	Boston and Albany R. R.	New York Central and Hudson River R. R.	Erie R. R.	Lake Shore and Michigan Southern Rwy.	Pennsylvania R. R.	Pittsburg, Fort Wayne and Chicago Rwy.	Chesapeake and Ohio Rwy.	Illinois Central R. R.	Chicago, Rock Island and Pacific Rwy.	Chicago, Milwaukee and St. Paul Rwy.	Chicago and Alton R. R.	Union Pacific Rwy.	Louisville and Nashville R. R.	All railways in the United States.
1867	1.603	1.955	.....	1.641	.....	2.074	2.129	.....	2.798	3.132	.....	.....	.....	2.733	1.994
1868	.....	1.940	.....	2.021	.....	1.926	2.017	.....	2.791	2.982	.....	.....	.....	2.845	2.164
1869	1.696	1.974	.....	2.324	.....	1.872	1.970	.....	2.914	3.047	2.897	.....	.....	2.894	2.144
1870	1.945	2.343	1.770	2.470	2.204	2.167	2.282	3.979	3.290	3.426	3.273	.....	4.301	3.194	2.392
1871	2.010	2.517	1.920	2.396	2.503	2.322	.....	4.037	3.358	3.435	3.322	.....	3.775	3.340	2.632
1872	1.923	2.275	1.863	1.904	2.321	2.379	.....	3.992	3.034	3.229	3.404	.....	3.730	3.240	2.521
1873	1.820	2.176	1.799	1.927	2.221	2.317	.....	3.686	3.095	3.131	3.099	.....	3.544	3.102	2.486
1874	1.984	2.229	1.929	2.088	2.214	2.349	2.301	3.542	2.966	3.063	2.935	2.949	3.394	3.412	2.544
1875	1.910	2.180	1.885	1.955	2.088	2.259	2.107	3.231	2.882	2.687	2.690	2.755	2.878	3.219	2.378
1876	1.864	2.099	1.693	1.859	1.846	1.819	1.830	3.322	2.804	2.626	2.805	2.614	2.974	3.018	2.183
1877	1.947	2.174	1.953	1.772	2.182	2.185	2.192	3.786	2.942	2.772	2.994	2.798	3.140	3.167	2.458
1878	1.969	2.217	1.978	2.158	2.255	2.277	2.258	3.738	3.122	2.933	3.029	2.795	3.226	3.345	2.573
1879	1.888	2.137	2.044	2.090	2.221	2.253	2.228	3.630	3.066	2.971	2.908	2.417	.....	3.444	2.484
1880	1.885	2.096	1.996	2.041	2.135	2.222	2.156	2.959	2.514	2.806	2.868	2.076	.....	3.476	2.442
1881	1.820	1.970	1.862	2.016	1.988	2.152	1.895	2.989	2.164	2.666	2.856	1.828	3.341	3.168	2.446
1882	1.715	1.993	1.808	1.948	2.156	2.249	2.024	2.605	2.388	2.505	2.579	1.951	3.300	2.706	2.391
1883	1.790	2.088	1.986	1.673	2.196	2.297	2.193	2.373	2.424	2.504	2.516	2.141	3.128	2.614	2.402
1884	1.651	1.908	1.942	2.189	2.170	2.258	2.222	2.379	2.225	2.572	2.553	1.900	2.952	2.342	2.323
1885	1.843	1.838	1.419	1.756	2.058	1.950	1.569	2.270	2.211	2.466	2.563	2.026	2.749	2.103	2.216
1886	1.756	1.853	1.845	1.890	2.098	2.114	2.130	2.131	2.208	2.420	2.415	2.023	2.135	2.436	2.142
1887	1.89	1.880	1.989	2.039	2.260	2.125	2.255	2.074	2.268	2.328	2.538	2.062	2.301	2.394	2.245
1888	1.978	1.976	1.967	1.851	2.280	2.111	2.10	2.025	2.197	2.312	2.445	2.123	2.248	2.429	2.349
1889	1.957	1.869	1.932	1.722	2.286	2.076	2.18	1.709	1.927	2.285	2.415	2.128	2.135	2.370	2.165
1890	1.915	1.858	1.910	1.584	2.254	2.094	2.25	2.056	2.022	2.149	2.359	2.004	2.045	2.403	2.167
1891	1.869	1.818	1.905	1.601	2.105	2.070	2.23	2.155	2.073	2.322	2.408	2.205	2.059	2.483	2.142
1892	1.916	1.828	1.887	1.589	2.183	2.028	2.00	2.181	2.101	2.308	2.464	2.043	2.104	2.448	2.126
1893	1.869	1.835	1.882	1.551	2.195	1.968	1.98	1.989	1.999	2.095	2.414	1.981	1.987	2.432	2.108
1894	1.851	1.794	1.857	1.509	2.069	1.993	2.00	1.905	1.925	1.891	2.191	1.776	1.758	2.365	1.986
1895	1.819	1.770	1.837	1.560	2.215	1.971	2.06	1.980	1.995	2.146	2.411	2.119	1.962	2.318	2.040
1896	1.769	1.752	1.838	1.641	2.148	1.950	1.88	1.952	1.979	2.108	2.375	2.117	2.075	2.187	2.019
1897	1.811	1.754	1.842	1.543	2.108	1.958	2.02	1.980	1.979	2.155	2.289	2.116	2.101	2.254	2.022

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