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THE BUREAU OF ENTOMOLOGY

ITS HISTORY, ACTIVITIES AND ORGANIZATION

BY

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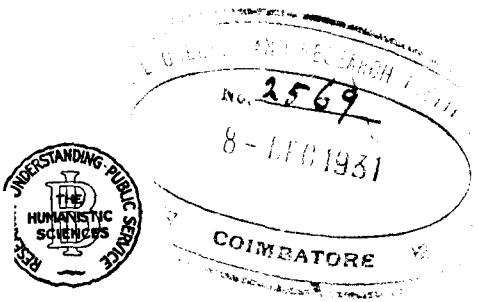

THE BROOKINGS INSTITUTION
WASHINGTON
1930

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THE BROOKINGS INSTITUTION

The Brookings Institution—Devoted to Public Service through Research and Training in the Humanistic Sciences—was incorporated on December 8, 1927. Broadly stated, the Institution has two primary purposes: the first is to aid constructively in the development of sound national policies; and the second is to offer training of a super-graduate character to students of the social sciences. The Institution will maintain a series of coöperating institutes, equipped to carry out comprehensive and inter-related research projects.

The responsibility for the final determination of the Institution's policies and for the administration of its endowment is vested in a self-perpetuating Board of Trustees. The Trustees have, however, defined their position with reference to the scientific work of the Institution in a by-law provision reading as follows: "The primary function of the Trustees is not to express their views upon the scientific investigations conducted by any division of the Institution, but only to make it possible for such scientific work to be done under the most favorable auspices." Major responsibility for "formulating general policies and coördinating the activities of the various divisions of the Institution" is vested in the President. The by-laws provide also that "there shall be an Advisory Council selected by the President from among the scientific staff of the Institution and representing the different divisions of the Institution."

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FOREWORD

The first essential to efficient administration of any enterprise is full knowledge of its present make-up and operation. Without full and complete information before them, as to existing organization, personnel, plant, and methods of operation and control, neither legislators nor administrators can properly perform their functions.

The greater the work, the more varied the activities engaged in, and the more complex the organization employed, the more imperative becomes the necessity that this information shall be available—and available in such a form that it can readily be utilized.

Of all undertakings, none in the United States, and few, if any, in the world, approach in magnitude, complexity, and importance that of the national government of the United States. As President Taft expressed it in his message to Congress of January 17, 1912, in referring to the inquiry being made under his direction into the efficiency and economy of the methods of prosecuting public business, the activities of the national government " are almost as varied as those of the entire business world. The operations of the government affect the interest of every person living within the jurisdiction of the United States. Its organization embraces stations and centers of work located in every city and in many local subdivisions of the country. Its gross expenditures amount to billions annually. Including the personnel of the military and naval establishments, more than half a million persons are required to do the work imposed by law upon the executive branch of the government.

" This vast organization has never been studied in detail as one piece of administrative mechanism. Never have the foundations been laid for a thorough consideration of the relations of all of its parts. No comprehensive effort has been made to list

its multifarious activities or to group them in such a way as to present a clear picture of what the government is doing. Never has a complete description been given of the agencies through which these activities are performed. At no time has the attempt been made to study all of these activities and agencies with a view to the assignment of each activity to the agency best fitted for its performance, to the avoidance of duplication of plant and work, to the integration of all administrative agencies of the government, so far as may be practicable, into a unified organization for the most effective and economical dispatch of public business."

To lay the basis for such a comprehensive study of the organization and operations of the national government as President Taft outlined, the Institute for Government Research has undertaken the preparation of a series of monographs, of which the present study is one, giving a detailed description of each of the distinct services of the government. These studies are being vigorously prosecuted, and it is hoped that all services of the government will be covered in a comparatively brief space of time. Thereafter, revisions of the monographs will be made from time to time as need arises, to the end that they may, as far as practicable, represent current conditions.

These monographs are all prepared according to a uniform plan. They give: first, the history of the establishment and development of the service; second, its functions, described not in general terms, but by detailing its specific activities; third, its organization for the handling of these activities; fourth, the character of its plant; fifth, a compilation of, or reference to, the laws and regulations governing its operations; sixth, financial statements showing its appropriations, expenditures and other data for a period of years; and finally, a full bibliography of the sources of information, official and private, bearing on the service and its operations.

In the preparation of these monographs the Institute has kept steadily in mind the aim to produce documents that will be of direct value and assistance in the administration of public

affairs. To executive officials they offer valuable tools of administration. Through them, such officers can, with a minimum of effort, inform themselves regarding the details, not only of their own services, but of others with whose facilities, activities, and methods it is desirable that they should be familiar. Under present conditions services frequently engage in activities in ignorance of the fact that the work projected has already been done, or is in process of execution by other services. Many cases exist where one service could make effective use of the organization, plant or results of other services had they knowledge that such facilities were in existence. With the constant shifting of directing personnel that takes place in the administrative branch of the national government, the existence of means by which incoming officials may thus readily secure information regarding their own and other services is a matter of great importance.

To members of Congress the monograph should prove of no less value. At present these officials are called upon to legislate and appropriate money for services concerning whose needs and real problems they can secure but imperfect information. That the possession by each member of a set of monographs such as is here projected, prepared according to a uniform plan, will be a great aid to intelligent legislation and appropriation of funds can hardly be questioned.

To the public, finally, these monographs will give that knowledge of the organization and operations of their government which must be had if an enlightened public opinion is to be brought to bear upon the conduct of governmental affairs.

These studies are wholly descriptive in character. No attempt is made in them to subject the conditions described to criticism, nor to indicate features in respect to which changes might with advantage be made. Upon administrators themselves falls responsibility for making or proposing changes which will result in the improvement of methods of administration. The primary aim of outside agencies should be to emphasize this responsibility and facilitate its fulfillment.

While the monographs thus make no direct recommendations for improvement, they cannot fail greatly to stimulate efforts in that direction. Prepared as they are according to a uniform plan, and setting forth as they do the activities, plant, organization, personnel and laws governing the several services of the government, they will automatically, as it were, reveal, for example, the extent to which work in the same field is being performed by different services, and thus furnish the information that is essential to a consideration of the great question of the better distribution and coördination of activities among the several departments, establishments, and bureaus, and the elimination of duplication of plant, organization and work. Through them it will also be possible to subject any particular feature of the administrative work of the government to exhaustive study, to determine, for example, what facilities, in the way of laboratories and other plant and equipment, exist for the prosecution of any line of work and where those facilities are located; or what work is being done in any field of administration or research, such as the promotion, protection and regulations of the maritime interests of the country, the planning and execution of works of an engineering character, or the collection, compilation and publication of statistical data, or what differences of practice prevail in respect to organization, classification, appointment, and promotion of personnel.

To recapitulate, the monographs will serve the double purpose of furnishing an essential tool for efficient legislation, administration and popular control, and of laying the basis for critical and constructive work on the part of those upon whom responsibility for such work primarily rests.

CONTENTS

THE BUREAU OF ENTOMOLOGY

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CHAPTER I

HISTORY

The Bureau of Entomology is one of the scientific branches of the Department of Agriculture. Its function is to conduct research studies of insects in their economic relation to agriculture and forestry, agricultural products, and the home, and their primary bearing on the health of man and animals. The Bureau experiments with the introduction of beneficial insects, it develops and conducts experiments with insecticides and insecticide machinery, and it identifies insects sent in by inquirers.

While entomological work had been carried on to some extent in the Agricultural Division of the Patent Office, it was not until the creation of the Department of Agriculture under the act of May 15, 1862 (12 Stat. L., 387), that specific provision was made for an Entomologist. The next year the Entomologist was given an assistant and in 1878 the service became a definite Division. This Division was advanced to the rank of a Bureau on July 1, 1904. Prior to July 1, 1928, the Bureau of Entomology had certain regulatory functions. These with the exception of the enforcement of the Honeybee Importation Act of August 31, 1922, were transferred to the Plant Quarantine and Control Administration on that date.

Early Entomological Studies in the United States. Before the extensive development of agriculture in the United States farmers were not seriously troubled with insect pests. There was little occasion to import foreign plants, hence no new de-

structive insects were introduced. The native insects were mainly confined to the indigenous vegetation of the country, and they did not materially attack cultivated crops. According to Dr. L. O. Howard,[1] after the War of the Revolution, damage was done to orchards by *Carpocapsa pomonella,* to small-grain crops by *Cecidomyia destructor,* to stored grains by the angoumois grain moth (*Sitotroga cerealella*), all of which were introduced from abroad, and by *Blissus leucopterus,* a native insect which attacked the small-grain crops. As commercial relations with foreign countries grew and became world-wide, increased numbers of insect pests were brought into the country from abroad. As these pests attracted more and more attention through their ravages, entomologists began to devote more of their attention to the practical problem of insect control, and thus the science of economic entomology came into being in this country.

The earliest official investigations in the field of economic entomology were carried on by individuals under state auspices. In 1841 Dr. Thaddeus W. Harris prepared a report on " Insects injurious to vegetation," under a resolution of the legislature of Massachusetts. This work concerned itself largely with the classification and habits of insects and contained such remedial suggestions as would occur to an experienced farmer.

In 1853 Dr. Asa Fitch was appointed by the state of New York to investigate injurious insects. In 1856 he presented to the legislature his first of a series of fourteen annual reports on " the noxious, beneficial, and other insects in the State of New York." These reports mark the beginning of official entomological work.

Other early official state work in this field was begun in Illinois in 1867 by Benjamin D. Walsh, who was succeeded in turn, by Dr. William Le Baron and by the Rev. Cyrus Thomas. In 1868 Charles V. Riley was appointed State Entomologist of Missouri, and the result of his labors appeared in

[1] Howard. The historical development and present organization of applied entomology in the United States (1927).

nine published reports. This work of Riley's is regarded as having opened a new era in the practical application of entomology.

Entomological Work in the Patent Office. Entomology was considered in connection with agricultural research by the national government from the very beginning. It appears from a statement in the annual report of the Commissioner of Patents for 1862 that about twenty years before, or about 1842, a suggestion was made by Judge Buell of New York for the establishment of "a great national department of agriculture," one of the objects of which was to be "establishing a professorship of botany and entomology."

Before the employment of an entomologist by the Patent Office in 1854, occasional articles on entomological subjects appeared in the annual reports of the Commissioner of Patents. Most of these articles were prepared by Townend Glover, who later became the first entomologist of the Department of Agriculture. Thus, the annual report for 1849 contained discussions of insects affecting grains, peas, and beans; that for 1852 a discussion of the cotton caterpillar, rust and rot; that for 1854 discussions of insects injurious to vegetation and of insects beneficial to agriculture, such as bees, and silk-worms; and the reports for 1854 and 1855 contain discussions of insects affecting the cotton plant and insects frequenting orange trees.

The appointment, on June 14, 1854, of Mr. Glover by the Patent Office as "Expert for collecting statistics and other information on seeds, fruits, and insects in the United States," marked the beginning of continuous work in the field of entomology by the Patent Office. In the beginning, Mr. Glover made special studies of insects frequenting the cotton plant and the diseases affecting it in Mississippi and Tennessee, and of insects which infested the orange groves and cotton fields in Florida. The results of his studies of the citrus insects were published in the annual report for 1858. Other studies concerning insects injurious to vegetation and their control continued to occupy the attention of the entomologist, and reports and

articles on entomological subjects regularly appeared in the annual reports of the Patent Office. Mr. Glover severed his connection with the Patent Office early in 1859, his final report being published in the annual report for 1858. No attempt was made to fill his position in the Patent Office, but occasional articles by outside entomologists were published in the annual reports.

The entomological work of the Patent Office, together with other agricultural work, was transferred to the Department of Agriculture upon its creation in 1862.

Entomological Work in the Department of Agriculture. The act establishing the Department of Agriculture declared its purpose to be "to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word, and to procure, propagate and distribute among the people new and valuable seeds and plants." The chief executive officer was the Commissioner of Agriculture, who was authorized to "employ other persons for such time as their services may be needed, including chemists, botanists, entomologists, and other persons, skilled in the natural sciences pertaining to agriculture."

Administration. Upon the organization of the Department, the Commissioner of Agriculture appointed Mr. Glover to the position of Entomologist. Referring to this appointment, the Commissioner said in his annual report for 1863:

> Entomology being one of the subjects mentioned in the act establishing this department, and the destruction of fruit and other crops by insects having now become so serious, I determined to make it an important branch of the department, and have employed a gentleman well known throughout the country as a skillful practical entomologist, who has been paying special attention to the best modes of extirpating insects injurious to vegetation. Through him, I have made arrangements to place on exhibition, in the department, his large collection of insects, accompanied with drawings and descriptions; also his valuable collection of *facsimiles* of all the fruits of the country, together with his complete herbarium.

The entomological work at this time was carried on under a general provision in the first agricultural appropriation act, February 25, 1863 (12 Stat. L., 691), "for promoting agricultural and rural economy." Specific provision for the salary of the Entomologist was made for the first time in the appropriation act of March 2, 1867 (14 Stat. L., 440, 451), which included an entomologist among other specified employees. Shortly after his appointment a clerk was assigned to assist Mr. Glover.

The same act appropriated $10,000 "for the purchase of the Glover Museum." This consisted of a private collection of insects, birds and models of fruits, which had been made by Mr. Glover, during many years previous to his employment by the government. The purchase was made in 1867, and Mr. Glover was entrusted with the curatorship of the museum in addition to his other duties. He at once took steps to arrange and to amplify the collection, devoting most of his time to this work during the first year. This collection formed the nucleus for the "agricultural and economic museum or cabinet, illustrating . . . in the most practical way, the relations existing between the farmers' insect enemies and his feathered friends." The capacity of the museum was extended in 1873 by the addition of a room for an exhibition of economic entomology, adapted to the rapidly increasing collection of beneficial and injurious insects, and arranged to illustrate some of the most injurious species preying upon each product, in their different stages. It also exhibited the architecture of insects, their cases, nests, galls, cocoons, and specimens showing how animal and vegetable substances are injured, eaten, or otherwise destroyed by insects. The collection remained in the custody of the Division of Entomology until 1878, when it was transferred to the Smithsonian Institution.

In 1865 Mr. Glover was sent to Paris to represent the Department of Agriculture at an entomological convention and to visit an exposition of insects useful or injurious to the crops, which was held under the patronage of the Minister of Agriculture of France. On this occasion he received a gold medal

for his work in entomology, which was adjudged by the jury "to be original in its style and character and deserving to be copied by the entomologists of France as a desideratum in the application of the science to agriculture."

The entomological work during the latter part of the sixties consisted of studies concerning the caterpillar or cotton army-worm, the elm-tree beetle, the Western potato beetle, the Western grasshopper, and a number of other insects which were most numerous or destructive or which had theretofore escaped observation. The investigations covered the habits of these insects in respect to their food, transformations, etc., and the best remedies to be used for the destruction of those which were injurious. The annual reports contained the results of these studies and other educational articles. An increasing interest on the part of agriculturists was manifested during this period by the receipt of many inquiries and specimens of insects for identification. When new insects were received which had not been described, they were figured by the Entomologist and plates were made of them and published with as much of their natural history, habits, etc., as was known.

Appropriation "for entomological works of reference" was first made in the act of May 8, 1872 (17 Stat. L., 61, 78). This item of appropriation was repeated for a long series of years.

In 1874, 1875, and 1876 there were enormous flights of locusts (*Melanoplus spretus*) from Montana and the Dakotas down over the cultivated regions of Colorado, Kansas, Nebraska, and Missouri, said to be the greatest outbreak of migratory locusts in the history of the country. An act of March 3, 1877 (19 Stat. L., 344, 357), made provision for the salaries and expenses of "a Commission of three skilled entomologists, to be appointed by the Secretary of the Interior, to report upon the depredations of the Rocky Mountain locusts in the Western States and Territories and the best practical methods of preventing their recurrence, or guarding against their invasions, who may be attached to the United States Geological and Geographical Surveys of the Territories." This act carried an

appropriation of $18,000. Five subsequent acts carried annual appropriations ranging from $5,000 to $25,000 for the expenses of the Commission. The members of the Entomological Commission were Charles V. Riley, then State Entomologist of Missouri, A. S. Packard, an entomologist, and Cyrus Thomas, State Entomologist of Illinois.

In 1880 the Commission was placed under the Department of Agriculture, as the result of an appropriation act of June 16, 1880 (21 Stat. L., 259, 276), which provided "That after the close of the next fiscal year all work of the character herein provided for shall be exclusively under the control of the Agricultural Department, and all operations under the Interior Department shall be fully and finally closed before the thirtieth day of June, eighteen hundred and eighty-one." An act of March 3, 1881 (21 Stat. L., 381, 383), provided that "the report of the said commission, and an itemized statement of their expenditures, shall be made to the Commissioner of Agriculture."

The Entomological Commission issued five reports, the first and second while in the Interior Department, and the remaining three while in the Department of Agriculture. The first report, for the year 1877, related to the Rocky Mountain locust and the best methods of preventing its injuries and of guarding against its invasions," and the second report, for the years 1878 and 1879, issued April 4, 1881, related to "the Rocky Mountain locust and the Western cricket," and treated of the best means of subduing the locust in its permanent breeding ground. The third report, dated July 31, 1882, the first issued under the Department of Agriculture, related chiefly to "the Rocky Mountain locust, the Western cricket, the armyworm, canker worm, and the Hessian fly"; the fourth report, dated March 15, 1884, dealt with the cotton worm, and contained a chapter on the boll worm (not related in any way to the cotton-boll weevil); and the fifth report, dated January 2, 1888, dealt with insects injurious to forest and shade trees. The Commis-

sion also issued separates from these reports, and seven bulletins and twelve circulars while in the Interior Department.

Until 1878 the entomological work of the Department of Agriculture was carried on under the general provision made for that Department, except that carried on under the specific appropriations mentioned above. The appropriation act of June 19, 1878 (20 Stat. L., 178, 204), for the first time made specific provision for general entomological work in an item "for investigating the history and habits of insects injurious to agriculture; for experiments in ascertaining the best means of destroying them; for chemicals, traveling expenses, and other expenses in the practical work of the entomological division." From that time on, specific provision has been made each year for entomological work. The above-mentioned act made an additional appropriation "for the special purpose of investigating the history and habits of insects injurious to the cotton plant."

In June, 1878, Townend Glover was superseded as Entomologist of the Department of Agriculture by Charles V. Riley, then State Entomologist of Missouri. During Mr. Glover's incumbency, from 1863 to 1878, he issued seventeen reports on economic entomological subjects, but he did little in the nature of field or experimental work.

In April, 1879, Mr. Riley resigned and was superseded on May 1 by Professor J. Henry Comstock, then assistant professor in charge of entomology at Cornell University, who had been investigating cotton insects as a temporary field agent under Mr. Riley. Professor Comstock remained in office until March, 1881, when he resigned to resume his college work, and Mr. Riley was reappointed. During his term as Entomologist, Professor Comstock published an elaborate report on insects affecting cotton, for which a special appropriation had been made, and two annual reports, that for 1880 containing an exhaustive treatise on the scale insects (*Coccidae*) of the United States.

Mr. Riley remained in office until June, 1894. At the time of his reappointment in 1881, the Entomological Division had

a staff of four men trained in entomological work, and the total annual appropriation for this service was $2000 for the salary of the Entomologist and $5000 for entomological work. The work comprised an investigation of insects injurious to orange trees which lasted several years and disclosed that the chief enemies of citrus fruits were scale insects or bark lice; broadening of this investigation to include a study of all scale insects affecting cultivated plants and especially fruit trees, which was continued for a number of years; a study of insects injuriously affecting the chief staples, such as corn, wheat, rice, sugar corn, and vegetables; a study of the cranberry insects; raising different varieties of silk-worms with a view to experimenting in silk culture, and issuing of a manual of instruction for silk production; rearing to the perfect stage new or little-known injurious insects for the purpose of gaining a knowledge of their habits and transformations in order to facilitate the discovery of remedies; and conducting extended correspondence relative to noxious insects. Whenever information was received of any insect irruption of particular interest, an assistant was sent to the spot to make observations, or a local observer was employed.

In 1881 Mr. Riley began the preparation of a series of special bulletins, written in popular style and amply illustrated, on the most widespread and important injurious insects. These were intended to replace much of the correspondence by rendering unnecessary constant repetition by individual letters. The Division gave special attention to the warning of farmers, by means of its publications, of visitations of the armyworm and the cotton worm.

With the organization of the experiment stations in 1888, official entomological work was greatly broadened in the United States. An act of March 2, 1887 (24 Stat. L., 440), known as the " Hatch Act," provided for the establishment in each state of an agricultural experiment station.[2] Many of these stations

[2] See Institute for Government Research, The Office of Experiment Stations (1924). Service Monograph 32.

operated in close connection with the state agricultural colleges organized under the Morrill Act of July 2, 1862. These stations undertook entomological investigations among other lines of scientific work in agriculture.

Another important factor in the expansion of applied entomological work in the United States was the founding, in August, 1889, of the Association of Economic Entomologists. This organization, which has grown to over eight hundred members, has been greatly instrumental in bringing together economic entomologists from all parts of the country, and even from foreign countries, for consultation and for coöperative work. Annual meetings of the Association are held at different points of the country, the discussions and papers being published, together with other articles on entomology, in a bi-monthly publication, entitled the "Journal of Economic Entomology," established in 1908. The Association has organized several geographic divisions, such as the Pacific Slope Division, the Rocky Mountain Division, the Northern States Division, the Central States Division, and tthe Cotton States Division, each of which holds annual meetings. It also has committees which consult upon questions of general policy and upon many other points which need the harmonizing decisions of a central unified body. The Association has aided in securing legislation for the study, control, and quarantine of injurious insects.

By an act of February 9, 1889, the Department of Agriculture was elevated to the status of an executive department under the supervision of a Secretary of Agriculture. This change of departmental status, however, had no immediate effects upon the work or status of the Division of Entomology, its title and functions remaining the same as before.

The facilities for investigation of the Division of Entomology were greatly extended by the installation, in 1891, of a new insectary, which was fitted up with the most approved arrangements for the study of insects in the way of breeding cages and jars, and the development of new apparatus.

In 1894, Mr. Riley submitted his resignation as Entomologist to take effect June 1 of that year. He had held the position for sixteen years. During his incumbency of the office the work accomplished by the Division was of the highest order and was largely instrumental in placing the science of applied entomology in the United States upon a sound basis. He published twelve annual reports, thirty-one bulletins, two special reports, six volumes of a periodical bulletin, "Insect Life," and a large number of circulars of information. He developed both the scientific and the practical side of entomology, and brought about advances in insecticides and insecticidal machinery which were of far-reaching importance. At that time the Division had grown to nine entomological workers. The annual appropriations, however, rarely exceeded $30,000 during this period.

Mr. Riley was succeeded by Dr. Leland O. Howard who had been his chief assistant since 1880. At the beginning of Dr. Howard's régime a reorganization was effected in the Division of Entomology by which the entire force of regular field agents was dispensed with, and a policy was adopted whereby field workers were employed for specific purposes only for limited periods. This arrangment, however, was afterwards modified.

After the death of Professor Riley, which occurred on September 14, 1895, Dr. Howard was appointed honorary curator of insects of the National Museum, a position which he still occupies. This has kept that institution in close relation with the entomological work in the Department of Agriculture.

Beginning July 1, 1904, the entomological service of the Department of Agriculture was advanced to Bureau status (33 Stat. L., 276, 289). The appropriations increased steadily from this time on and at times large sums were appropriated for emergency work in connection with the Mexican cotton-boll weevil, the gipsy and brown-tail moths, etc.

On April 26, 1910 (36 Stat. L., 331), a law was enacted prohibiting the shipment in interstate commerce for sale of any insecticide or fungicide which is adulterated or misbranded in

any way, and its enforcement was entrusted to an Insecticide and Fungicide Board,[3] of which a representative of the Bureau of Entomology was a member *ex officio*, until its abolition on June 30, 1927.

Two years later another important administrative body of independent status, *i. e.*, reporting directly to the Secretary of Agriculture, was established in the Department, on which the Bureau was represented. This was the Federal Horticultural Board, provided for by Congress for the administration of the Plant Quarantine Act of August 20, 1912. Under the terms of this act, the Board was to consist of members of the Bureau of Entomology, the Bureau of Plant Industry, and the Forest Service. The chairman of the Board during the entire period of its existence (1912 to 1928) was Dr. Charles L. Marlatt, Associate Chief of the Bureau of Entomology. On July 1, 1928, under a reorganization of the plant quarantine work of the Department, the function of this Board was replaced by the creation of a new office for the administration of all plant quarantine and regulatory work of the Department, namely, the Plant Quarantine and Control Administration. Under this reorganization Dr. Marlatt continued as Chief of the new office until December, 1929. The Bureau however continued to be represented on a plant quarantine board, which was retained as an advisory body but without administrative functions. The important relationship of the Bureau to the plant quarantine and control work conducted by the Federal Horticultural Board and the Plant Quarantine and Control Administration which succeeded it is briefly discussed in a paragraph under the title, " Plant Quarantine and Inspection."

On October 17, 1927, Dr. Howard retired from the office of Chief of the Bureau of Entomology and was succeeded by Dr. Marlatt, a member of the entomological staff of the Department since 1888, and Associate Chief since 1922.

[3] Created by the Secretary of Agriculture, December 22, 1910 (General Order 143). This order named four individuals representing, respectively, the Bureaus of Animal Industry, Plant Industry, Entomology and Chemistry.

During the thirty-three years that Dr. Howard occupied the office of Entomologist there was an enormous expansion of the entomological work of the national government. Many things have contributed to this growth. According to Dr. Howard:[4]

The rapid growth of agriculture in the United States, the planting of enormous areas in a single crop, the desire to get the largest results in the easiest way, have all contributed to an extraordinary increase of injurious insects. Agriculture conducted by the methods largely used in this country down to a comparatively recent date has been planned without regard to the increase of insect damage, and thus opportunities for unprecedented increase have been offered to injurious species, and they have taken advantage of it. Moreover, down to 1912 the country was virtually unprotected from the entrance of insect pests from other countries. Plants and plant products liable to carry pests new to this country were allowed entrance, without examination, at all ports, and their arrival in sound condition was facilitated by the rapidly increasing speed of sea traffic.

The importance of economic entomology was driven home to the public in a most striking way during the decade beginning with 1890; first, by the advent of the cotton-boll weevil from Mexico about 1892; next, by the appearance of the San José scale in eastern orchards about the same time; third, by the ravages made in New England by the gipsy moth and the brown-tail moth; fourth, by the discovery in the late nineties of the transmission of malaria and yellow fever by mosquitoes.

Soon after this, the alfalfa weevil (*Phytonomus posticus*) made its appearance in Utah, and spread rapidly. Later the European corn borer (*Pyrausta nubilalis*) was found to have established itself in the United States, and still later the Japanese beetle (*Popillia japonica*), and both have since spread rapidly.

It would be impracticable to give an historical account of all the various activities of the Bureau of Entomology during its long existence. Brief accounts of the more important work undertaken by the Bureau are given in the following pages.

[4] Howard, as above.

Plant Quarantine and Inspection.[5] It had long been recognized that a great many of the insect pests which are destructive to the crops of North America had been introduced from foreign countries through the agency of commerce in plants and plant products, but apparently little if any thought was given until a fairly late period to the possibility, by appropriate legislation, of preventing or at least restricting further entry of such pests.

The beginning in the United States of plant quarantine legislation, having this object, in part at least, was that instituted by the State of California about 1880-81 and since continued, the principal incentive being the grape phylloxera, which had comparatively recently gained entry into vineyards in the northern portion of that state.

The first concerted effort to secure a national plant quarantine law was in 1897 and was initiated by the Ohio State Horticultural Society, the particular incentive being the rapidly increasing spread of the San José scale in the Eastern United States and the emphasis which this gave to the need of restriction against further entry of such pests and as to interstate movement of plants. On the call of this Society, a national convention, broadly representative of agricultural and horticultural interests, including commercial organizations, met in Washington in March, 1897, and drafted a national plant quarantine bill relating both to foreign imports of nursery stock and also to interstate traffic in such articles. The scope of this bill, international and interstate, prevented any general agreement as to its terms being arrived at, and, although it was more or less modified and reintroduced on several occasions during following years, no definite action resulted and interest in the effort largely died out.

The final and successful effort to secure federal legislation (1908-12) resulted from the initiative and follow-up of Dr.

[5] For a more comprehensive history of plant quarantine and inspection see Institute for Government Research, The Plant Quarantine and Control Administration. Service Monograph 59.

Marlatt, the incentive in this instance being the increase, which developed in 1907-8, of infestation of imported European nursery stock with the larval nests of the brown-tail moth and with occasional egg masses of the gipsy moth.

During the first half of this period (1880 to 1912) the Bureau of Entomology had been accumulating information as to the origin and manner of entry of foreign pests which had already become established in the United States, and had begun the accumulation and publication of data on the existence in foreign countries of other important pests the entry of which would be a special menace to our crops.

In connection with the convention of 1897, papers were presented by Dr. B. T. Galloway, at that time Chief of the Division of Vegetable Pathology and Physiology of the Department, and by Dr. Howard, the former on the subject of "Plant Diseases and the Possibility of Lessening Their Spread by Legislation" and the latter on "The Desirability of an Inspection System Against Foreign Insects." Dr. Howard later prepared and published an article in the Yearbook of the Department for 1907 entitled "The Danger of Importing Insect Pests," in which he discussed important pests known to occur in foreign countries and likely to be introduced through the agency of commerce with plants and plant products. The purpose of this article was to emphasize the necessity of legislation providing for national quarantine and inspection of imported plants and plant products.

In 1906 the Bureau began a definite inspection service in relation to plants imported by the Bureau of Plant Industry of the Department of Agriculture. The introduction of new and rare plants had become an important phase of the work of that Bureau, and much of this material was being collected in regions which had never been explored entomologically, and therefore under special risk as a source of pests of various types new to this country. To minimize this risk, the Bureau undertook to inspect all such importations and to provide for their fumigation, or even their destruction whenever definite infestation was

determined and it was felt that the inspection and fumigation had not adequately safeguarded the situation. Similarly all imported plant material, prior to distribution by the Department, was given inspection and, if necessary, fumigation as a basis for certification for such distribution. In the fiscal year 1906-7, 916 lots of imported plants were inspected—the largest single lot containing five thousand plants—and 581 certificates covering distributions by the Department were issued by the Bureau. The inspection and certification with respect to Department importations was continued by the Bureau until the passage of the Plant Quarantine Act, when this work was taken over by the Federal Horticultural Board.

In 1909 the Bureau organized a sort of voluntary coöperative—state and federal—inspection of commercial imports of nursery stock and other plants. In January of that year the Bureau had been advised by the Commissioner of Agriculture of New York that brown-tail moth nests had been found in considerable numbers in shipments of seedling-fruit stocks from France, and later advice indicated that a similar condition had been noted in other states. The Bureau sent out warning letters to state entomologists with the object of getting such officials to make inspection of all shipments into their respective states of such seedling-fruit stocks and to collect and destroy the larval nests of this moth. The Bureau also obtained, through the cooperation of the Customs Service, records of all importations and of the railroads concerned in transporting these shipments to destination, and gave advance notification to the appropriate state officials of such movement. During this first year information was thus sent concerning some eight hundred shipments distributed to thirty-five different states. The inspection of these shipments showed not only the presence of the brown-tail moth but of certain other important pests, new to or not widely distributed in the United States. This work of inspection of shipments of seedling-fruit stocks and other nursery stock was continued by the Bureau until it was taken over in 1912 by the Federal Horticultural Board. Incidentally, this Bureau work

and state coöperation must be credited with having protected the United States during this period from the very general distribution and spread, through the agency of such nursery stock, of the gipsy and brown-tail moths, thousands of nests of the former being found, particularly on fruit stocks, and occasional eggmasses of the gipsy moth, such infested shipments being reported from destination points in a great many states.

The enforcement of the quarantines promulgated under the act of 1912, as already indicated, was independent of the related bureaus; nevertheless such enforcement was closely connected with these bureaus through the nature of the organization of the Board. It was natural, therefore, that the Bureau of Entomology particularly and also the Bureau of Plant Industry should have been brought into active aid and coöperation in the administration of this act, and in this way the Bureau of Entomology was given general field and administrative charge, as an agent of the Board, of such important quarantine and control activities as those in connection with the Mediterranean fruit fly and melon fly, the European corn borer, the gipsy moth and brown-tail moth, the Japanese beetle, and the Mexican fruit fly. When the Federal Horticultural Board was abolished and the Plant Quarantine and Control Administration was created on July 1, 1928, as a result of the act of May 16, 1928 (45 Stat. L., 539, 564), these regulatory activities of the Bureau of Entomology were transferred to the new organization.

The fact has already been noted that perhaps one-half of the important pests of agriculture and forestry of this country are introduced species. About one hundred of these are important crop destroyers or are injurious to live stock or to man in one relation or another. Among these are: The codling moth, Hessian fly, asparagus beetle, hop-plant louse, cabbage worm, wheat-plant louse, oyster-shell bark louse, pea weevil, croton bug, angoumois grain moth, horn fly of cattle, San José scale, gipsy moth, brown-tail moth, Argentine ant, alfalfa-leaf weevil, and the European corn borer. Others, such as the cotton-boll weevil, cotton-leaf worm, the harlequin cabbage bug, the sugar-cane

borer, and in recent years, the pink bollworm and the Mexican fruit worm, have reached the United States by natural or artificial means from countries and islands to the south.

Importation and Exportation of Useful Insects. Early in the history of applied entomological work it was discovered that insect pests could be destroyed or controlled in many instances by the importation and establishment of insect enemies and parasites. In 1886 agents of the Division of Entomology were sent to Los Angeles to make experiments with redemies for the destruction of the cottony cushion scale, an injurious insect from Australia, accidentally introduced about twenty years before, which was doing enormous damage to orange, lemon, olive, and other fruit trees of California. A year later an entomologist was sent to Australia and New Zealand by the Department of State to study parasites of this destructive pest. These parasites were introduced in California, and one of them, a ladybird (*Novius cardinalis*) increased so enormously and was so active an enemy of the scale, that in a few years this pest could only be found with difficulty. In 1892 some of these beetle predators were sent to Cape Colony, South Africa, and to Egypt, New Zealand, and other foreign countries, where they also proved effective.

Owing to the success obtained by the introduction of this scale enemy, an agent of the Entomological Division was sent to Australia and New Zealand in 1891, at the joint expense of the Division of Entomology and the State Board of Horticulture of California, for the purpose of studying and importing into California other insects which might prove of benefit to horticultural and agricultural interests.

After some years of effort, the Division of Entomology succeeded in 1901 in introducing a parasite (*Scutellista cyanea*) from Italy, and later from South Africa, which preys upon the black scale, a serious enemy of the olive and citrus trees. This insect proved to be very effective.

In the same year a beetle was introduced from Hungary which is an enemy of several destructive plant lice which had been

imported from Europe. A fungus disease of grasshoppers was imported about the same time from South Africa.

Special attention was given in 1905 to the importation of parasites of the gipsy moth and brown-tail moth; and the kelep or Guatemalan ant enemy of the cotton-boll weevil. During the year 1906 several species of European lady-birds, destroyers of plant lice, scale insects, and soft bodied insects of other groups, were imported from Austria, France, and Germany; and in 1908 parasites of the eggs of the elm-leaf beetle were imported and successfully established in Memphis, New York, and Washington.

Before the year 1898 attempts to introduce the growing of Smyrna figs in California failed because the fruit never matured. An expert of the Bureau of Plant Industry about that time went to Algeria to study fig culture with the idea of ascertaining the cause of this failure. He discovered that the fertilization of the fig fruit was brought about through the medium of the fig wasp (*Blastophaga grossorum*), and sent a supply of insects to this country. The Bureau of Entomology studied the habits of these insects and instructed tree owners in their propagation, with the result that the problem of fig culture in this country was solved and the growing of Smyrna figs was commercially established.

The study abroad and the importation of insect enemies and parasites and of bees continue to be an important branch of activity of the Bureau of Entomology.

Foreign countries have given much aid to the Bureau of Entomology in its efforts to discover insect enemies and parasites and to prevent the introduction of destructive insects, and they have rendered this service without compensation. The Bureau also has rendered considerable assistance to foreign countries in their efforts to control or exterminate insect pests. Many important parasitic and predatory insects have been exported to countries where they were of assistance in this warfare against injurious insects. A most striking instance of the value of this work occurred in 1898, when the orange groves of Portugal were

threatened with extinction by the ravages of the white scale. The Bureau of Entomology, in coöperation with the State Board of Horticulture of California, sent specimens of the lady-bird (*Novius cardinalis*), enemy of the white scale, previously imported from Australia by the Bureau, which annihilated the scale in Portugal in a little more than a year. In 1906 and 1907 the Bureau exported to Italy certain important parasites of an injurious scale-insect (*Diaspis lanatus*) found upon peach, cherry, pear, lilac, and other trees and bushes in the United States, which had wrought more damage in Southern Europe because it attacked the mulberry upon which the prosperity of the Italian silk industry depends. In 1907 the Bureau sent to France for immediate transportation to Algeria, large shipments of a sanddigging wasp (*Monedula carolina*), common in the Southern states, which is an effective enemy of American *Tabanids,* flies, which in Algeria carry a dangerous disease of the dromedary. In 1908 efforts were made to send and establish American bumble bees to the Philippine Islands to fertilize clover. Coöperation of this kind has since been continuously carried on with entomological services of foreign countries.

In 1928 a meeting of the International Congress of Entomology was held in Ithaca, which was attended by entomologists from all the leading countries of the world, and resulted in increased coöperation between the Bureau of Entomology and foreign entomological services.

Classification of Insects. Although it was not segregated as a formal project until 1897, the identification and classification of insects has formed an important part of the activities of the Bureau of Entomology from its inception as a branch of the Patent Office. The vital need for the proper identification of injurious and beneficial insects was recognized from the beginning, with the result that the early reports of the entomologists contained important papers on the classification of injurious and beneficial insects. Similar work by specialists of the Bureau of Entomology appeared in Insect Life, in bulletins of the Bureau and of the Department of Agriculture, and in the

Proceedings and Bulletins of the National Museum. Hundreds of papers dealing with the subject of insect classification have been published by Bureau specialists in various technical entomological journals. In addition, the Bureau, during all its history, has given to other federal agencies and to state entomologists and quarantine officials assistance in the way of supplying identifications for insects believed to be of economic importance. The demand for work of this sort has grown steadily with the development of entomology in this country until to-day the scientists who are engaged in this identification work furnish to other sections of the Bureau, to the Plant Quarantine and Control Administration, to other governmental agencies, to state entomologists and experiment station workers, and to private workers interested in entomology, many thousands of identifications annually. Similar assistance is given to Canadian and other foreign entomologists in the most important economic groups of insects.

Bee Culture. Apiculture has occupied the attention of the Department of Agriculture since the beginning of its entomological activities. In 1881 the Entomological Division took up investigations in bee culture as a continuing activity, and special provision has since been made for apicultural studies and research in the annual appropriation acts. The Bureau has been studying diseases of bees since 1907; the physiology of bees, since 1908; the wintering of bees and bee behavior, since 1912; beekeeping regions, since 1921; and intermountain bee culture since 1926. Bee culture in the Southern states was made the subject of investigation in 1929. In 1917 the Bureau began demonstration work in beekeeping.

On August 31, 1922, an act (42 Stat. L., 833) was approved "To regulate foreign commerce in the importation into the United States of the adult honeybee (*Apis mellifica*)." The enforcement of this act was entrusted to the Bureau of Entomology and it is still one of its functions.

Silk Culture. Experiments with silk-worms were first mentioned in the annual report of the Commissioner of Agriculture

for 1871, but it was not until thirteen years later that Congress began to make specific appropriations for their development and culture in the United States. In 1884 while the Entomologist, Professor Riley, was abroad at the invitation of the Minister of Agriculture of France to demonstrate a proposed method of dealing with the underground vine pest (*Phylloxera*), he studied certain features of silk culture in Europe. The same year an appropriation of $15,000 was made in an act of June 5, 1884 (23 Stat. L., 39), "For the encouragement and development of the culture and raising of raw silk to be expended under the direction of the Commissioner of Agriculture." Similar appropriations were made each year to and including the fiscal year 1891, and this work became for the time an important function of the Division of Entomology. The Division collected and disseminated information relating to silk culture, purchased and distributed silk-worm eggs and mulberry trees and books of instruction, and carried on experiments with automatic machinery for reeling silk from the cocoon. The Commissioner of Agriculture was authorized to sell, in open market, the reeled silk and silk waste produced in these experiments and to apply the proceeds of the sales to the payment of legitimate expenses incurred.

An act of June 30, 1886 (24 Stat. L., 100, 101), in addition to appropriating $10,000 for the use of the Division of Entomology, as above, appropriated $5000 "For the encouragement and development of the culture of raising raw silk . . . to be expended under the direction of the Woman's Silk-Culture Association of the United States, located at Philadelphia, and to be paid directly to said association." The following year this appropriation was repeated and a like sum of $5000 was given to the California Ladies' Silk Culture Society of California, for each of the three succeeding years; and for each of two years, appropriations of $2500 were made "for the study and experiments by Joseph Neumann, of the wild native silkworm of California."

The silk culture work of the Division was revived when an act of June 3, 1902 (32 Stat. L., 286, 303), made an appropriation of $10,000, "To enable the Secretary of Agriculture to collect and disseminate information relating to silk culture in the United States, and for all expenses for experimental work in connection therewith." Silk investigations were specifically provided for in five subsequent annual appropriation acts. A systematic effort was made to introduce the culture of the domestic silk-worm into the United States. Guaranteed eggs were purchased in Italy, mulberry cuttings of the best varieties were purchased abroad, manuals of instruction in the raising of silkworms and in the care of silk-worm-food plants were issued, and two silk reels were purchased in France. Model silk plantation sites were selected. It was regarded by the Division that previous work undertaken by the Department of Agriculture in the years 1882 to 1891 demonstrated the possibility of raising excellent cocoons of the domestic silk-worm in all parts of the United States where the white mulberry will grow. The Bureau devoted its attention to the practical aspects of establishing the silk industry. A small crop of cocoons was raised at the Department of Agriculture in the spring of 1903, eggs were sent to applicants who had proper supplies of food for the worms, and mulberry cuttings and rooted plants were sent to others. The imported reels were put in operation in Washington, and two expert reelers were secured from France, and other persons were trained in silk reeling.

The appropriations for this activity were discontinued after 1908, and the work was finally abandoned. It was found that in view of the nature of the work involved in the culture of silkworms and the reeling of the silk, the industry in this country could not compete with that in Japan, Italy, and other foreign countries where labor is very much cheaper than in the United States.

Forest and Shade-Tree Insects. Forest insect investigations have been carried on almost from the beginning of governmental entomological work by the joint activities of what are now the

Bureau of Entomology and the Forest Service. In 1890 the Division of Entomology, in coöperation with the Forest Service and the Department of the Interior, began economic investigations of the *Scolytid* bark and timber beetles of North America, to determine the character and extent of damage caused by these insects to forest growth and forest products and to discover methods of preventing losses from their attacks.

In April, 1899, an extensive series of investigations of conditions relating to depredations by insect enemies of forests was begun by these two services. The original studies were carried on in April, May, and June in California, Oregon, Washington, and Idaho. Similar investigations were made in the two following years in the spruce forests of northwestern Maine, the Black Hills Forest Reserve of South Dakota, and on hickory and other forest trees near Geneseo, New York.

The plan of work as adopted at that time was "to conduct original investigations in the forest and laboratory to determine: (1) The principal insect enemies of forests and forest products; (2) the character and extent of the problems which, on account of the losses involved, demand special attention; and (3) the more important facts in the life and habits of the destructive insects, local forest management, lumbering operations, beneficial insects, and other natural influences, upon which to base conclusions and recommendations relating to practical methods of preventing losses." The work was carried on by means of: "(1) A system of field operations in charge of special field agents and investigators, conducted at temporary field stations in the several distinctive forest regions during the spring, summer, and fall months; (2) office and laboratory work at Washington during the winter months in the study of the results, and the preparation of manuscript for publication."[6]

In May, 1902, a temporary field station was established at Elmore, South Dakota, in coöperation with the Bureau of For-

[6] Unpublished manuscript of the Division of Entomology.

estry, for conducting experiments relating to the pine-destroying beetle of the Black Hills. On July 1, 1902, an office of forest-insect investigations was established, the personnel of which consisted of members of the Bureau of Entomology and the Forest Service. This office was equipped to carry on extensive investigations of forest insects, including not only destructive insects but also those beneficial to forest trees.

A formal coöperative agreement was entered into between the Bureau of Entomology and the Forest Service whereby the division of the work and of the expense to be incurred was stipulated. Similar agreements have subsequently been made, the last being in the form of instructions by the Secretary of Agriculture, dated February 16, 1920.

The first attempt to deal with the bark-beetle infestation by direct control measures was undertaken in 1906 in the Black Hills National Forest. After that a series of projects was carried on in the West from funds appropriated for protection of the forests.

In 1909 attention was called to an increasing epidemic of the mountain-pine beetle in the Flathead National Forest in Montana. As it centered largely in inaccessible timber along the west side of the Continental Divide, it was not deemed advisable to attempt control at that time. Since then the epidemic has increased and has gradually moved southward through the Missoula and Bitterroot National Forests, and now centers on the west side of the Continental Divide near the Montana-Idaho boundary. In 1925 the infestation began sweeping across to the eastern slopes of the Continental Divide on the Beaverhead National Forest, and developed into such proportion that $100,000 was expended by the Forest Service during the spring of 1928 in an effort to check further spread.

In 1920 a serious pine-beetle epidemic broke out in southern Oregon and northern California, affecting valuable private holdings and also National Forest and Indian Reservation timber, on an area of over a million acres and involving a loss of lumber valued at three million dollars. Through the initia-

tive of private interests, a special deficiency appropriation of $150,000 was made on December 15, 1921 (42 Stat. L., 327, 331), for carrying out control work in this region, with the cooperation of the state authorities of California and Oregon and the timberland owners concerned. In 1923 a serious Black Hills beetle epidemic developed on the Kaibab National Forest and the Grand Canyon National Park, for the control of which special appropriation was also made.

Since 1918 annual surveys have been conducted of losses resulting from the attack of the pine beetle in the heart of the yellow-pine district of southern Oregon and northern California on an area of over two million acres. The annual losses here during the period from 1918 to 1926 have varied from one-half of one per cent to over two per cent of the stand. This means that a total of twelve per cent of the stand has been killed in nine years, representing 1,500,000 feet of high-grade, merchantable lumber.

Another area centering about the Modoc National Forest, involving both public and private lands, was surveyed from 1921 to 1927, disclosing that during this seven-year period a total of over nine per cent of the stand had been destroyed, representing 506,000,000 board feet, and that there has been a gradual increase of the infestation in this region from four-tenths of one per cent in 1923 to over three per cent in 1927.

Concerning the effectiveness of this forest-insect-control work, a report of the Forest Protection Board, made in 1928,[1] has this to say:

It is of course a physical impossibility to completely control all these epidemics which are now threatening the federally-owned timber. Such a program would involve an appropriation of over $3,000,000, and labor could not be obtained locally to conduct operations on such a large scale. The best that can be done, is to extend protection to the most valuable portions of these stands until these epidemics die down, and to make preparations for the future to prevent the development of epidemics on such a large scale.

[1] Unpublished manuscript.

The expenses of carrying on the forest-insect work of the Bureau of Entomology were originally paid out of general appropriations for "entomological investigations." An act of March 4, 1909 (35 Stat. L., 1039, 1050), for the first time made specific appropriation "for investigations of insects affecting forests." Since then annual appropriations have been made for this purpose, which have gradually increased from $12,000 for the fiscal year 1910, to $79,570 for 1928. After that, these annual appropriations were lumped with those for research on the gipsy and brown-tail moth.

Statements in the reports of various organizations concerned show that appropriations and allotments were annually made for forest insect-control work by the Forest Service since 1906, varying in amount from fifty dollars in 1909 to $67,501 in 1927, the total being $464,944 for the twenty-two year period. During this same period, the statements show $63,503 was appropriated or allotted for the use of the National Park Service, and $36,903 for the use of the Office of Indian Affairs, and private appropriations of $219,906 were made for the control of forest insects.

In recent years attention has been given to the study of insects affecting forest products and the testing of wood preservatives especially for the prevention of damage by termites.

Among the forest insects studied by the Bureau of Entomology are the pine-bark beetles, the larch sawfly, the tip-moth, the white-pine weevil, the hickory bark beetle, the turpentine borer, and the boxwood leaf miner.

Gipsy Moth and Brown-tail Moth. The gipsy moth, one of the very destructive tree pests of Europe, became established in Medford, Massachusetts, in 1868, as a result of the importation of the eggs of the insect by a French professor of astronomy. By 1889 it had become a veritable plague and during the following ten years the State of Massachusetts expended more than one million dollars in an attempt to exterminate the pest. The effectiveness of the work was preventing visible damage, and as the

insects had been reduced to very small numbers, the legislature decided that the project should be discontinued.

In 1897 the brown-tail moth was discovered in Somerville, Massachusetts, probably brought in on nursery stock a few years before. This insect is a fruit and ornamental-tree pest in Europe causing periodical damage, and is highly objectionable because the caterpillars cause dermal poisoning to human beings. Work on this insect was attempted by the state and abandoned in 1900.

During this period the Bureau of Entomology published several reports on these insects and coöperated with the state authorities. As the problem was originally confined to a single state, aid was not immediately provided by Congress. An appropriation act of April 23, 1897 (30 Stat. L., 4), mentioned the gipsy moth among other injurious insects to be investigated by the Bureau.

During the next five years these insects increased enormously and spread so rapidly to adjoining states that work was resumed by the State of Massachusetts, and Congress appropriated $82,500 in 1906 to assist in preventing their spread.

The Bureau of Entomology field-control program included survey and clean-up work in coöperation with the States of Maine, New Hampshire, Massachusetts, and Rhode Island, and later this was extended to Connecticut and Vermont.

Owing to the size of the area involved, federal as well as local funds have been increased from time to time to enlarge the field clean-up operations and to provide for the enforcement of quarantine restrictions. Experimental work was also conducted to discover better methods of control, and parasites and natural enemies of these pests were imported in great numbers from Europe and Japan.

In 1911 the research work which had previously been financed jointly was taken over and has since been managed by the Bureau. The states concerned coöperated in the field-control activities but confined their clean-up operations to the inside territory, while the Bureau conducted operations in the outlying infested territory.

In 1913 the federal work was combined as a field division of the Bureau and sub-divided into three units: (1) Enforcement of the quarantines declared by the Federal Horticultural Board; (2) scouting and extermination work to prevent spread, and cleaning up outlying infestations; and (3) experimental work embracing a study of the habits and behavior of these insects for the purpose of utilizing the information secured to assist in the control and in the investigation of the natural enemies in foreign countries, including the introduction and dissemination of beneficial species to the infested region in New England.

During the World War period the loss of experienced personnel and the heavy turnover in man power, together with increased cost of operation, seriously affected the efficiency of the undertaking. All foreign work had to be abandoned, and conditions after the war, both here and abroad, retarded normal progress. In spite of every effort the insect continued to spread, and in 1922 several infestations were found in New York.

In 1923 a modification of the plan of operation resulted in the establishment of an area known as the barrier zone, about thirty miles wide, bounded on the west by the Hudson River, extending north to the Canadian border and including parts of New York, Vermont, Massachusetts, and Connecticut. The purpose was to keep the zone free from the gipsy moth and prevent spread to the westward. This project has been continued up to the present time in coöperation with the Department of Conservation of the State of New York, and the spread of the pest has been arrested. The result of this intensive work has prevented the region west of the Hudson River from becoming permanently infested with this destructive pest which would involve great loss to tree growth and heavy expenditure of funds for protection.

Isolated colonies of the insect have been exterminated by the Bureau in Ohio, Pennsylvania, New York, and New Jersey, in coöperation with the states concerned.

In 1920 a widespread infestation was found in New Jersey involving more than four hundred square miles. This resulted from the importation of infested trees from Europe. Intensive work by the Bureau and the states has materially reduced the infested area, and it is expected that the insect will be exterminated within a few years.

The introduction of natural enemies from abroad has been of great value in reducing the injury caused by this insect during some seasons in the worst infested areas.

The brown-tail moth has been confined to the territory east of the Connecticut River as a result of field-control work, the effectiveness of imported natural enemies, disease, and adverse weather conditions.

In 1928 the quarantine and control activities of the project were transferred to the Plant Quarantine and Control Administration, the research phases of the work remaining with the Bureau of Entomology.

San José Scale. The San José scale (*Aspidiotus perniciosus*) was imported into California with a small shipment of the flowering peach trees from the Orient about 1870. It made its first appearance in the eastern part of the United States at Charlottesville, Virginia, in 1893, and as it spread, it threatened the destruction of all the eastern orchards. Until methods of effective control were developed, this pest occupied much of the attention of the Division of Entomology and caused more concern among farmers and fruit growers than any insect pest that had appeared. An investigation of the scale was carried on in 1896 and 1897, a summary of the results of which was published with a bibliography in March, 1898. Such interest was aroused that thousands of monographs, bulletins, and circulars, about this pest were issued and distributed.

In 1901 a representative of the Division discovered that the country of origin of this scale was Northern China, where a predatory enemy of the scale kept it in check. This predatory enemy, a lady-bird (*Chilocorus similis*), which feeds on the San José scale and related forms and on the white peach scale, was

imported and liberated in orchards in different parts of the country and while successfully established, did not multiply to an extent of controlling the scale especially on account of the widespread practice of orchardists of spraying which interfered with the lady-bird's food supply. The spray used, namely, a lime-sulphur wash as a winter treatment of this scale, obviated to a large extent the necessity for a competent natural enemy. These and other methods of control and extermination resulting from the experimentation of the Division of Entomology have proven so effective that since about 1905 commercial orchard growers no longer fear the scale insect. Precautions are still being taken by growers, however, and many millions of dollars are spent annually for spraying against this pest. Its presence in this country has induced a number of European countries to establish embargoes or near embargoes against apples and other deciduous fruits exported from this country. It has greatly reduced the number of old-time home orchards in country, village, and suburban districts, on account of the labor and difficulty of the frequent treatments required to safeguard the crops.

Insects Affecting Man and Animals. In the early nineties the Division of Entomology began the investigation of disease-carrying insects which affected the health of man and of animals. In 1898 investigations were begun concerning the life history of houseflies and mosquitoes and their disease-carrying potentialities. The information obtained was supplied to scientists, and that concerning the mosquitoes has resulted in the elimination of yellow fever in Havana. Important studies were made in 1905 of yellow fever carrying mosquitoes, on the results of which, quarantine regulations of the Public Health and Marine Hospital Service concerning the yellow fever emergency were based. Through the activities of the Bureau the important points in the life history of malaria-carrying mosquitoes have been ascertained and control remedies have been worked out, and methods of suppressing and preventing the breeding of the housefly, mechanical carrier of typhoid fever, have been developed.

During the period 1910 to 1913 studies of the tick, which transmits to man the dreaded disease known as Rocky Mountain spotted fever, were conducted. The territory where this tick abounds was determined, and important facts were ascertained relating to the life history, habits, and means of control. As a result of investigations of the external parasites of poultry the discovery was made of the effectiveness of sodium fluoride in louse control, and methods of using this material were developed which have become standard practice throughout the country. The fact that the cattle grubs or ox warbles were causing losses of millions of dollars to the cattle and tanning industries stimulated the reopening in 1913 of investigations of these parasites which were begun in the early nineties. Especial attention was given to the distribution of the pests, a complete study of their life histories, and the finding of more economical and effective methods of control.

In 1913 special attention was given to housefly control, in 1915 to body and head-lice control and to control of insects in establishments operating under meat inspection. Much intensive work was also carried on about this period with reference to insects affecting the health of animals, such as the investigation of cattle-fever and other ticks during the years 1904 to 1915. In the years 1912 to 1915 studies were undertaken of the stable fly, fly control under farm conditions, screw worms, horse fly, horn fly, ox warbles, chicken fleas, sheep-scab mite, goat louse, and other similarly injurious insects. The investigation of insects affecting the health of man and animals is still being carried on as one of the major groups of projects.

In 1924 studies were undertaken in Florida to find the causative organism of the human malady known as "creeping eruption," which was attributed to an insect. This work resulted in the discovery that the trouble was due to the larva of a hookworm which is common in the intestines of dogs and cats in the tropics.

Cereal and Forage Insects. Cereal and forage insects have occupied the attention of the Bureau since its beginning. In the summer of 1904, the Bureau began a series of major projects relating to cereal and forage insects, originally designated as field-crop insect investigations. An expert was placed in charge, who with several assistants, planned a systematic study of cereal and forage insects which is being continued to the present time. During the first year, the Hessian fly and the jointworm occupied the special attention of these investigators, and in subsequent years studies were made of the alfalfa weevil, chinch bug, corn leaf aphis, wireworms, white grubs, wheat jointworm, false wireworms, insects affecting clover seed, cutworms, rootworms, alfalfa seed chalcis, insects affecting soya beans and cowpeas, the fall armyworm, the southern corn root worm, the sod webworms, the range caterpillar, the corn ear worm, grasshoppers, the southern leaf beetle, rice insects, the sugar-cane moth borer, the Mormon cricket, the overflow worm, the green bug, and others.

The alfalfa weevil (*Phytonomus posticus*) was first discovered in 1909 in the vicinity of Salt Lake City. In twenty years it has spread so extensively that at present it is infesting one or more counties of eight states, namely, Nebraska, Colorado, Wyoming, Utah, Idaho, Nevada, Oregon, and California. Its study became one of the major projects of the Bureau, and it is still occupying the Bureau's attention. Methods of control developed by the Bureau consist of the application of an arsenical spray, the establishment of parasites, and large-scale dusting by means of aeroplanes. One of the parasites introduced by the Bureau (*Bathyplectes curculionis*) is beginning to make itself felt as a factor in control. It was also discovered that many varieties of birds feed largely on these insects.

European Corn Borer. The study of the European corn borer (*Pyrausta nubilalis*), which at present is generally considered the most dangerous of all corn insects, was begun in 1918. This insect doubtless came from southern Europe and is believed to have gained entrance into the United States some time in 1909

or 1910, but it was not discovered until 1917. Infested broom corn imported from Europe was definitely traced to Everett, Massachusetts, where the first infestation of the pest was discovered, and to Amsterdam, New York, and St. Thomas, Ontario.

At the close of the scouting season in 1929 the area known to be infested by the European corn borer in the United States included the southern two-thirds of New England; the northern extremity of New Jersey; all of New York; three-fourths of Pennsylvania and Ohio; the Panhandle of West Virginia; nearly all of the agricultural portion of Michigan; and the northwestern fourth of Indiana. It is spreading in that part of the country at the rate of from twenty to thirty miles a year and is rapidly increasing in intensity. The present distribution of the pest is the result of at least three original focal points of infestation which were started simultaneously.

The Bureau, in coöperation with the Federal Horticultural Board and its successor, the Plant Quarantine and Control Administration, has been carrying on investigations and control measures concerning this pest since 1918, and annual specific appropriations have been made for the work since 1919.

In September, 1926, a conference of the International Corn Borer Organization was held in Detroit, which was attended by representatives from the corn belt and many other sections and resulted in the appointment of a committee to decide what action would seem most advisable in connection with corn-borer control in the United States. This organization movement and the realization of the seriousness of the problem induced Congress to authorize in an act of February 9, 1927 (44 Stat. L., 1065), and to appropriate, for immediate use, by a joint resolution of February 23, 1927 (44 Stat. L., 1177), $10,000,000 to be expended for additional control purposes in coöperation with state authorities and private organizations and individuals.

The activity which resulted from this appropriation is commonly called the "1927 Spring Clean-up Campaign." Its purpose was to determine whether, by concerted effort under unified

control and uniform procedure, the spread of the insect into new territory could be prevented or retarded and the borer population held at such a minimum as would prevent it from inflicting commercial damage to the corn crop in territory already infested.

The campaign was organized along three major lines of activity, namely, an educational program, publicity work, and control operations. The control operations were carried on by the Bureau of Entomology and the Federal Horticultural Board under additional authority conferred by state legislation.

In the act providing for the control of the European corn borer, Congress stipulated that the various participating states should provide the necessary regulatory legislation. This was interpreted to mean legislation requiring the farmers in the clean-up areas to destroy all cornstalks and corn debris in fields, feed lots, barnyards, etc., on or before May 1, 1927. It was also arranged that the states deputize the employees of the United States Department of Agriculture, thereby authorizing them to enter private property, and, in case it should not be properly cleaned within the specified time, to do such work as might be necessary, the cost to be charged in whole or in part to the property owners.

Provision was made by Congress to compensate the farmers for the extra work involved, and the Secretary of Agriculture issued regulations allowing a maximum of two dollars per acre for extra labor when the farmer cleaned his premises in a satisfactory manner.

The federal appropriation of $10,000,000 became available February 23, 1927, but owing to a provision in the law requiring all the states included in the control area to possess essential regulatory legislation previous to the expenditure of any part of the federal fund, the actual work of control did not begin until March 14, 1927.

One of the first things given consideration was the purchase in the open market of a large quantity of mechanical field equipment for this work. As the details preliminary to the award of

the contracts were completed in the interval that elapsed between the time the appropriation was made and the date upon which it was certified that the states had provided the necessary legislation, many awards were made for equipment on March 14, delivery began almost immediately, and work was started in the field on March 21, 1927. This equipment consisted of more than 250 carloads of machinery, including motor cars and trucks.

The several states involved issued regulations governing the clean-up. The control work was divided into five branches, namely, (1) field operation; (2) engineering and maintenance; (3) advisory and research; (4) accounting, finance, and disbursements; (5) supplies, purchases, and property.

The area to be cleaned up consisted of about 40,051 square miles, located principally in Ohio, Michigan, and Indiana, but including eight counties in western Pennsylvania and five counties in western New York. There were estimated to be 2,500,000 acres of corn land in this area. The program prepared for this campaign was based on the assumption that the farmers would do all the work on 2,000,000 acres or eighty per cent, leaving the government to do the work on 500,000 acres, or twenty per cent, of this entire area. Equipment for this purpose was accordingly provided.

The first field operation was that involved in a proposal to lend stubble pulverizers and tractors to farmers prior to May 1, to be used largely in fields already planted to small grains in which corn stubble of the previous summer existed. This equipment, consisting of a tractor and pulverizer for each unit, was operated by federal forces, and for this a charge of one dollar per acre was made, such charges to be deducted from any extra labor fee that might subsequently become due the farmer.

All farmers in the infested territory were visited at least once before May 1 and advised as to what would be expected of them in the way of cleaning up their fields, and copies of the regulations of the Secretary of Agriculture setting forth the requirements to be fulfilled to receive extra labor fee, were mailed to the farmers in the " clean-up " area.

The approved methods of work used in this campaign were: Stubble pulverizing; plowing cleanly; polling, raking, and burning; machine burning; and hand picking of stalks and debris.

At the beginning of the work a proclamation was issued to the farmers of the clean-up area stating that they would be given until May 1 to clean up their cornfields, but that after that date the state and federal forces, under state authority, would step in and finish the operation where necessary. On account of the continued wet weather the time limit for the completion of the farmer's work was extended from May 1 to May 15, and exemptions were necessitated in some cases in areas where less than one per cent infestation occurred. On May 16 compulsory work was started. Wherever it was apparent that the farmer was trying earnestly to do his work and had been handicapped by weather conditions, a further extension of time was allowed.

Early in June the final inspection was started, and it became necessary to appoint additional inspectors to determine the fees for extra labor due the farmers. During the campaign the federal and state authorities were in touch with 202,338 farms, in which there were 2,505,005 acres of corn. In all, 185,000 farms passed inspection. The maximum number of employees engaged at any one time was 7000, who were working over an area of 35,000 square miles.

The clean-up campaign was a "control experiment to reduce the number of corn borers in the infested area and slow down or prevent the natural spread of the pest." It resulted in a great reduction of the number of borers in the clean-up area, there being an average of ninety-eight out of every one hundred destroyed, and it held the infestation in 1927 to just about the same intensity as it was in 1926. There were many direct and indirect results of the campaign, such as its far-reaching educational value, the demonstration of the fact that "it could be done," and that such unprecedented coöperation was possible.

As regards the effect of this great experiment in repressive measures on the insect, the scientifically conducted surveys made

before and after the clean up campaign was waged, showed that in Ohio and New York a marked reduction in the number of borers had been obtained. In both Michigan and Pennsylvania the borer was greatly slowed up in its rate of increase, and the moral effect of the campaign, which was the real net result of the work, persisted through 1928, so that in the heavily infested localities it induced the farmers to handle their lands so as to escape almost entire commercial loss.

Deciduous-Fruit Insects. While the Bureau had long been dealing with the various insects injurious to deciduous-fruit trees, these activities, in 1905, were grouped under one general head entitled "deciduous-fruit insect investigations." In that year an expert was assigned to take general charge of this group of projects, and he was given the assistance of a number of men trained in this field of work. The Bureau also took up the study of the plum curculio, the peach-tree borer, and other deciduous-fruit insects. Other projects were undertaken from time to time, including the thrips on pear trees and other deciduous-fruit trees in California, the coddling moth, the grape-berry moth, grape insects in California, the apple tree borer, apple plant lice, the apple tree caterpillar, apple insects of the Ozark Mountains, the oriental peach moth, peach borer, other peach insects, pecan insects, other nut insects, cranberry insects, blueberry maggots, other small fruit insects, deciduous-fruit nursery investigation, predatory and parasitic insects, fungus diseases of insects, orchard insecticides and spraying machinery, insecticidal constituents of plants, and others. These studies led in many cases to the discovery of effective remedies, which when applied enabled orchardists to resume the growing of normal crops. Notable among these results is the case of the pear thrips, which at one time threatened the destruction of the Pacific Coast deciduous-fruit industry. An oriental fruit worm which was brought to this country about 1910 with flowering Japanese cherries, is doing much injury to deciduous fruits such as peaches, plums, prunes, apples, pears, and others. It has become

established in a half-dozen eastern states and is spreading westward and southward to Missouri and Texas. No effective means of controlling it have so far been determined.

Truck-Crop and Stored-Product Insects. In their systematic relationships the plants grown as garden vegetables for human consumption comprise members of many botanical families and are extremely varied in habit and season of growth. Consequently, in no other group of projects is a greater variety of insect pests encountered. The relative value of vegetable crops is high, their culture intensive, and their cultivation widespread. On this account they are brought more forcibly to the attention of a greater proportion of the population than crops of any other type, and the control of their insect pests presents a general popular interest. The value of the crops and their manner of cultivation adapt them especially to the application of a wide range of control measures against the insects attacking them, and intensive methods can be more successfully applied to this group than to any other. The problems involving control of the insects attacking truck crops have long occupied a prominent place, and have assumed the status of a continuous major group of activities.

Since the organization of the Division of Entomology the insects attacking truck crops have been a subject of investigation, but their importance first received official recognition in 1891. For more than thirty years thereafter the Division was actively engaged in the prosecution of these problems. When this important group of projects was first segregated it included also the insects attacking flower gardens, ornamentals, greenhouse plants, shade trees, and stored products. In 1905 this group of miscellaneous projects was assigned to the newly created "Truck-Crop and Special-Insect Investigations." Prior to that time a large series of publications had been issued covering preliminary studies of such widely divergent subjects as the rose leaf beetle, flour beetles, meal worms, beetles attacking stored grains, the Indian meal moth and the Mediterranean flour moth, the weevils attacking stored beans, peas, and cowpeas, the

strawberry weevil, the tobacco flea beetle, the oak twig pruner, the leopard moth, greenhouse insects attacking violets and roses, and many other subjects, in addition to a comprehensive series of bulletins and articles on various truck-crop and sugar-beet insects, such as cutworms, wireworms, leaf tyers, webworms, and flea beetles.

In 1906 a serious outbreak of the curly leaf disease on sugar beets was encountered and two field agents were detailed to the investigation of the causes. From that time on, with expansion of funds and personnel, the activities concerning truck-crop insects increased rapidly.

In 1907 a field station for the study of the melon aphid and several species of injurious caterpillars was established in southern Texas, with headquarters at Brownsville, and a second station covering investigations on the tomato fruitworm, and the pickle and melon worms was established in Florida.

In 1908 an additional station covering studies of the spinach and cabbage plant lice, the Colorado potato beetle, the bean leaf beetle, the pea aphid, and other insects was established at Norfolk. Milling companies in Kansas, Arkansas, Missouri, and Texas urged an investigation toward the control of flour beetles and the Mediterranean flour moth. A study of insects attacking export flour and rice, was initiated, beginning at the mill and following the product through shipping and dock conditions to arrival at the port of destination in Europe, resulting in materially decreased infestation.

The division in which this work was carried on received the designation "Truck-Crop and Stored-Product Insect Investigations" in 1909. Popular demand for solution of other serious insect problems increased, and in 1910 two additional field laboratories were established, a field station at Rocky Ford, Colorado, in which studies of truck-crop insects, particularly the melon aphid, the sugar-beet leaf beetle and the sugar-beet webworm were initiated; and a station in California covering sugar-beet wireworms and various truck-crop insects. At the request of

the importers who had experienced great difficulties with wormy figs imported from Asia Minor, an entomologist was detailed to Smyrna for an investigation of the fig moth and its occurrence from the orchard and through the packing house to the arrival of the prepared product in the United States. Through the coöperation of the fig packers at Smyrna, methods of treatment before packing were devised which insured a more wholesome product for American consumers.

Additional field stations were established in 1911 in Indiana, for a field study of the onion thrips; on Long Island, New York, for a study of insects injurious to late cauliflowers; and a project for the control of the hop-vine flea beetle, the hop red spider and the hop aphid was begun in the Pacific Northwest, with headquarters in northern California and Washington. An investigation of damage by the Indian meal moth to peanuts in storage in southern Virginia was also completed, and the damage was materially reduced.

In 1912 an additional field station for the study of sugar-beet insects was established in Idaho, where preliminary studies of the sugar-beet leaf hopper, which previously had been definitely connected with the transmission of the curly leaf disease of beets, was undertaken. Work was begun on the potato tuber moth in southern California and at points in Texas, and an investigation of insects attacking dried fruits was initiated in California, through which changes in packing methods of material value to the industry were devised. Experiments for the control of the Angoumois grain moth, seriously injurious to wheat in Pennsylvania and northern Maryland, were also undertaken.

In 1913 a station for the study of insects affecting sugar beets and potatoes was established in western Kansas, where studies of several species of blister beetles and grasshoppers attacking these crops were undertaken. Investigations of the pea aphid in Michigan and Wisconsin were initiated, and a special study was made of the insects responsible for the transmission of the mosaic disease of cucurbits, which had caused great losses to the pickle

industry, the cucumbers affected by this disease being rendered unfit for pickling purposes. A station was also established in Louisiana for investigation of the bean leaf hopper and corn ear worm.

In 1914 three stations were established in Michigan, Wisconsin, and Indiana, in coöperation with the Bureau of Plant Industry, to provide for an expansion of the studies on cucumber mosaic. It was found that certain aphids and the striped cucumber beetle were responsible for transmission of this disease. In tidewater Virginia, lady beetles from California were introduced in large numbers, with the result of an apparent decrease in the damage by the spinach aphid. By 1916 the work incident to vegetable-insect control had so greatly increased that the Division was reorganized and the projects covering insects affecting ornamentals and shade trees were delegated to other divisions of the bureau.

On account of the additional responsibilities necessitated by the World War, the work on stored-product insect investigations was separated in 1917 and established as an independent division.

When this country entered the war a substantial expansion in appropriations and in consequent investigational effort took place. A fund for the employment of extension entomologists became available and nine were stationed in important truck-growing centers throughout the United States to aid in increasing production and lessening insect injury to vegetable food products. The sweet potato was placed upon the army ration and production was increased throughout the country with the result that the sweet-potato weevil, the most serious world pest of the crop and already established along the Gulf Coast, became transferred to several large producing inland districts in the South, and its establishment elsewhere was feared on account of the large demand for planting stock, in which this weevil is carried. Laboratories for the control of this pest were established in all of the Gulf States and studies begun as to the means for

preventing injury by the weevil in regions where it was already established. A comprehensive plan of attack, based on cultural practices was developed, whereby damage, and the possibility of introducing the weevil to unaffected localities, was minimized through the careful selection of stock used for propagation and the sorting of potatoes used for food supplies. These practices were introduced to the producers, whose coöperation was gradually enlisted, until by the time of the Armistice the spread of the weevil was thoroughly in hand, and an effort was made in three states where infestation was comparatively restricted, to effect complete eradication in certain key districts. One of these in northern Florida, after seven years of work was released as "weevil free" in 1924.

In 1920 the Mexican bean beetle was found to have increased its range, evidently through transportation in war material, and had appeared for the first time east of the Rocky Mountain Plateau near Birmingham, where an area of about twenty square miles was infested. A field laboratory and quarantine organization for the study of this pest was at once established, but it was soon found that due to the long flights of the insect in the direction of prevailing winds, quarantine measures were impracticable of execution.

In 1924 the work on truck-crop insects was reorganized, the projects being divided into eight, later nine, major groups. In 1927 the work on tobacco insects, heretofore under Southern Field Crop Insects, was transferred to this group.

Tropical, Subtropical, and Ornamental-Plant Insects. While the Bureau has carried on important projects concerning citrus-fruit insects from time to time, these projects were first organized into a major group under the head of "Insects Affecting Citrus Fruits" in 1909, and in the appropriation act of March 4, 1909 (35 Stat. L., 1039, 1051), a separate item was inserted "For investigations of insects affecting citrus fruits." After 1912, insects in this group were provided for under the head of "Tropical and Subtropical Insects." The designation of this group in the appropriation acts was subsequently changed several times,

the most recent being "Insects affecting tropical, subtropical, and ornamental plants and including research on the Parlatoria date scale and the Mediterranean and other fruit flies."

An investigation of citrus-fruit insects in California and one in Florida were begun in 1907. In Florida the white fly had been for many years one of the greatest obstacles to the success of the citrus-fruit industry, and it had been studied by both the Bureau of Entomology and the Bureau of Plant Industry. In 1905 a preliminary survey of the infested territory was made. A specific appropriation made for the study and control of this insect for the fiscal year 1927, enabled the Bureau to undertake life history studies of the white fly, natural control by parasitic insects and fungus diseases, and control by fumigation and by contact insecticides. By 1913 the investigational side of this project was substantially completed; inexpensive and effective methods of spraying had been found; and a series of orchard demonstrations was being carried on in Florida to serve as an object lesson of the efficiency of the methods of control developed in the experimental work of the Bureau. A circular on spraying and other reports on the white fly were published.

In 1912 the Bureau of Entomology began to participate in the investigation and control of the Mediterranean and other fruit flies, in coöperation with the Federal Horticultural Board. In that year the Bureau also began to coöperate with the Board in the inspection and certification of Hawaiian fruit offered for shipment to the United States, and in the investigation, inspection, and regulation of the entry of fruits imported from Mediterranean and other countries in which the fruit flies were known to occur. Investigations were also made of the life history, control, and natural enemies of the Mediterranean and other fruit flies. A study of the geographical distribution of fruit flies was begun in 1916, and an investigation of fruit flies and other tropical and subtropical fruit insects in the Canal Zone was begun in 1918.

In April, 1929, a Mediterranean fruit-fly infestation was discovered in Florida, and steps were immediately taken by the

Plant Quarantine and Control Administration, with the cooperation of the Bureau of Entomology, for the prevention of the spread and the eradication of this pest. The work of the Bureau in this connection is dealt with in the chapter on Activities.

Other important projects carried on by the Bureau under this head since 1907, were investigations of orange thrips, fruit flies in Hawaii, date-palm insects, tropical and subtropical insects in greenhouses, the fluted scale in Louisiana, the camphor scale, the Mexican fruit worm, the bulb fly, the lesser bulb flies, the narcissus bulb fly, and the citrus thrip. The investigation of tropical, subtropical and ornamental-plant insects continues to be one of the major groups of projects of the Bureau.

In the summer of 1907 an investigation of hydrocyanic gas fumigation, directed against certain scale insects on citrus trees in California, was undertaken by the Bureau and completed three years later. The investigation resulted in developing a more scientific method of fumigation, which greatly increased the efficiency and reduced the cost of this method of treatment. It was demonstrated that an orchard once fumigated by this method would remain clean for three years instead of requiring annual fumigation as by former less scientific methods.

Insects Affecting Southern Field Crops. In 1909 the investigation of a major group of insects designated as "Insects affecting Southern field crops." was begun, a specific appropriation therefor having been made in the agricultural appropriation act of March 4, 1909 (35 Stat. L., 1039, 1050), for the fiscal year 1910. These investigations included the cotton-boll weevil and other insects injurious to cotton, and insects affecting tobacco, rice, and sugar cane. The appropriation for 1910 also specified the Argentine ant in this group of investigations, much attention being given to this insect for a number of years. Appropriations in similar form were made for each subsequent year until 1929, when this group was discontinued. In the new grouping sugar cane and rice insects are considered in the cereal and forage group and tobacco insects in the group of truck crop

insects, and a separate group was organized for insects affecting cotton, where these insects are considered in this historical discussion. The Argentine ant is no longer an important object of investigation by the Bureau.

Cotton Insects. Investigations of insects affecting the cotton crops were originally considered under a major group entitled "Southern field crop insect investigations" organized in 1909. In 1928 a separate group for cotton insects was created, specific appropriation having been made for "Insects affecting cotton and including research on the pink bollworm of cotton," in the agricultural appropriations act of May 16, 1928 (45 Stat. L., 558).

The investigations of cotton insects that have been carried on by the Bureau of Entomology include the cotton-boll weevil, the cotton-root aphis, the cotton hopper, theArizona weevil, the pink bollworm, the cotton bollworm, and the cotton-leaf worm. Of these the most dangerous and destructive are the cotton-boll weevil and the pink bollworm.

The boll weevil (*Anthonomus grandis*) was discovered about the year 1892 in Texas, where it had been introduced from from Mexico. In the annual report of the Division of Entomology for 1894 it was described as "a new and very active enemy of the cotton crop. . . . It is in the shape of a weevil which bores into the bolls." A study was begun in 1895, but the work of dealing with the pest was then left to the State Entomologist of Texas because the Department of Agriculture had no funds that were available for this purpose. In 1899 the Division of Entomology, with the aid of local entomologists, began a work of mapping out the geographic distribution of this insect and of dealing with it systematically. The cotton-boll weevil reached the borders of Louisiana in 1903, Mississippi in 1907, and Georgia in 1915. The extreme northwestern border of Florida was reached in 1910.

The Bureau of Entomology estimates that the annual loss from boll-weevil depredations is well in excess of $200,000,000.[4]

[4] Farmers' Bulletin, 1329, p. 2.

As this insect pest spread throughout the cotton belt, it became such a menace to the cotton-growing industry that a considerable amount of money and effort was expended by the Department of Agriculture and by state and other organizations in the years that followed its introduction to combat the pest. Not only the Bureau of Entomology, but also the States Relations Service, the Federal Horticultural Board, and the Bureau of Chemistry of the Department of Agriculture, and many state, county, and municipal agencies, universities and colleges, business associations, and private individuals coöperated in this work, which is still being carried on.

As the result of these intensive studies, while no actual and radical remedy of an exterminative character has been found, a system of cotton-plantation management has been developed, based on these studies, which enables the planter to grow good crops, even in the presence of the weevil.

The Bureau has coöperated from time to time with the Federal Horticultural Board, and is now coöperating with the Plant Quarantine and Control Administration, in the work of exterminating the pink bollworm. This work, being mainly a matter of inspection and quarantine, has been dealt with by that Board and is now performed by the Plant Quarantine and Control Administration.

Japanese and Asiatic Beetles. The Japanese beetle (*Popillia japonica*) was first discovered in this country in 1916 near Riverton, New Jersey, by inspectors of the New Jersey Department of Agriculture, having probably been brought over directly from Japan in a shipment of iris roots. In 1917 the Bureau of Entomology began to give active attention to this pest, in 1919 a domestic quarantine against it was promulgated, and in 1919 and 1923 special items were included in deficiency appropriation acts for the prevention of the spread of this insect. Special items "To enable the Secretary of Agriculture to meet the emergency caused by the spread of the Japanese and Asiatic beetles" have been inserted each year since 1926 in the annual agricultural appropriation acts.

The Japanese beetle has a wide range of food habit and is causing loss to many kinds of fruit trees, such as apple, grape, plum, cherry, peach, and small fruits; various shade trees, such as the elm and maple; and sweet and field corn; and some other vegetation. It defoliates the trees and in some cases may eventually destroy them. While the insect is of little importance in Japan, in this country it has demonstrated such a capacity for injury and such a facility for spread that it is threatening to overrun much of the United States and do great damage. The beetle breeds most abundantly in lawns and pasture lands as a soil-inhabiting white grub. Within two years after its discovery in 1916, it had covered an area of six square miles, and by the middle of 1928 the infested area extended to over 21,000 square miles in New Jersey and parts of New York, Connecticut, Pennsylvania, Delaware, Maryland, Virginia, and the District of Columbia. The beetles are spread by flight and, between June 15 and October 15, may be carried in shipments of certain crops, into which they crawl, such as sweet corn, cabbage, lettuce, grapes, and forage crops, and in straw, soil, and compost.

No practical means of exterminating this pest have so far been developed. The Bureau of Entomology is attacking the problem of control by making biological and ecological studies of the insect; by studying its physiological activities, and the chemotropic and phototropic response of the beetle; by investigating arsenical compounds and arsenical substitutes as insecticides; by studying control of the beetle in soil; and by the introduction of parasites. Thorough and timely spraying affords effective protection to fruit and ornamental trees.

The domestic Japanese Beetle Quarantine No. 35 was promulgated September 24, 1918, effective June 1, 1919, and until June 30, 1928, its enforcement was entrusted to the Bureau of Entomology, in coöperation with the Federal Horticultural Board and with officers of the state of New Jersey, after which this function was transferred to the Plant Quarantine and Control Administration. The original order regulated the movement interstate to any point outside the townships of Delran, Chester,

and Cinnaminson, in the County of Burlington, New Jersey, of sweet or sugar corn only.

It was soon discovered that not only sugar corn, but also other farm products and greenhouse stock, soil, etc., were carriers of either the beetle or the grubs, and as the infested area was growing rapidly, Quarantine No. 35 was superseded by Quarantine No. 48, promulgated September 30, effective October 1, 1920, and this has been frequently revised from time to time to cover the newly discovered host plants and other objects and the increased infested territory.

It is recognized that this pest will ultimately spread widely in the United States. The main hope for the future is in natural enemies or the application of more effective methods of control than any which have so far been devised. Its natural spread by flight, which cannot be controlled, seems to be from five to ten miles per year. The object of the quarantine restrictions is to restrain its spread by long jumps on carriers, such as farm and truck crops and fruits and florists' and ornamental stock.

Quarantine No. 48, as revised and amended and now in force, regulates the movement interstate to any point outside New Jersey and the regulated areas of Pennsylvania, Delaware, New York, Connecticut, Maryland, Virginia, and the District of Columbia of: (1) Certain fruits, vegetables, and other farm products, between June 15 and October 15, inclusive, and (2) nursery stock, sand, soil, earth, peat, compost, and manure throughout the year.

State quarantines similar to the above, but restricting intrastate shipments, have also been promulgated and are being enforced by state officers in the infested states.

The Asiatic beetle (*Anomala orientalis*) was first established in Connecticut in 1926. Biological investigations and methods of control have been carried on by the Bureau and by the Plant Quarantine and Control Administration ever since. In its grub or larvæ stage it causes severe injury to lawns.

Other beetles more recently introduced from Japan, known as *Aserica castanea,* occurring in the vicinity of New York City

and on Long Island, and *Serica similis* discovered on Long Island, are being studied by the Bureau.

Insect Pest Survey. In March, 1921, the Bureau of Entomology, at the suggestion of entomologists of the state agricultural experiment stations and of other research and educational institutions, created an Office of Insect Pest Survey, in order that both the Bureau and outside workers in entomology might be kept more closely in touch with entomological conditions throughout the country. Before its inception there was no machinery for collecting statistical data on entomology other than the localized surveys of a few states and sporadic surveys carried on here and there to ascertain the distribution of some particular insects. This office is still in existence.

War Activities. Immediately after the outbreak of the World War the Bureau of Entomology devoted special attention to insect pests and beneficial insects affecting food production in the United States. Early in the spring of 1917 arrangements were made to secure additional systematic reports from various sections of the country regarding the prevalence of insects attacking food crops.

A Food Production Act of August 10, 1917 (40 Stat. L., 273, 274), made an emergency appropriation of $441,000 " For the prevention, control and eradication of insects and plant diseases injurious to agriculture, and the conservation and utilization of plant products." The activities provided for in this appropriation were carried on by the Bureau of Entomology and the Bureau of Plant Industry.

Another act, November 21, 1918 (40 Stat. L., 1045, 1046), appropriated $811,300 for " The prevention, control and eradication of insects and plant diseases injurious to agriculture, and the conservation and utilization of plant products." This included appropriations of $55,000 for " control of cereal and forage insects"; $22,000 for "control of stored-product insects"; $35,000 for " control of vegetable and truck-crop insects "; $30,000 for " control of sweet-potato weevil "; $45,000 for " control

of deciduous-fruit insects"; $10,000 for "control of citrus-fruit insects"; $20,000 for "control of insects injurious to live stock"; $3000 for "control of rice insects"; $9000 for "control of sugar-cane insects"; and $3000 "for general supervision of emergency insect-control work"; making in all $232,000 for special entomological work. These appropriations were in addition to those made in the regular annual appropriation acts.

With these additional funds, the Bureau of Entomology was enabled to enlarge its force of entomologists and to organize an efficient service for obtaining and distributing full and accurate knowledge of the exact conditions throughout the country, with reference to injurious insects, especially those threatening the staple crops, and to carry on demonstration work among the farmers. The reports which were received daily from the field were promptly digested and transmitted to all state and station entomologists and to others who were in a position to assist in reducing losses from insect attacks. The field workers, in cooperation with the state authorities, conducted an extensive campaign to disseminate this information concerning means of preventing insect ravages and to demonstrate proper methods of insect-pest control.

During the war the Bureau called the attention of the beekeepers of the country to the necessity of a great increase in honey, due to the shortage of sugar. It sent out specialists who held meetings, addressed over 25,000 beekeepers, visited apiaries, and gave personal instruction, with the result that the honey crop was greatly increased and a greater domestic consumption and a ten-fold increase in honey exportation were effected.

On account of the use of arsenic in munitions, conferences were held with chemists and insecticide manufacturers of the country with the view of bringing about a more conservative use of arsenic in insecticides and effecting a better distribution of the supply to cover the needs of farmers, fruit growers, gardeners, and others.

The Bureau of Entomology also rendered valuable war service by coöperating with other governmental agencies. It assisted the Quartermaster General's Department of the Army by inspecting quantities of grain and other material intended for shipment to Europe, and gave advice as to fumigation and other treatment when such stored products were found to be infested with insects. It also inspected warehouses and mills for the same purpose in many parts of the country.

The Bureau coöperated with the Office of the Surgeon General of the Army in the matter of experimental work in medical entomology. All insect remedies reported to the Medical Department of the Army were referred to the Bureau for opinion or for test. Extensive work was done on the subject of the body louse, and branch laboratories were established for experimental tests. Experts of the Bureau were engaged in some of the concentration camps on special work against disease-carrying insects. At the close of the war, one of these experts, a reserve officer, had charge of the great delousing plant at Camp Mills, through which troops returning from Europe were passed.

The Bureau also gave advice to representatives of the War and Navy Departments and the Shipping Board relative to insect damage to lumber and stored wooden implements.

CHAPTER II

ACTIVITIES

The activities of the Bureau of Entomology are mainly devoted to research and education, the only regulatory function being the enforcement of the Act of August 31, 1922 (42 Stat. L., 833) concerning the importation of the adult honeybee. The research work is directed toward the solution of economic problems in entomology. It includes studies of insects injurious to crops and crop products and the development of methods for eradication or control; of insects affecting the health of man and of livestock, and insects infesting human habitations or injurious to industries; and of beneficial insects including those which may be utilized as insect-controlling agencies in the solution of agricultural problems, and those forming the basis of certain industries or on which more limited industrial processes depend. The work of the Bureau is largely carried on in the field, only the administrative work, research on taxonomy, an insect pest survey, and some technical laboratory work being carried on at the central office in Washington. Over three-fourths of the employees are engaged in field work. Much of the field investigational work is carried on in coöperation with the state departments of agriculture and state agricultural experiment stations.

The field work is carried on in field laboratories of a more or less temporary character, where the expert workers can be in touch with the centers of activity of the injurious species of insects. The investigations cover cultural methods of insect control, whereby it may be ascertained, through intimate study of the life round of the insects in connection with farming methods, whether by variation of cultural practice the insect damage

may not be materially reduced. Insect parasites and other natural insect enemies of imported insect pests are studied, imported, and established, and by this means more or less control is obtained of insects introduced from other countries. Technical, mechanical, and chemical methods of control are studied and developed, including sprays and spraying machinery, fumigation for citrus orchards, nursery stock, mills, and warehouses, or trapping methods and other means of mechanical destruction. Sometimes all of these cultural, biological, and mechanical measures are used at the same time in dealing with a problem. The Bureau coöperates with the Plant Quarantine and Control Administration in preventing the introduction of new and dangerous insect pests.

The Bureau of Entomology has the largest organization in the world for investigation and research on insect pests. On June 30, 1929, it was actively engaged on seventy-six major projects in the investigation of at least five hundred insects known to be injurious to agriculture. There are, however, numerous other insects involved in these investigations which are not included in the primary list. Remedial treatment has been found for every important injurious insect in the United States, but continued efforts are being made to find something more effective or something simpler or less expensive.

The functions of the Bureau of Entomology are not defined in any organic statute, except in so far as they are mentioned in general or specific terms in the annual appropriation acts. The specific activities or "projects" of the Bureau vary from time to time according to the needs that arise. The annual appropriation act for the fiscal year 1930 (45 Stat. L., 1208) makes provision for the following official activities: The promotion of economic entomology independently or in coöperation with other branches of the national government, states, counties, municipalities, organizations and individuals concerned; insects affecting deciduous fruits, grapes, and nuts, including research on the Japanese and Asiatic beetles; insects affecting tropical, sub-

tropical, and ornamental plants, including research on the Parlatoria date scale and the Mediterranean and other fruit flies; insects affecting truck and garden crops, including insects affecting tobacco and sugar beets; insects affecting forests, including research on the gipsy and brown-tail moths; insects affecting cereal and forage crops, including sugar cane and rice, and including research on the European corn borer and for the control of the cricket in northwestern Colorado; insects affecting cotton, including research on the pink bollworm of cotton and boll-weevil research control work in Oklahoma; insects affecting man and animals; insects affecting stored products; taxonomy and interrelations of insects, including the importation and exchange of useful insects and an insect pest survey; and bee culture.

The entomological activities of the Bureau are considered under the following main groups: Deciduous-fruit insect investigations; cereal and forage insect investigations; cotton insect investigations; forest and shade-tree insect investigations; truck-crop insect investigations; bee-culture investigations; stored-product insect investigations; tropical, subtropical and ornamental-plant insect investigations; investigations of insects affecting the health of man and animals; taxonomy of insects; bioclimatics; insect pathology; insect morphology; exchange of useful insects; history of economic entomology; and insect pest survey.

The main and subordinate groups of present activities of the Bureau are known as " projects," each of which is discussed in the following pages.

Deciduous-Fruit Insect Investigations. The activities concerning the deciduous-fruit insects include life history studies of, and the development of remedies for, the more important insects attacking apples, peaches and other orchard fruits, blueberries, grapes, and nuts, and the Japanese and Asiatic beetles. These investigations are carried on under authority of the item of appropriation for " Insects affecting deciduous fruits, grapes and nuts, and including research in the Japanese and Asiatic beetles."

Apple Insects. The most important activity concerning the apple insects is laboratory work on a new treatment developed by the Bureau for the San José scale. This consists of an emulsion of the so-called red engine lubricating oils, replacing the lime-sulphur wash heretofore applied. These emulsions are being found to be more effective and less disagreeable than lime-sulphur and without injury to the trees when used for the treatment of the San José scale on all classes of deciduous fruits. The important facts of this investigation in the field were determined during the years 1921 to 1924, but the investigations of laboratory and other phases of the work are still in progress.

The Bureau is also giving attention to the codling moth which causes wormy apples. The present work is concerned with problems in connection with the quantity of spray residue on fruit at harvest time, involving the correction of spray practice, spray schedules, search for arsenic substitutes for spraying, and coöperation with the Bureau of Plant Industry and the Bureau of Chemistry and Soils in determining whether the arsenic on apples can be removed by the use of solvents.

Peach Insects. The peach-tree borer, which has been a menace to peaches and other stone fruit from the earliest times, has occupied the attention of the Bureau since 1915. While preliminary experiments were completed in 1918, additional investigations at certain points are still being carried on. The investigation of various materials for the destruction of the peach borer has resulted in finding that paradichlorobenzene was effective in destroying most of the borers without injury to the trees. This treatment has come into general use by the peach growers of the country and has replaced the expensive and laborious method of worming the trees in the spring and fall of each year.

Attention is also being given to a new oriental peach moth, information being obtained on the biology and habits of the insect and on control measures. The peach moth is a first cousin to the codling moth. It was probably introduced on Japanese

flowering cherry trees and was first discovered in Washington. It has spread to practically all states east of the Mississippi.

Experiments being made by the Bureau indicate considerable control by a combination of different measures, but as no effective method of control has been found, remedial work is still under way.

Blueberry Maggot. A study of the blueberry maggot has been occupying the attention of the Bureau since July 1, 1925. Owing to the presence of maggots in canned blueberries, officers of the national government have found it necessary to condemn more or less of the pack with resultant losses to the canners. A survey of the blueberry maggot situation has been made by the Bureau, and much ecological and other data bearing on the severity of infestation have been secured. Studies are being carried on of the biology, tropism, and other characteristics of the insect, tests of various remedial measures are under way, and promising results in control are being obtained from the use of powdered arsenicals. Investigations show that much can be done to reduce the fly population by proper sanitary precautions in packing houses, and educational work along this line is being carried on by the Bureau.

Grape Insects. The Bureau is carrying on studies of the biology of grape-leaf hoppers; the grape-berry moth; and the grape-root worm; of methods of dealing with the ravages of the rose chafer, which has become a serious pest of the grape and other fruit and shade trees and shrubs; and of improved methods of spraying for the grape-leaf hopper, the grape-berry moth, and other grape insects.

Nut Insects. Investigations are being carried on of insects attacking nuts. Biological studies are being made in Georgia and Texas of insects injurious to pecans, such as the pecan weevil, pecan-nut case bearer, pecan shuck worm, and the budmoth, attention being given to control experiments in pecan groves; baits likely to attract the moths are being tested; and tests of sprays for the control of the nut case bearer and leaf case bearer

are being made. In West Virginia studies are being made of the biology of several insects attacking chestnut and hazelnut and pecan trees.

Japanese Beetle. Work against the Japanese beetle is carried on in coöperation with the Plant Quarantine and Control Administration and the New Jersey and Pennsylvania State Departments of Agriculture. The work is sub-divided into the following sections: Administration, quarantine enforcement, biologic investigations, beetle and grub insecticide investigations, and field work.

The spread of the Japanese beetle has been rapid since its discovery in 1916. Within two years it covered an area of six square miles, and by 1929 the infested area extended to Massachusetts, New Jersey, New York, Connecticut, Pennsylvania, Maryland, Virginia and the District of Columbia. The beetles are spread by flight and are carried in the shipments of certain crops, into which they crawl, such as sweet corn, cabbage, lettuce, grapes, and forage crops, and in straw, soil, and compost. Scouting that has been carried on reveals a constant natural spread of the Japanese beetle which cannot be prevented. The beetles attack fruit trees, such as apple, grape, plum, cherry, peach, and small fruits; various shade trees, such as the elm and maple; and some other vegetation.

The Bureau is attacking the problem of control by making biological and ecological studies of the insect; by studying its physiological activities and the chemotropic and phototropic response of the beetle; by investigating arsenical compounds and arsenical substitutes as insecticides; by studying control of the beetle in soil; and by the introduction of parasites.

Biological and ecological studies of the Japanese beetle have been carried on since 1917. The Bureau has obtained a knowledge of its life history, habits, and injuries, its manner of spread, and the areas affected, in order to develop successful methods of control. Information is being accumulated concerning its success in becoming established in the United States to ascertain the possible seriousness of the pest, should it spread to

other localities not now infested. Detailed investigations are being conducted relative to the effect of environment, and of the relationship of temperature, humidity, food plants, soil, light and topography to the abundance of the Japanese beetle. New spray materials have been developed and certain foreign parasites have been established.

The physiological activities of the Japanese beetle in all of its stages are being studied in an effort to clarify certain phenomena encountered in insecticidal, parasite, toxicological, and pathological investigations. This work includes metabolic studies, correlated with changes in climatological conditions, food, and disease, and it is expected to result in a more comprehensive understanding of the beetle in its reactions to various stimuli and thereby to improve control methods.

The chemotropic and phototropic studies are expected to result in a material reduction in the cost of control. The insects are attracted for a distance of one-quarter to one-half mile by the odor of geraniol when sprayed on foliage. In this way they may be concentrated on a few plants and then killed with a contact spray. Traps have been devised, which when baited with geraniol will capture 10,000 or more beetles per day. Certain colors have been found to be attractive to these beetles, and by coloring certain insecticides their efficiency may be greatly enhanced.

Investigation of arsenical compounds as insecticides for the Japanese beetle has been made by the Bureau since 1920. Certain definite phases of this problem were completed in 1925 and 1926. A new material known as "oleate coated arsenate of lead" has been developed and commercialized. The application of this spray has increased the average number of beetles killed from about thirty per cent with the usual arsenical sprays to ninety per cent when the coated lead is used. Methods and time of application of sprays have been improved until it is now possible for the grower adequately to protect his fruits and other plants at a cost which is not prohibitive.

The Bureau has made studies of several groups of compounds, particularly those of barium and fluorine, some of which offer possibilities as substitutes for arsenate of lead, but this work is still incomplete. The Bureau has developed a pyrethrum soap which has been commercialized and successfully used against the Japanese beetle. On account of the toxic qualities of arsenate of lead to human beings, it is dangerous to use it for spraying fruit directly previous to harvesting, and the desirability of using a substance less harmful to man is apparent. The development of the contact spray has made possible the partial control of the beetle on flowering plants and early peaches.

A method of controlling grubs in turf and in soil balls about the roots of nursery stock has been developed, consisting of the application of carbon disulfide emulsion. This treatment of nursery plants enables plant growers in the infested area to ship their stock and thus to retain their trade. The treatment of golf greens and lawns with the emulsion prevents the destruction of the sod by the larvæ. A second method of rendering turf grub-proof, developed by the Bureau, is by the application of toxic compounds, such as arsenate of lead and certain silicofluorides mixed with the soil before seeding, or mixed with the top dressing after seeding.

The work of introducing Japanese beetle parasites into the United States was begun in 1920 and is still being carried on by the Bureau. By this means it is hoped to reëstablish a natural balance in this country similar to that in Japan. Work in the foreign field has resulted in the discovery of fourteen species of these parasites in Japan, China, and India, all but three of which have been successfully shipped in a living condition to the receiving station at Riverton, New Jersey. Of these, five are actually established.

Asiatic Beetle. Little is known about the Asiatic beetle, the study of which was not begun by the Bureau until 1926. Scouting has shown that the insect occurs in Connecticut and parts of New York. The larva is similar in its habits to the larva of the Japanese beetle and may prove to be a serious pest. As

a result of soil treatment large numbers of Asiatic beetles have been destroyed in New Haven, and valuable lawns have been saved from destruction.

Orchard Insecticides. Experimental work is being carried on with different insecticides and other means to determine the best and most economical methods of controlling orchard insects. The insecticides with which experiments have been made in recent years are calcium arsenate, dipyridyls and related compounds, pyrrols and related compounds, and petroleum oils as contact insecticides.

The use of calcium arsenate for orchard insecticidal purposes has proved a disappointment, but the poison has been of value when used against the cotton-boll weevil. In coöperation with the Bureau of Chemistry a large amount of dipyridyl and related pyridine compounds have been prepared and examined for insecticidal action, and while the investigation is still incomplete, the outstanding result is the discovery of a compound which closely approaches nicotine in toxicity. The study of pyrrols and related compounds as contact insecticides is also being made in coöperation with the Bureau of Chemistry and Soils, and may result in the discovery of a highly toxic substitute for nicotine.

The Bureau, in coöperation with the Bureau of Chemistry and Soils, is carrying on investigations to determine a number of important points concerning the use of petroleum oils in the control of orchard insects. Oil emulsions are extensively used for the control of the San José scale and other insects, and any improvements which increase the toxicity of the emulsions, or reduce the cost of materials and labor, are beneficial to horticulturists.

Cereal and Forage Insect Investigations. No group of insect pests directly affecting agriculture is of greater economic importance than those which injure cereal and forage crops under growing conditions. The various projects of the Bureau dealing

with these pests are carried on under items of appropriation "For insects affecting cereal and forage crops, including sugar cane and rice and including research on the European corn borer." Among the insects that are being studied under this head by the Bureau are the European corn borer, grasshoppers, the alfalfa weevil, the Hessian fly, the chinch bug, the corn ear worm, the native stalk borer, the alfalfa seed chalcis, the joint-worms, the billbugs, sugar-cane and rice insects, and other cereal and forage insects.

European Corn Borer. The European corn borer (*Pyrausta nubilalis*) is generally believed to be the most formidable pest of corn which has yet appeared in this country. So great is the menace of this pest that Congress has appropriated about fourteen and one-half million dollars for its study and control since 1918.

The mature form of the corn borer is a moth or miller and it is the immature or larval stage that bores into all parts of the corn plant and also attacks more than two hundred other plants.

The investigational and control work carried on by the Bureau of Entomology and the Plant Quarantine and Control Administration, respectively, in coöperation with state authorities and private organizations and individuals include: quarantines to restrict the movement through commerce of products that may be infested, in order to prevent long-distance spread of the pests; scouting to determine the extent of the yearly spread; clean-up of heavily infested areas to determine possibilities of control under farm methods and management and as a means of controlling spread; studies of life history and habits as a basis for methods of control; study of insecticides; introduction of parasites from Europe, Japan, and the Asiatic mainland, where the pest has been long established; and cultural practices in the planting of corn and the clean-up of farms.

In 1917 a clean-up campaign was authorized by Congress and an appropriation of $10,000,000 was made for carrying it on

in coöperation with the state authorities and individual farmers, an account of which is given in the preceding chapter.

There appears to be no possibility, however, of complete eradication. In addition to the activities of entomologists of this Bureau, agronomists of the Bureau of Plant Industry are studying the development of varieties of corn better adapted to corn-borer conditions, and agricultural engineers are endeavoring to improve and facilitate clean farming operations, with the view of making it possible to grow corn profitably in spite of the corn borer.

Grasshoppers. Destructive major outbreaks of grasshoppers occur periodically in certain regions of the United States, but minor outbreaks occur nearly every year in some parts of the country. During general outbreaks the total losses of crops throughout entire counties have been common. No very widespread outbreak of this pest has occurred in recent years. The Bureau has aided in developing cheap, effective grasshopper bait which is widely used throughout the country, and is still occupied with its improvement. In several states, an annual survey is made to determine the areas where outbreaks may be expected, and to take precaution to have the necessary supplies of poison and the organization to control the pest.

Alfalfa Weevil. The control of the alfalfa weevil has been occupying the attention of the Bureau since 1910. The weevil attacks alfalfa and clover. It has spread from the original infestation in Utah, some time previous to 1905, into Oregon, Idaho, California, Wyoming, Colorado, Nevada, Washington, and Montana, and in 1928 it was found in western Nebraska. The Bureau has developed a method of control through the application of an arsenical spray, and dusting experiments which seem promising are being made with land machines and airplanes. Parasites of the pest obtained from Europe have been introduced in large numbers with considerable success. Investigations to determine the possibility of limiting the spread of the pest through carriage in freight cars are under way. The

Bureau recently prepared a Farmers' Bulletin and a motion picture film describing the life history stages and the control of this insect.

Hessian Fly. The Hessian fly is a small fly or midge the maggot of which attacks the growing wheat, and is its most formidable enemy. It has destroyed hundreds of millions of bushels of wheat in a single year in the United States. During the season of 1918-19 there was a wave of infestation of this insect pest, when control measures were generally adopted which have materially reduced the damage. Studies have been made to determine safer dates for planting winter wheat, and this information has been published. A complete study of the parasitic complex of this pest has resulted in many important published contributions to the knowledge of insect parasites in general, and especially of the identity and biology of most of the twenty-nine species now known to attack the pest in this country. Annual regional surveys are being carried on to determine the relative abundance of the pest from year to year in the principal winter wheat-growing regions. Such information is regularly supplied to the states coöperating in the survey and is utilized by the wheat-growers to govern their efforts at control.

Chinch Bug. The chinch bug is a small insect, which is a serious enemy of wheat and is also very injurious to corn. Its ravages extend throughout the corn and winter-wheat states. During general outbreaks it causes losses running into millions of bushels of wheat and corn. The severity of the infestation depends greatly upon climatic conditions, dry weather being favorable to its increase. Investigational and experimental control work is being carried on by the Bureau. Several publications on the chinch bug have been issued, containing explicit information regarding effective methods of combat. During serious outbreaks advisory aid is extended to farmers, state officers, and extension workers.

Sugar-cane Insects. Research and investigational work is being done by the Bureau to obtain control of the insect pests

of sugar cane. A practical method of controlling the sugar-cane moth borer by soaking seed cane in water, either cold or hot, has been worked out. Parasites have been introduced from Mexico and Cuba and are now being brought in from Argentina. The native parasites are being investigated with a view to aiding them in their beneficial work, should this prove practicable. The relationship of insects as possible agents in the transmission of sugar-cane diseases, notably the rots and related troubles, is being investigated in coöperation with the Bureau of Plant Industry. An annual survey to determine the status of the sugar-cane moth borer in relation to sugar production is being made in coöperation with the Bureau of Agricultural Economics.

Rice Insects. The Bureau is studying the life history and methods of controlling rice insects. Parasites have recently been discovered which attack both the rice stalk borer and the sugar-cane moth borer, also a pest of the rice plants. Hibernation studies are being made of the rice water weevil and the rice stalk bug.

Other Cereal and Forage Insects. Much valuable information on the control and natural history of numerous serious pests of cereal and forage crops has been obtained. Research programs have been planned and practical control methods have been developed for such pests as the jointworms, cutworms, Southern corn root worm, corn ear worm, corn billbugs, sod webworms, the true armyworm, the fall armyworm, the alfalfa seed chalcis, the clover root borer, the clover flower midge, the alfalfa caterpillar, the green clover worm, and others. Publications have been issued reporting these results and carrying this information directly to the farmer.

Investigations of Insects Affecting Cotton. The investigation of cotton insects constitutes one of the important groups of activities of the Bureau. These investigations are carried on under authority of an item of appropriation "For insects affecting cotton and including research on the pink bollworm of cotton." The projects at present being carried on in this group of

activities are investigations of the life history and the development of means of control of the cotton-boll weevil, the Arizona weevil, the pink bollworm, and miscellaneous cotton insects.

Cotton-Boll Weevil. The cotton-boll weevil has occupied the attention of the Bureau of Entomology for thirty-three years. The insect thrives throughout the cotton belt, except in the extremely dry parts of the country such as western Texas and Arizona.

Control measures have been developed whereby a large part of the annual loss to cotton growers may be avoided. But while this has been accomplished, much remains to be done in the development of new remedies and the improvement of methods of applying old ones. Of all the various methods that have been tried, the most effective method of control so far developed has been the dusting of cotton fields at the proper time with calcium arsenate. For the determination of the best method of applying this poison, experiments are being made with various types of dusting machines and with airplanes.

The Bureau is studying the relation between the chemical nature of calcium arsenate and its effectiveness for insect control. Weevil hibernation studies are being made. The Bureau is also engaged in a check-up of various control measures, and is rendering service in testing proposed remedies and issuing warnings against the use of nostrums and useless so-called remedies.

Thurberia or Arizona Weevil. Another weevil known as the Arizona wild-cotton or Thurberia weevil is occupying the attention of the Bureau. In structure it is similar to the cotton-boll weevil, but it differs from that insect in several of its habits and in that it can stand higher temperatures and thrives in arid and semi-arid areas. Federal quarantines are being enforced by the Plant Quarantine and Control Administration to prevent movement from the infested area, and intensive scouting is under way to determine the extent of infestation in the cotton fields. Special studies are being conducted to determine

the feasibility and possible cost of some type of clean-up of the insect in nature as a possible permanent solution of this problem. Studies are also being made of the native host plant and possible methods of exterminating this plant.

Pink Bollworm. The Bureau of Entomology coöperates with the Plant Quarantine and Control Administration in its work of preventing the spread of the pink bollworm of cotton. It is engaged upon elaborate research investigations of this pest, covering such studies of the biology and habits of the insect as may aid in their control. Flight habits are being studied through the agency of the airplane. Experiments are being made of the possibility of control by parasites. Especial attention is being given to hibernation, survival, and emergence, with particular reference to the effect of different cultural practices on winter survival. This work is being carried on in the Laguna district of Mexico and in Texas.

Other Cotton Insects. The insects known as the cotton flea hoppers comprise a number of closely related species, which in recent years have appeared in almost every cotton-growing area in the main humid cotton belt. They attack the cotton plants in the early season by feeding all over the plant and puncturing it, causing the cotton to lose the fruit while the buds are very small. Investigations are being carried on by the Bureau to determine the possibility of at least reducing the damage by indirect control measures, such as field and ditch clean-ups. The use of insecticides, especially sulphur is also receiving much attention. The various species of these insects and the host-plant relationships are also under its investigation.

Increasing damage is being done to the cotton plant by the cotton leaf perforator and the cotton leaf worm, and biological and control studies of the former are being made at a station at Calexico, California. In the case of the leaf worm moths, special studies are being carried on to determine the relation between the wind conditions and the direction of migration of these moths. The Bureau carries on observations of other cotton

insects, such as the bollworm, grasshoppers, and various caterpillars, and advises farmers how to meet local outbreaks as they occur.

The Bureau is also making studies of insect activity in the upper air by means of insect-collecting traps carried between the wings of airplanes. These are important in connection with the questions of spread and movement of different cotton insects.

Forest and Shade-Tree Insect Investigations. There are five projects of the Bureau dealing with forest and shade-tree insects: Investigations of insects affecting forest trees; coöperative forest-insect control; insects affecting forest products; investigations of insects injurious to shade trees and hardy shrubs; and gipsy-moth and brown-tail moth research. These projects are carried on under authority of an item in the appropriation acts " For insects affecting forests and including research on the gipsy and brown-tail moths."

Insects Affecting Forest Trees. The work of dealing with insects affecting forest trees has been a continuous project for over twenty-five years. As now limited, it embraces problems east of the Rocky Mountains. Under it are maintained coöperative studies with the Forest Service experiment stations and miscellaneous investigations on forest insects. The service factor as contrasted to the following projects is only incidental. At present three field stations are maintained, two in coöperation with the Forest Service experiment stations, at Amherst, Massachusetts, and Asheville, North Carolina, and one near Washington. Approximately $20,000 is devoted to the maintenance of the work at these points. Eventually it is the aim to have entomologists at every Forest Service experiment station.

Studies of the major forest insect pests are conducted in order to learn more of the conditions favoring or detrimental to serious damage, and to make this knowledge available to the forester so that it can be applied in developing sound practices in timber culture. Some species of trees and some types of forests are little affected by insects, but even in such cases

insects may be the limiting factor in successful timber production. The growing of future timber crops in certain forest types is regarded as highly hazardous unless the practice is based on an adequate consideration of the insects affecting such types. In our common and highly artificial agricultural practices we have so altered natural conditions that we invite insect depredations, and consequently, we must wage a continuous war against these enemies. This applies equally well to our forests. Numerous examples might be cited where man's activities through selective logging or other alterations in the original forest have brought about insect epidemics. On the other hand under more natural conditions, such as existed in our original forests, a greater degree of stability is maintained. It is known from the experience of European foresters in their desire for immediate gains that serious consequences have resulted from entirely disregarding nature's methods. Therefore, as cultural practices for growing timber are developed, the complex relations existing in the forests must be more fully understood to avoid fatal mistakes. Insects are one of the most important of these biotic factors. They are usually considered chiefly in their rôle as destroyers of green standing timber, yet this is only one of a number of their relations. Other important rôles, such as bringing about changes in the composition of the forest, often increasing the percentage of less desirable species, inhibiting the reproduction of certain desirable species, affecting the rate of growth and thus lengthening the rotation period and augmenting the ill effects of fire, cannot be disregarded.

Some of the more important insects dealt with are the white-pine weevil, the larch sawfly, the spruce budworm, the pine tip-moths, the Southern pine beetle, and the turpentine borer.

Coöperative Forest-Insect Control Work. The coöperative control work is confined to the forested areas of the Rocky Mountain and Pacific Coast regions. It is carried on between the Bureau of Entomology and the Forest Service, the National Park Service, and other land managing agencies and private

timber land owners. Coöperation in insect control is necessary because it involves not only many technicalities based on an intimate knowledge of the habits of the specific insects causing the damage possessed by entomologists but likewise a detailed knowledge of the topography of the lands under control as well as close contacts with local labor and transportation facilities which are only available to the administrative officers on the ground.

In a memorandum of the Secretary of Agriculture dated February 16, 1920, details are given of the mode of coöperation between the Bureau of Entomology and the Forest Service and other government agencies which is still being followed. In this memorandum it is stipulated that the Bureau of Entomology shall be responsible for conducting surveys and for giving specific recommendations for control on the request of other federal agencies and for the assignment of an entomologist to the project during the period of control when conditions warrant. In other words, the Bureau of Entomology acts as a clearing house on all matters pertaining to the technique and advisability of control. This service is rendered to all federal agencies and to private timberland owners on request.

The various federal agencies administering timber lands are responsible for the protection of these resources from insects as well as from other destructive forces, and in the case of insect injury this responsibility involves: preliminary recognition of the injury; reporting of the situation to the Bureau of Entomology for expert advice; and control of the outbreaks. The actual control of insect outbreaks is conducted by the land-managing agencies by means of funds specifically provided for that purpose, after agreements as to methods and extent of control are reached through conference with the Bureau of Entomology.

In practice this coöperative method of dealing with the problem has been successful, and it is regarded as being much more practicable than if the entire work were carried out by one federal agency, or were all paid for out of a single fund.

The most troublesome of these insects are several destructive species of bark beetles, such as the Black Hill's beetle, the mountain pine beetle, and the Western pine beetle. Surveys of a considerable portion of the forests in the Rocky Mountains and Pacific Coast regions and Southern pineries have shown that the loss from this class of beetles amounts to from fifteen to twenty million dollars annually.

The major activities of the Bureau in this field consist of the technical administration of several control projects and examinations and surveys as a basis for recommendations concerning control, and continued research on the bionomics of several species. Methods of control have been developed, but these are improved each year. They have been adopted by many private owners and by national agencies having to do with timberland administration, such as the Forest Service and the Office of Indian Affairs.

Insects Affecting Forest Products. Experiments are being carried on and effective methods have been developed by the Bureau for the prevention of insect damage to crude and finished products, and educational and demonstrational work is being done. The insects which cause such injury are chiefly termites and powder-post beetles, which attack all types of wood construction and lumber in warehouses, yards, and mills, and cause an estimated annual loss of $45,000,000. It has been demonstrated that methods suggested by the Bureau, such as improvements in management, handling of stock, and proper storing, will prevent the greater part of the powder-post damage to seasoned woodwork. Many wood preservatives have been tested, found effective, and recommended for use in preventing damage to all types of wood construction and prolonging the life of the material. It has been demonstrated that by slight modifications in the construction of buildings, practically all termite damage can be prevented.

Insects Injurious to Shade Trees and Hardy Shrubs. With regard to the protection of shade trees and hardy shrubs against

insect pests, the activities of the Bureau consist largely of the distribution of information on well-known control methods and advice on shade-tree and hardy-shrub insect problems. A small amount of research on biology and control of several locally injurious insects has resulted in effective remedies. Informal cooperation is maintained with the National Park Service and with state and city entomologists.

Gipsy Moth and Brown-tail Moth. Since 1906 the Bureau of Entomology has been giving constant attention to the prevention of the spread of the gipsy and brown-tail moths. A special item appears annually in the appropriations for the Department of Agriculture " To enable the Secretary of Agriculture to meet the emergency caused by the continued spread of the gipsy and brown-tail moths."

These moths were both accidentally introduced into this country from Europe. The gipsy moths have gradually spread until they now cover all of New England, and have begun to invade New York, New Jersey, and Canada. The brown-tail moths are located in Maine, Massachusetts, and New Hampshire. The gipsy moth is not spread by flying. It spreads either by the small caterpillars being blown by the wind immediately after hatching, or by the egg clusters being carried on consignments of lumber, stone, or other products that may be shipped out of the infested area.

The caterpillars of the gipsy moth, which are hatched in the spring of the year, have voracious appetites and feed on many kinds of leaves, especially of the apple, oak, willow, alder, and birch trees. They also attack the foliage of shrubs and herbaceous plants. Repeated strippings of foliage by the moths for several years in succession usually kill the trees. In the case of evergreens, a single defoliage is sufficient to cause death to the tree. The brown-tail moth caterpillars feed on the foliage in the late summer when they are hatched, and again in the spring when they leave their winter resting places. These resting places are in the form of tents spun at the tips of twigs, which become conspicuous after the leaves have fallen in the autumn.

The Bureau conducts experiments to determine the best methods of controlling these insects, introduces and establishes parasites and natural enemies, and colonizes them in the infested territory, and it coöperates with the Plant Quarantine and Control Administration in the establishment and maintenance of a quarantine against the further spread of these pests. The Bureau also coöperates with state and local authorities in this control work.

For the control of the gipsy moths, barrier zones have been established and scouting is done by the Bureau to locate and destroy colonies of the gipsy moths within these zones. The extermination work is being carried on from these zones inward toward the center of the infested areas. Where egg-cluster infestation is found, the clusters are treated with creosote without removal from the trees, so that there will be no scattering of the eggs, the creosote killing the eggs by contact. This is usually done with a swab, soaked in creosote, on the end of a stick. In the spring, when the caterpillars are very small, infested trees are sprayed with arsenate of lead, which kills them by poisoning.

Another means of control is the liberation of parasites. Intensive studies are being made of several of the species of parasites that occur in European countries, in order to learn more concerning their habits in their native homes and to insure better success in establishment in this country. Out of over sixty species of parasites of the gipsy moth that have been imported, about fifteen have survived and have been established in the infested areas.

The most effective control of the brown-tail moth consists of cutting off and burning the winter tents in which the larvae are clustered. Another treatment is by spraying with arsenate of lead in the fall of the year when no fruit is involved or when the larvae leave their tents and resume feeding in the spring. Many of the parasites imported to destroy the gipsy moths also attack the brown-tail moths.

Truck-Crop Insect Investigations. The truck-crop insect investigations of the Bureau are divided into nine major groups, namely: sweet-potato-weevil control; bean insects; tobacco insects; pea insects; mushroom insects; berry insects; sugar-beet insects; soil insects; and miscellaneous truck-crop insects.

Sweet-Potato-Weevil Control. The sweet-potato weevil, a pernicious root and tuber borer in plants of the morning-glory family, is a beetle about one-quarter of an inch in length, steel blue and red in color. It is the most serious insect pest affecting the sweet potato, which it attacks in the larval form, tunneling through the tubers and stems, and rendering the crop unmarketable. Several isolated infestations in Florida, Georgia, Mississippi, and Alabama have been selected as test fields, and a force of inspectors stationed at each with a view to the development of measures by which attacks could be eliminated. These consisted of careful clearing of the ground from all crop remnants, selection of weevil-free seed potatoes, isolation of the draw bed, prevention of transportation of infested draws, and education of the growers to the importance of careful cultural methods. Weevil-free draws were supplied to growers whose entire crops were infested. The project has been materially assisted by the coöperation of the regulatory organizations of the affected states. Although declared "weevil free" since 1924, a research laboratory is still maintained at the test station at Sanford, Florida, in which additional studies of the conditions favoring weevil injury are being made. A laboratory at Biloxi, continues the eradication project in south Mississippi, with sub-stations and inspectors at Bay St. Louis and Picayune, Mississippi, and at Grand Bay, Alabama.

Bean Insects. The Mexican bean beetle is a native of the American continent extending in its range from tropic to tropic. It has been known for many years in the arid regions along the east front of the Rocky Mountain plateau and throughout New Mexico and Arizona, where it has seriously ravaged the bean crop. In the summer of 1920 it made its appearance in a small

infestation near Birmingham, apparently by transportation in supplies carried from Colorado. It has spread rapidly and has since invaded Mississippi, Georgia, Tennessee, Kentucky, Indiana, Ohio, North and South Carolina, Virginia, West Virginia, Maryland, Pennsylvania, Delaware and New Jersey, and is approaching the commercial bean growing districts of New York, Michigan, and Wisconsin. It has been found more than one hundred miles north of Toronto, Canada. It feeds primarily on all cultivated beans, but attacks certain related crops to some extent. It is a lady beetle about a quarter of an inch long, golden brown in color and bearing black spots on the wing covers. At the beginning of the investigation an attempt was made to control its spread by quarantine work, but due to the beetle's seasonal migrations by extended flight this method was found impracticable. A laboratory for the study of the insect was established at Birmingham, near the center of the infestation. The present activity of the Bureau involves the determination of efficient control measures, particularly since the bean plant is extremely susceptible to injury from the ordinary types of arsenicals and since the conditions encountered by the beetle differ somwhat from those found in its original home on the Rocky Mountain Plateau. The Mexican bean beetle promises to become a major pest of beans throughout its present range and is increasing its spread from year to year.

Laboratory work is now being carried on at Columbus, Ohio; Norfolk; Geneva, New York; and Estancia, New Mexico. Studies are being made of the life history and habits of the beetle, the ecological conditions suitable to its successful multiplication and hibernation, its natural enemies and parasites, and bilogical and other control measures. Tests are being made of arsenicals for use on bean foliage under different conditions, and an attempt is being made to develop new non-poisonous insecticides to control the insects when attacking snap beans. An investigator has also been sent to southern Mexico, believed

to be the original home of the beetle, where it is hoped to find parasites capable of controlling this pest in its northern distribution.

Studies of the bean leaf hopper, a serious pest of bean and potato, are also being undertaken at the laboratory at Columbus.

Tobacco Insects. The work on tobacco insects is carried on at a field station at Clarksville, Tennessee, with sub-stations at Quincy, Florida; Tempe, Arizona; and Chadbourn, North Carolina. At the main field station, tests have been under way as to means of controlling chemically the tobacco hornworms, which have long been injurious to tobacco, particularly to the large leaf varieties of tobacco. These are the larvae of large sphinx moths, which feed normally upon the nectar of flowers. A considerable list of chemicals suitable for use as attrahents have been tested and two promising aromatic compounds, constituents of flowers frequented by the insect and available synthetically, have been adapted to the control of the adults with the result of a substantial reduction in infestation in fields so treated. A thorough study of the various species of cutworms attacking the tobacco crop and of their biology and habits has been made. At the sub-station at Quincy, investigations are in progress leading to the control of the tobacco flea beetle and budworm, while at Chadbourn, an intensive study of the wireworms attacking tobacco under field conditions is being made. The sub-station at Tempe is charged with the control of the tobacco stalk borer, a serious pest to the new commercial production of tobacco of high nicotine content and suitable for insecticidal purposes, the climate and soil there being particularly suitable for production of these grades of tobacco.

Pea Insects. The pea aphid, particularly with reference to its attack on cannery peas, has proven to be one of the most serious and difficult pests with which entomologists have had to deal. It is a small green louse-like insect about one-eighth of an inch long, which multiplies rapidly and under suitable weather conditions increases to such an extent that it may lit-

erally be gathered by the bushel from infested fields. It sucks the sap from the pea vines, thereby reducing the yield and quality of the crop and ultimately killing the vines. A station at Madison, Wisconsin, has been established for the investigation of this pest, with a sub-station at Columbus, Wisconsin, an important cannery center, during the summer. Investigations are being made of the value of contact insecticides, such as nicotine dust, and a mechanical contrivance, the aphidozer, resembling the old-time reaper, which gathers the insects into a metal pan, has been tested with some success in collecting large quantities of the aphids from broadcast peas. Biological studies are being made with a view to foretelling outbreaks and rates of dispersal as aids to intelligent control practices.

Mushroom Insects. In the large mushroom district occupying a portion of Chester County, Pennsylvania, are produced the major proportion of commercial mushrooms grown in the United States with a value of more than $5,000,000 annually. Several serious insect pests, including the mushroom mite, two or more species of mushroom maggots, and mushroom springtails have caused serious losses in the industry, and a section with headquarters at Arlington, Virginia, and Kennett Square, Pennsylvania, is now investigating the life history and control of these insects. The relation of insects to the transmission of two serious mushroom diseases is also the subject of an investigation in coöperation with the Bureau of Plant Industry.

Berry Insects. Three serious berry diseases, the red-raspberry mosaic, the mild mosaic, and the raspberry-leaf curl, have caused severe losses in commercial fields of raspberries in New York, Michigan, Wisconsin, and Minnesota, and in the Pacific Northwest. In coöperation with the Bureau of Plant Industry, the Bureau of Entomology undertook studies of these diseases in 1926, and has since been pursuing investigations of the insect carriers responsible for their dispersal in commercial berry plantings. Experimental work is also being carried on at Baton Rouge against the strawberry weevil and the strawberry root

aphid. Studies of the life history of these insects and tests of effective control measures are being undertaken.

Sugar-Beet Insects. A field station was established in 1924 at Twin Falls, Idaho, in which a continuation of the studies with reference to the sugar-beet leaf hopper is being conducted. The project is being attacked from a new angle and with particular reference to its ecological aspects. In the sections of the West subject to " curly top," a movement of leaf hoppers occurs under certain climatic conditions favoring early ripening of the wild food plants in the territory surrounding the sugar-beet regions. The leaf hoppers migrate for considerable distances, carrying with them the virus of the disease from affected wild host plants, entering and inoculating the fields extensively, and causing serious losses. Climatic conditions favoring the retention of the leaf hoppers on their wild host plants are readily determinable by an annual survey of the breeding grounds and a knowledge of weather conditions thereon. An effective plan for the prediction of a probable severe attack before planting time for the beet crop, has been worked out and is resulting favorably in the localities in which it has been tested. Complete biological and ecological studies of the insect and its transmission of this disease with a view to determining the regions most unlikely to be subject to attack by virtue of surrounding conditions, for the extension of sugar-beet planting, are also under way. At substations at Richfield, Utah, and at Berkeley, California, correlations of seasonal migration and seasonal history work are being conducted.

Soil Insects. There are two types of wireworms attacking cultivated crops in the United States, and one of these, the dry land or cultivated land type of wireworm, particularly injurious in the Rocky Mountain and Pacific states, has long been a puzzle as to effective control measures. Most of the Eastern wireworms lay their eggs in grass lands and the larvae are driven to feed upon cultivated crops by the interruption of their feeding grounds by cultivation during their two or three years' life his-

tory in the soil. In the Pacific states the injurious species of wireworms possess a different life history, depositing their eggs directly in cultivated ground and attacking the crops planted therein primarily. Since wireworms are subterranean insects feeding at the roots of plants, the methods of treatment are involved and difficult, and as yet they are only partially successful. Two principal stations are charged with work in these lines, one being at Walla Walla, with a sub-station at Toppenish, Washington, while the other is at Alhambra, California, with sub-stations at Garden Grove and San José. Complete life history studies of these wireworms, investigations of their damage to various crops, reactions to environmental and other stimuli, soil fumigation as control, stomach poisons, traps, and the effects of crop rotation, mechanical control, and soil moisture are among the features being studied.

Miscellaneous Truck-Crop Insects. Other insect studies made by the Bureau of Entomology which do not properly fall within any of the above-mentioned groups or projects, include investigations of the European earwig, the brown vegetable weevil, the corn ear worm, the Porto Rican mole cricket, the seed corn maggot, the celery leaf tyer, the pepper weevil, the potato stalk borer, the sweet-potato wireworm, the Colorado potato beetle, the potato flea beetle, and various forms of aphids. Insecticide studies are also being made.

The European earwig, which has become established in localities both on the east and west coasts of the United States, is a serious pest of garden crops as well as of ornamental plants, particularly in the Pacific Northwest. An effort is being made to devise traps and baits suitable to the control of the pest, and arrangements are being made for the importation of European parasites. Comprehensive studies are being made of the food plants and of any reactions of the insect which may afford opportunities for the adaptation of control measures. This work is being carried on at Puyallup, Washington.

An investigation is being made at Gulfport, Mississippi, of a recently imported pest known as the brown vegetable weevil.

It is about one-half inch in length and possesses a peculiar life history. It attacks a number of important vegetable crops and has shown considerable capacity for damage.

Studies of the corn ear worm in its attack on tomatoes and beans, and studies of the life history of certain Southern cucumber beetles are being made at Baton Rouge.

The Porto Rican mole cricket, and the seed corn maggot in its attack on early potatoes, are being studied at Chadbourn, North Carolina.

Studies of the celery leaf tyer, the most serious pest of celery, are being conducted at Sanford, Florida, and at Alhambra, California.

Other crop-insect-pest studies are made at various stations of the Bureau.

Bee-Culture Investigations. The work in apiculture at present carried on by the Bureau of Entomology under the item in the appropriation acts "For bee culture" comprises the following projects: Bee behavior, regional beekeeping methods, intermountain bee culture, physiology of bees, demonstration work in beekeeping, bee diseases, and southern states bee culture.

Bee Behavior. In order to maintain profitable commercial apiaries it is necessary to have a proper understanding of the principles involved in bee behavior. The aim of the Bureau in undertaking this activity is to learn the basic principles of bee behavior with the view to correctly applying these principles toward the production of honey. Attention has been given to queen-rearing. Detailed observations have been made on the feeding of larvæ. The behavior of the honeybee in collecting pollen and the manipulation of wax scales have been studied. In order to minimize winter losses, many phases of the wintering problem have been undertaken. Investigations on the temperature of the cluster and on heat production of honeybees in winter have resulted in giving specific directions to beekeepers for preparing their colonies for wintering, whether wintered outdoors in packing cases or in cellars. Different types of insulating mate-

rials for packing bees have been tested and the ones most efficient and economical have been recommended. The weakening of colonies through swarming has been much reduced in commercial yards, largely through information resulting from a study of swarm control. Methods for the production of high grade comb honey have been worked out. The effect on honeybees of spraying fruit trees with arsenicals has been investigated.

Studies on the brood-rearing cycle of the honeybee have been made. An investigation of the different races of honeybees has been undertaken to determine both their biometric and biological differences. The genetics of the honeybee is also receiving attention.

The effects of weather factors upon flight activity and upon other behavior of bees in gathering nectar and upon the temperature conditions within the hive during the active season are all receiving attention. For measuring the flight activity of honeybees, automatic recording apparatus has been devised. The Bureau has issued nineteen publications dealing with various aspects of bee behavior.

Regional Beekeeping Methods. The Bureau is carrying on a survey of all the principal honey producing regions in the United States. This was begun in 1921 and will continue until all the regions will have been surveyed.

Surveys have been made of the so-called tulip-tree region, buckwheat region, and clover region, and specific directions have been given for managing bees in those regions. Data are being gathered on other regions but such work is necessarily slow because the Bureau's resources do not permit the sending of observers directly into the field. Data for drawing isophenes of the principal honey producing plants are being collected. Samples of honey from all principal sources in the United States have been collected and studied, and a set of standard grades covering all classes of honey has been recommended to the trade.

It is of economic importance to know the type of beekeeping to follow in any particular region: the method of wintering,

whether outdoors or in cellars; the method of swarm control; whether the character of the nectar flow favors the production of comb or extracted honey; or the raising of queenbees or package bees for shipment; all these depend upon the character of the region involved. Knowledge of the type of bee diseases to expect and their treatment, and of the exact character of various regions is of extreme value to the migratory beekeeper.

The classification and grading of honey is an important adjunct to its successful marketing. With the coöperation of the Bureau of Agricultural Economics an instrument for determining the colors of extracted honey was adopted, and United States grades have been recommended for both extracted and comb honey. With the coöperation of the same Bureau a study on the cost of production of honey in the various commercial-producing regions is under way. The Bureau is coöperating with the Bureau of Chemistry and Soils by obtaining samples for analyses of the various honeys produced in this country.

Intermountain Bee Culture. A special study of intermountain bee culture methods was begun by the Bureau in 1926, and a laboratory for doing investigational work has been established at Laramie, Wyoming. As the states in the intermountain region produce more honey for shipment than any other section; and the majority of beekeepers in this region are commercial producers, special studies are being made here where the beekeepers are continually confronted with peculiar problems concerning swarm control, wintering, disease eradication, and numerous others.

Physiology of Bees. In order to understand many reactions of the bee to manipulations or environmental factors or to be able to induce the bees to produce more honey than is needed for their own maintenance—the bee never having become domesticated—it is necessary to obtain an intimate knowledge of the structure and functions of various organs in the body of the bee, and thus to take advantage of its honey storing instincts. The reaction of bees to lights of various wave lengths and intensities has been studied to some extent.

The embryology of the honeybee has been worked out and details of the morphology of the honeybee larva have been completed. To know the structure and functions of the sense organs and the influence of odors on activity, the anatomy of the honeybee has been painstakingly studied, and experiments have been made on the rate of growth and feeding of honeybee larvæ. The utilization of carbohydrates by honeybees has also been studied. At the present time the Bureau is giving attention to the utilization of other food products and the physiological changes taking place within the body of the bee during various seasons of the year.

Demonstration Work in Beekeeping. During the World War, the Bureau of Entomology had as many as eighteen men in the field at one time, who worked in close coöperation with the state extension services for the purpose of stimulating the production of honey and organizing and instructing the beekeepers in the best methods of production, in order to help in replacing the shortage of sugar. The work of these men was gradually taken over by the several state extension divisions, and by 1924 none was in the employ of the Bureau. The present activities of the Bureau along this line consist of giving assistance in demonstrations and meetings held by beekeepers in various parts of the United States, the attendance of members of the Bureau staff at such meetings, and preparing and sending out for use at such meetings, letters, lectures, lantern slides, and moving pictures.

Bee Diseases. It is estimated that bee diseases take an annual toll of at least $2,000,000, in spite of all that is known concerning them. Definite causes for several of the more serious bee diseases have been ascertained and control methods have been devised, so that with this knowledge available, it is possible to make a success of beekeeping in any place in which there occurs an abundance of nectar-producing plants. The Bureau is now attempting to determine definitely the agencies through which these diseases spread and to evolve methods of preventing their spread.

Almost every advancement made in this country in the study of bee diseases is directly attributable to investigations which have been made by the Bureau. Methods have been evolved for successfully combating European and American foul-brood, diseases which have been so destructive that many beekeepers had to discontinue entirely the keeping of bees, and fruit growers were seriously handicapped by the removal of their most dependable pollenizing agent. Other bee diseases have received careful attention. The Bureau diagnoses hundreds of samples of adult bees and brood as an aid to the beekeepers and state apiary inspectors. Twenty-seven publications have been issued by the Bureau dealing with bee diseases.

In connection with the study of diseases of bees, the Bureau administers the act of August 31, 1922 (42 Stat. L., 833) entitled "An act to regulate foreign commerce in the importation into the United States of the adult honeybee (*Apis mellifica*)." Under this law only scientific institutions, queen-breeders, and individuals qualified to conduct scientific investigations are permitted to import queenbees. All orders for foreign queenbees must first be sent to the Bureau, to be forwarded to the foreign queen-breeder. Shipments of queenbees with the attendant worker bees are examined by the Bureau immediately upon entry in this country, and if found free of the mite *Acarapis woodi,* are forwarded in new cages with new attendant worker bees to the consignee.

Southern States Bee Culture. The Southern States Bee Culture Field Station was established to study the many special beekeeping problems of importance in the Gulf states. In this region are located the centers of the package-bee and queen-rearing industries of this country. Commercial honey producers from other states buy large quantities of bees in packages and also large numbers of queenbees from this region each year. Honey production in this region presents peculiar problems, which are receiving attention.

Stored-Product Insect Investigations. Important projects are being carried on under an item of appropriation for "insects affecting stored products." The general supervision of the work is exercised from the central office in Washington, which also conducts much research work of a miscellaneous nature. The field activities are covered by seven permanent stations in which important problems dealing with the biology and control of insects attacking stored-grain insects, bean weevils, and dried-fruit insects are under way. These investigations cover the control of insects attacking agricultural products for human consumption held in storage as well as manufactured vegetable and animal products, and also include the group of insects infesting households, except in their rôle as vectors of diseases affecting man and animals. The investigations have for their object the conservation of grain crops from the time that they are harvested until they have reached and been used by the ultimate consumer, involving protection through the various warehousing, manufacturing, and other commercial transactions necessary for proper marketing. They include projects on stored-grain insects, such as the corn and rice weevils, the Angoumois grain moth, the flour beetles, bean and pea weevils, insects attacking dried fruit, the tobacco or cigarette beetle, and insects affecting other vegetable and animal products in storage, such as the ham skipper, cheese mites, and the clothes moths. The various projects thereunder are outlined as follows:

Grain Insects. The development of methods for conserving stored grain and grain products from insect attack is the most important project of this branch. Under it are made investigations of insects destructive to corn, wheat, rice, and other grain crops from the time they are harvested until they are used by the consumer. Not the least of these studies are those of pests destructive to milled grain products, such as flour, meal, breakfast food and animal and poultry feeds, grains stored on the farm, transported by rail or ship, or held at local and terminal elevators, and the pests occurring in and distributed by flour mills.

At Sligo, Maryland, an investigation of the Angoumois grain moth as a pest of the eastern winter-wheat belt is being conducted. The Angoumois grain moth is a small moth, about one-half inch in wing spread, which feeds as a larva inside the kernels of wheat, corn, and other grains. It has long constituted a serious problem in the North Atlantic states. The first summer generation deposits its eggs in the field on the heads of ripening grain, and the larvæ are carried into the storage rooms on the farm at harvest time. The later generation feeds on the stored grain, especially when the grain is stored with the straw in the barn for ripening before threshing. The normal weight of a bushel of grain under the worst conditions is sometimes reduced nearly seventy-five per cent by the attacks of this pest. Improved methods of handling have reduced injury from the Angoumois grain moth materially as a result of the studies accomplished under this investigation.

At the Kansas City laboratory studies are being made of the insects which secure entrance to flour at the mill and which frequently, particularly during the holding of flour for ripening and under the conditions encountered on export docks and ships, cause material injury and loss of quality. Special attention is being given to protect from insect infestation flour designed for export, in order to maintain the American reputation for quality on export flour and to meet any possible objection from the standpoint of foreign pure-food laws.

At the Thomasville, Georgia, laboratory is conducted the work to conserve corn grown through the South from weevil attack. In Southern corn fields the rice weevil is likely to attack the corn before it is brought from the field, and a thorough infestation is accomplished before the grain can be placed in storage. Appropriate treatment to destroy the primary infestation immediately after the harvesting of the corn has been devised, particularly with reference to the elimination of the common practice in the South of storing the corn in the husk, which favors the retention of all weevils brought in from the field.

Bean Weevils. Two laboratories at Alhambra and Modesto, California, conduct investigations of the common bean weevil and the Southern cowpea weevil as pests of beans and peas grown commercially in California. Additional investigation has been made of the broad bean weevil. These weevils gain access to the beans in the field by depositing their eggs upon the pods and continue to breed in the stored product after harvesting, often rendering large quantities entirely inedible as they feed within the seeds. Several generations may result in the stored product when held over under favorable conditions if the infestation which takes place in the field is neglected. The discovery has been made that most serious losses from the infestation of beans in the field are due to neglected seed held in storage from preceding years near fields of growing beans. Cooperative examinations of farm deliveries at the warehouses assist materially in this investigation, and the organization of bean-weevil committees in the principal bean-growing sections is assisting materially in putting into practice the methods developed for producing clean bean crops.

Dried-Fruit Insects. A field laboratory at Fresno is engaged in investigating the principal insects infesting dried fruits, including large-scale practical experiments to determine the value of various control measures. Among the pests most injurious in this connection are certain fruit beetles and the Indian meal moth. The fruit beetles attack dried fruits on the drying racks, in the fields, and even at times on the trees. One serious difficulty is occasioned by the transmission of yeasts and other micro-organisms by these beetles from one fruit to another, rendering each fruit so visited sour or decayed. It has been found that processing practices, fumigation, orchard and farm sanitation, and the proper adaptation of packing house equipment and methods improve materially the quality of the product as received by the consumer.

Household Insects. This project deals with the control of such household pests as cockroaches, house ants, tow bugs, and

carpet beetles, particularly such important fabric pests as the clothes moths. Aside from the damage done in the household, these latter insects attack a wide range of animal substances (wool, hair, furs, feathers, casein, etc.) and are on this account of great importance to manufacturers and warehousemen handling such products. In addition to the information published for the aid of householders, tests of cedar chests have been undertaken and studies of mothproofing solutions have pointed to much of advantage in the protection of woollen goods, carpets, and furniture.

Insects Affecting Confections, Meat, Hides and Tobacco. An investigation of insects affecting confections employing nut meats, cocoa beans, cocoa malt preparations, and similar products is also under way, and studies are being made of insects attacking cured meats, such as hams, bacon, and dried beef. In this group also are included the insects attacking hides and skins prepared for the production of manufacturing leather and furs. These are likely to become seriously infested by such pests as the clothes moths and larder beetles while in storage, at points of collection, and during transportation, and serious losses are exacted. The tobacco or cigarette beetle, which deposits its eggs upon leaf tobacco in storage, and which frequently ruins manufactured tobaccos, particularly cigars, by boring out through the wrapper, is also under investigation.

Fumigation and Cold-Storage Experiments. At the Washington headquarters studies are being made of the effect of various fumigants upon insects and conditions best suited to their safe and successful application under commercial requirements. The value of cold storage of certain food products, furs, and household materials as a protection against the attacks of injurious insects is also subject to investigation.

Tropical, Subtropical, and Ornamental-Plant Insect Investigations. The Bureau of Entomology, under the item of appropriation "For insects affecting tropical, subtropical and ornamental plants and including research on the Parlatoria date

scale and the Mediterranean and other fruit flies," carries on investigations of the Parlatoria date scale, greenhouse insects, bulb insects, citrus insects, citrus thrips, the Mexican fruit worm, fruit flies, and insects affecting miscellaneous ornamentals.

Parlatoria Date Scale. The Parlatoria date scale has been an object of study by the Bureau of Entomology since 1913. It has infested the date palms in California, Texas, and Arizona and if unchecked would completely destroy the date-palm industry there. The Bureau's work consists of biological studies of this pest to devise an improved method of control. The control work is carried on by the Plant Quarantine and Control Administration.

Greenhouse Insects. Since the method of cyanide fumigation was developed by the Bureau of Entomology and calcium cyanide came on the market, it has been practically universally adopted by the florists of the country, all other fumigation methods having been discarded. The Bureau is carrying on technical experiments looking toward improvement in method, and making investigations in the general field of fumigation, including the testing of various dosages and exposures on a variety of plants, such as orchids and bulbs. Attention is also being given to the general subject of insecticides from the greenhouse standpoint, experiments being carried on with nicotine sulphate dusts, free nicotine dusts, oil emulsions, and the like.

Bulb Insects. Life-history studies of the larger bulb fly are being carried on and experiments are being made in the disinfection of bulbs. Several years ago the Federal Horticultural Board discovered that bulbs imported into this country were infested, especially the narcissi, and gave notice of a quarantine against the importation of these bulbs, and later against their interstate shipment. The Bureau is making a study of the domestic plantings of these bulbs to determine their condition with respect to infestation, and is endeavoring to prevent its further spread.

Citrus-Fruit Insects. An investigation was made during the years 1907 to 1920 of the citrus-fruit insects in California, in the course of which the use of hydrocyanic acid as an insecticide was discovered by experts of the Bureau, and fumigation methods were developed and standardized for the citrus industry. As a result practically every grove of any importance in California is regularly fumigated. Since this discovery cyanide fumigation has been resorted to for the removal of insect and other pests in houses, factories, mills, ships, cars, warehouses, greenhouses, etc., and extensive cyanide fumigation plants have been erected by the Federal Horticultural Board and the Plant Quarantine and Control Administration at ports of entry for the fumigation of imports.

The Bureau is now occupied with the problem of dealing with citrus-fruit insects in Florida, where the climatic conditions make the fumigation method unsatisfactory. Its work in this field comprises investigations of insecticides and control and biological studies, the latter of which have in recent years been concentrated on the new citrus aphid. Investigations have resulted in the discovery of lubricating-oil emulsions as insecticides, various types of which have been perfected. Lubricating-oil emulsion has become the standard remedy for white fly and scale insects in the Florida citrus belt. It has also been adopted in other fields, such as in the deciduous-fruit orchards, and in the treatment of park and shade trees. This work of the Bureau includes experiments with oils, oil emulsions, and emulsifiers. A satisfactory sulphur treatment has been discovered for the mite which is responsible for the russeting of citrus fruits.

Citrus Thrips. The Bureau has recently completed biological work on the citrus thrips and is making efforts toward satisfactory control.

Mediterranean Fruit Fly.[1] On April 6, 1929, discovery was made of the presence at Orlando, Florida, of the Mediterranean

[1] This subject is more completely dealt with in: Institute for Government Research, The Plant Quarantine and Control Administration. Service Monograph 59.

fruit fly. Confirmation of its identification was made in Washington on April 10. Work of combating the spread of this pest was at once begun by the Plant Quarantine and Control Administration, assisted by the Bureau of Entomology, which carried on the research.

This research work at once became the most important activity of the Division of Tropical, Subtropical, and Ornamental-Plant Insects of the Bureau. The laboratory of the Bureau at Orlando diverted all its energy to research on this insect, and the fruit-fly laboratories in Hawaii and Mexico were also utilized. The research in Florida as outlined by the Bureau covered:

(1) The development of effective sprays for the adult flies, and a checkup of these sprays as they are applied in the eradication campaign, the checkup being concerned both with the chemical nature of the materials under largescale operations and the effect of the sprays on the trees; (2) the development of attractants for the adults and the use of these attractants in traps throughout the infested territory, thus making it possible to follow the rise and fall of the fruit-fly populations, both in relation to the application of sprays in this territory and in relation to the elimination of hosts; (3) a quantitative survey of the wild fruiting plants in the infested territory to determine the facts and possibilities of spread of the fruit fly into uncultivated areas; (4) a similar survey of cultivated fruiting plants to determine the hazards from the presence of cultivated plants not exposed to attack by the fly in other countries; (5) experiments under caged conditions to determine what wild or cultivated fruits the fly will accept for oviposition if deprived of other host material; and (6) the development of methods of treatment which will guarantee susceptible fruits against the possibility of introducing infestation into other parts of the country.

The results up to the middle of the year 1929, have been the development of a more effective type of poison spray to kill the adult flies in orchards; the development of attractants to facilitate the collection of adult flies in orchards or elsewhere to determine the presence or spread of the pest; the development of a fumigant with which to kill adult flies in motor and

railway cars, buildings, and other premises; and the determining of methods for sterilizing fruit by refrigeration or heat. The latter methods are expected to make it possible to utilize all fruit not actually infested.

Studies are being made of wild and cultivated fruiting plants that might serve as hosts for the fruit fly. A calendar for all known hosts has been developed, showing the periods throughout the year in which these host plants are in fruit in Florida and liable to infestation.

A study has been made concerning the distribution of citrus fruits, the quantities produced and the dates of maturity, in order to indicate the fly hazard in relation to maturity and to the shipping problem.

At the Hawaiian laboratory tests have been conducted with different attractants advocated in other countries, the Mediterranean fruit fly being abundant in Hawaii; investigation was made of the possibility of larvæ surviving in citrus juice, this issue having been raised in connection with some of the disposal practices in Florida; studies in the susceptibility of Guatemalan avocados and of the parasites of the fruit fly have been made; and experiments have been conducted concerning the extremes of temperature at which larvæ cannot survive in infested fruit.

The determinations made by the Bureau as to host relationships of fruits and vegetables and other results of the research work have been utilized by the Plant Quarantine and Control Administration in making, in modifying, and in revoking quarantine restrictions.

Other Studies. Other studies relate to ant control with calcium cyanide dust and tests of various wood treatments against termites.

Investigation of Insects Affecting the Health of Man and Animals. Investigations are being made by the Bureau on the development and the determination of means for the control of insects affecting man and cattle, horses, sheep, goats, poultry,

and other animals and birds, including studies on fleas, flies, mosquitoes, the cattle grub, the horn fly, the wool maggot, the screw worm, poultry lice, mites, ticks, and others. Some of this work is done in coöperation with the Bureau of Animal Industry and the Public Health Service. Life histories of these different pests are determined with a view to discovering the particular period in the life of each species when control methods may be most effectively employed. Experiments are being conducted for the development of new and better methods of control or eradication, including the development of new insecticides and methods of applying them and the development of repellants and attractants. Whenever an effective remedy for a destructive insect is developed or an important discovery is made, the information is given to the public in the form of bulletins and statements through the public press. This activity is carried on under an annual appropriation "For insects affecting man and animals."

The work of the Bureau on mosquitoes as early as 1898 was largely instrumental in the elimination of yellow fever in Havana. The important points in the life history of malaria-carrying mosquitoes have been worked out, and control remedies have been devised including the use of the airplane in distributing the proper insecticides. The cause and prevention of creeping eruption have been discovered. Methods of suppressing and preventing the breeding of the housefly, the mechanical carrier of typhoid fever, have been developed and have been of great help to state boards of health.

Effective remedies have been developed for the control of chicken lice and mites, lice on horses and cattle, fleas on their various animal hosts, the screw worm of cattle, and flies about dairies. Important contributions have been made in the control of various species of ticks, including the Texas fever tick and the Rocky Mountain spotted fever tick. Extensive studies resulting in tentative control measures have likewise been made concerning horse bots, cattle grubs, the stable fly, the horn fly, wool maggots, goat lice, and various species of horse flies.

Taxonomy of Insects. One of the continuing activities of the Bureau of Entomology is the work of supplying accurate identifications and of classifying insects sent in from the field by Bureau workers, by workers in state experiment stations and in colleges and universities, by collaborators in this country and abroad, and by various individuals interested in economic entomology. In addition, many identifications are supplied annually to the Plant Quarantine and Control Administration and to other agencies in the Department of Agriculture and elsewhere in the federal service. This work is carried on by a corps of specialists who restrict their studies to particular groups of insects, study and describe species new to science in the course of their work, and prepare monographic papers on classification of different groups of insects, which are published for the use of other entomologists. This activity is a fundamental one to all the other projects conducted by the Bureau of Entomology and other entomological research institutions, as correct information regarding the identity of any economic species is a necessary preliminary to a study of its habits and injuriousness.

Information regarding the identity of various species of insects gives to quarantine and research workers and other entomologists a key to the literature discussing these insects, and permits them to obtain information regarding distribution, relationships, life history, and known habits, in so far as such information has been published, of the insects which they are investigating. Full knowledge of all these points prevents duplications of investigations, and thus often effects substantial savings in the study of economic insects. There are so many insects which are injurious to agriculture, and these so closely resemble each other or related insects not injurious, that only specialists having access to large reference collections of insects can hope to supply authoritative information regarding the identity of insect pests.

This identification work has an immediate direct bearing on the enforcement of quarantines, and in this way plays an im-

portant part in safeguarding the United States from the introduction of new insect pests. While the inspectors of the Plant Quarantine and Control Administration observe and collect the insects which come to this country in shipments of plants or in other ways, the responsibility for indicating whether these insects are actual or potential pests rests with these specialists of the Taxonomic Unit who undertake their identification.

Bioclimatics. Studies of insects and the plants with which they are associated in relation to climatic conditions have been carried on for many years by a specialist of the Bureau of Entomology, and further studies are being carried on to develop methods and systems for applying the results. In this work the Bureau has the coöperation of the Weather Bureau and the Bureau of Agricultural Economics.

At present the Bureau is engaged in assembling and preparing for publication as a comprehensive treatise, the matured results of the long continued lines of original research on the interrelations of plants, animals, climates, seasons, and geographic distribution. The source of this information, in addition to that of general and specific literature on related subjects, has been personal observations during extensive trips and explorations in all sections of West Virginia; a special official trip in 1892 through England, France, Germany, Austria and Switzerland; extensive trips through the United States, with special investigations in all of the states having extensive forest areas; personal observations and records at different places in and sections of the country, from members of the field force in forest insect work; and local observations and records made by the specialist and by his assistants in the District of Columbia and adjacent areas and at the field station near Mineral Wells and Kanawha Station, West Virginia.

Insect Pathology. The study of insect diseases is carried on both with the view to protecting beneficial insects and as a means of control or eradication of insect pests. The Bureau recognized

the economic importance of this work in 1906, when studies were begun of the diseases of bees, which have been continued to the present time. Similar studies of bee diseases are being made in the leading foreign countries.

During the past ten years studies on the diseases of insects in general have been carried on by the Bureau. Preliminary observations on a large number of infections have been made, the material coming largely from entomologists in the field. As a result of these studies a fair survey is had of the different kinds of insect diseases that are likely to be encountered. Facts so far ascertained appear to indicate that at least from two to four diseases may be expected for each insect species.

The character and quality of the work required in this field for the destruction of injurious insects are of the same kind that are required for the protection of insects beneficial to man. In some instances, perhaps, less work may be needed when it is desired to destroy insects than is required to protect them. On the other hand it is probable that in some cases more information will be required for their destruction than for their protection.

At present, studies are being made on creeping eruptions, which have been a major problem for the past four years; on the polyhedral diseases of insects; on bacterial infections of insects, such as infections occurring among the larvae of cutworms, hornworms, a catalpa and cecropia moth, the Colorado potato beetle, the Mexican bean beetle, white grubs, and wireworms; protozoan diseases of insects; and silk-worm diseases, on account of their similarity to other insect diseases.

Studies on the insect diseases for the purpose of protecting useful insects have a parallel in work done on the diseases of man and other animals. It is regarded as probable that some of the diseases will be effectively employed as one of the means for the artificial control of injurious insects as insect parasitism is now being employed, and that their introduction from foreign countries will be comparatively simple. In the biological control

of insects are included insect parasites, fungus diseases, bacterial diseases, protozoan diseases, helminthic diseases, and filterable virus diseases. Of these, only parasitism has received much study.

Observations are being added from time to time to the information which has been gained through preliminary studies made on new and other little known diseases encountered by entomologists in the field, material from which has been sent to the laboratory for diagnosis.

Insect Morphology. The Bureau has always recognized the importance of a knowledge of the morphology of insects and special studies in this field have been more or less continuously under way. These studies have included investigations of the exo-skeleton of insects, as well as the muscular, vascular, nervous, and alimentary systems. Investigations of the special senses, as taste, hearing, smell, etc., have been made and many papers and reports issued on these subjects. A knowledge of the comparative morphology of the parts of the insect's exo-skeleton is of great importance in classification studies, while information on the sight, hearing, taste, etc., of insects has contributed to the development of methods of insect control.

Exchange of Useful Insects; History of Economic Entomology. Since the retirement of Dr. Howard from the position of Chief of the Bureau of Entomology of the Department of Agriculture after over fifty-one years of service, he has been assigned to duties which are defined as follows: "Consulting specialist on matters pertaining to importation and exchange of useful and beneficial insects; advises on matters relating to development of entomology, and prepares publications on these and related subjects." Dr. Howard is also preparing a history of economic entomology. These activities are grouped by the Bureau under the head of "Exchange of useful insects; history of economic entomology."

Insect Pest Survey. The insect pest survey, which was instituted in March 1921, consists of collecting scientific data on

insect conditions throughout the country, studying these data from month to month and year to year with relation to the several factors that cause insect outbreaks, and preparing this information in the form of publications for the immediate use of entomological workers throughout the country. The information is obtained from seventy-five collaborators located in the several states, who are largely entomologists of the agricultural experiment stations, state entomologists, and entomologists in state universities and agricultural colleges. Each collaborator assumes responsibility for collecting information on all insect outbreaks within his respective territory and for transmitting it to the central office in Washington, where the information is digested, correlated, and edited for publication.

A bulletin of the survey covering from twenty to forty pages is issued monthly, but reports of serious outbreaks are published as soon as received in the form of special reports for the immediate use of entomologists working in near-by states in order that they may be forewarned of possible outbreaks in their territories. In cases of emergency such information is sent out by telegraph. An annual summary is prepared showing the year's insect conditions correlated with weather conditions and other factors which influence insect abundance.

As an incident to the work of the survey the preparation of a card index of the common names applied to insects in this country was begun some time ago. It is arranged alphabetically, first, under the common names and second, under the Latin names. The American Association of Economic Entomologists, which coöperates in this work, published in 1924, a list of common names approved by the working entomologists throughout the country for general use. In 1925, 1926, 1927, and 1928, it issued supplementary lists and others will follow from time to time.

The survey is now engaged upon a project to incorporate in its files all the published statistical data on economic insects of North America. This work will require many years, but when

completed will make available the greatest mass of statistical information on insects that has ever been collected. An atlas of economic insects, started several years ago, is also in course of preparation.

The files of the survey contain references to over 4400 species of insects reported as of more or less economic importance. These insects represent practically all the major orders and fall into about three thousand genera.

The survey is a medium through which entomological workers throughout the United States are kept in close touch with insect conditions everywhere. Through this survey, the Bureau is in a position to report at any time on the entomological situation in any part of the United States. Through its coöperation with the Dominion of Canada's Insect Pest Review, which was organized subsequent to the survey of this Bureau, it is also closely in touch with the situation throughout that country.

A new project was inaugurated during the past year, that of cross-indexing the entire survey records under the host-plant names. From this index it will be possible to ascertain all of the insects known to feed upon any plant or group of plants throughout the world. So far, only two-fifths of the American records have been cross-indexed, the index covering four hundred genera and over five hundred species of plants with their insect enemies.

CHAPTER III

ORGANIZATION

The work of the Bureau of Entomology is carried on in the central office in Washington and in the field. Much of it is done in coöperation with state agricultural experiment stations, state entomologists, and private organizations.

There are no statutes specifically providing for the creation of the Bureau of Entomology. Its existence has been recognized, however, in the appropriation acts and in certain regulatory laws. The reorganization effected July 1, 1928, whereby certain regulatory functions of the Bureau were transferred to the Plant Quarantine and Control Administration was brought about by the provisions of the appropriation act of May 16, 1928 (45 Stat. L., 557, 564), making appropriation for the fiscal year, 1929, which became effective on July 1, 1928.

The employees of the Bureau of Entomology are nearly all in the classified civil service and receive their appointments through examination and recommendation by the Civil Service Commission. The total classified personnel on March 1, 1930, numbered 515. In addition to the classified personnel there is a variable number of temporary unclassified field employees engaged from time to time as needed, and at some stations local collaborators render service without compensation.

The Bureau's scientific work varies and the field stations are changed from time to time as old insect pests are disposed of and new ones require attention. Its organization units are nearly all constituted and designated according to the insects or groups of insects dealt with by the entomologists and their assistants, each entomologist being usually occupied with but one order of insect or one insect group.

The Bureau has at present a net-work of observation points over the United States. These points are not distributed uniformly, but according to the existing requirements of the Bureau's work. They vary in importance from the stations of simple correspondents of the Bureau, unequipped with any special outfits, to thoroughly equipped entomological laboratories possessing rich resources for observational and experimental work. Some of the stations are very temporary in character; others are established at given points for more or less extended periods; while still others are organized for continuous work in a given region. Each local station is organized to conduct work on definite concrete problems. Each division has its own field organization, with its own particular stations established where the work is needed, the stations of one division being independent of those of another. The number of stations under any division and the personnel of the field forces vary according to the need. There are altogether over six hundred field stations.

The information contained in this chapter relates to conditions on March 1, 1930. On that date the Bureau of Entomology consisted of the general administration, comprising the offices of the Chief, Associate Chief, and Assistant Chief, a Business Administrative Section, an Information and Editorial Work Section, and a Library; and ten divisions concerned with: Deciduous-Fruit Insects; Cereal and Forage Insects; Cotton Insects; Forest Insects; Truck-Crop Insects; Bee Culture; Stored-Product Insects; Tropical, Subtropical and Ornamental-Plant Insects; Insects Affecting Man and Animals; and Taxonomy and Interrelations of Insects.

Offices of the Chief, Associate Chief, and Assistant Chief of Bureau. All the administrative and scientific research work of the Bureau is under the general direction and supervision of the Chief of the Bureau. An Associate Chief is in charge of the scientific research work. An Assistant Chief is in charge of the business administration of the Bureau.

Business Administrative Section. The functions of the Business Administrative Section are to carry on the business affairs of the Bureau, such as are usually centered in the office of a Chief Clerk. The Assistant Chief of Bureau is in direct charge of this Division and also of the Truck-Crop Insects Division. He is assisted by an Administrative Officer. The Section looks after the financial, accounting, and auditing work, the purchasing, and the personnel administration.

Information and Editorial Work Section. The informational and editorial work of the Bureau is carried on in a separate section of the general administration.

Library. A specialized entomological library is maintained in the Bureau as a section of the general administration.

Deciduous-Fruit Insects Division. The work on deciduous-fruit insects is directed by the Associate Chief of Bureau, whose office is in Washington. The other work, except some of the investigational work on orchard insecticides, is carried on at field stations.

Orchard Insecticides Section. The work on orchard insecticides is mainly performed at the central office. Studies of various contact and other insecticides are also being made in Sligo, Maryland.

Orchard Insect Survey. An associate entomologist is carrying on a survey of orchard insects.

Apple Insects Section. The work in connection with apple insects is carried on in the field. The stations for carrying on this work are located at Bentonville, Arkansas; Vincennes, Indiana; Wichita, Kansas; Sligo, Maryland, and Yakima, Washington. The Arkansas, Washington, and Purdue University agricultural experiment stations coöperate in this work.

Grape Insects Section. One field station at Sandusky, Ohio, in charge of an associate entomologist, is concerned with the study of grape insects. He coöperates in this work with the Ohio Agricultural Experiment Station.

Nut Insects Section. Pecan and other nut insects are being studied at three field laboratories and two branch laboratories. The field laboratories are located at Albany and Experiment, Georgia, and at French Creek, West Virginia. The Albany laboratory has a branch laboratory at Brownwood, Texas, and the Experiment laboratory a branch at Shreveport, Louisiana.

Blueberry Maggot Section. An entomological laboratory is maintained at Cherryfield, Maine, where an investigation of the blueberry maggot is being carried on in coöperation with the Maine Department of Agriculture.

Japanese and Asiatic Beetles Section. A large force of entomologists and other employees is engaged in the study of the Japanese and Asiatic beetles at Moorestown, New Jersey, the headquarters for this work. There are subsections for insecticide investigations, biological studies and parasite investigations. A foreign subsection for parasite investigations has been established, with a field station at Yokohama, Japan.

Plant-Disinfection Investigations Section. A field laboratory at Moorestown, New Jersey, is being used for carrying on plant-disinfection investigations.

Peach Insects Investigations Section. Another field laboratory is being maintained at Fort Valley, Georgia, for investigations concerning peach insects.

Cereal and Forage Insects Division. Investigations of cereal and forage insects are being carried on under the general direction of an entomologist stationed at Washington. The field work is organized into three principal groups concerned, respectively, with general cereal and forage insects, sugar-cane and rice insects, and the European corn borer.

General Cereal and Forage Insects Section. Investigations of cereal and forage insects are carried on at thirteen different stations located in twelve states but covering the entire agricultural area of the country. Foreign field stations have also been established in Argentina, France and Japan. Of the many insects studied, the Hessian fly, the grasshopper, the chinch bug,

the corn ear worm, the alfalfa weevil, and the corn borer are among the most important.

At Tempe, Arizona, biological investigations of corn and alfalfa insects, including the clover and alfalfa seed chalcis, southwestern corn borer, agricultural ant, alfalfa caterpillar, range caterpillar, grasshoppers, and corn plant lice, with experimental control work, are being carried on in coöperation with Arizona and Utah agricultural experiment stations.

The Sacramento entomological laboratory, which works in cooperation with the Agricultural Experiment Station of the University of California and with the Bureaus of Public Roads and Plant Industry, is carrying on investigations of the Hessian fly, wireworms, false wireworm, grasshoppers, alfalfa aphis, and range craneflies.

The laboratory at West Fayette, Indiana, carries on investigations of the Hessian fly, jointworms, lesser clover leaf weevil, grasshoppers, and the chinch bug. It coöperates with the Kentucky, Tennessee, Indiana, Illinois, Ohio, Wisconsin and Michigan agricultural experiment stations, the Ohio State University, and the Bureau of Plant Industry.

At Sioux City, Iowa, investigations of the pale western cutworm, the chinch bug, the Hessian fly, grasshoppers and the wheat-stem saw fly are being carried on in coöperation with the North Dakota and Montana agricultural experiment stations.

The entomological laboratory at Wichita, Kansas, in coöperation with the Kansas, Missouri, Nebraska, and Oklahoma agricultural experiment stations, is carrying on investigations of the chinch bug, Hessian fly, green bug, white grubs, cutworms, southwestern corn borer, and false wireworms. Local experiment plots are being maintained for determining local infestation and varietal resistance.

Biological and ecological studies of the overflow worm, Hessian fly, billbugs, the wheat jointworm, straw worms, sunflower insects, and the chinch bug are being carried on at the laboratory at Webster Groves, Missouri, in coöperation with the Missouri Agricultural Experiment Station.

The entomological laboratory at Bozeman, Montana, in coöperation with the Montana, North Dakota, and Colorado agricultural experiment stations and with the Entomological Branch of the Canadian Department of Agriculture, is carrying on investigations of grasshoppers and crickets affecting flax and cereal and forage crops.

At Forest Grove, Oregon, investigations of the clover root borer, wireworms, Hessian fly, plant lice, and grasshoppers are being carried on in coöperation with the Oregon Board of Horticulture and the Oregon Agricultural Experiment Station.

At a laboratory at Carlisle, Pennsylvania, investigations are being carried on of the Hessian fly and its natural enemies, in coöperation with the Pennsylvania Department of Agriculture and the Pennsylvania Agricultural Experiment Station, and with the Agricultural College and Experiment Station of New York.

At the laboratories at San Antonio, Texas, and at a branch laboratory at Beaumont, investigations are being made of the sorghum midge, grasshoppers, the green bug, the sugar-cane moth borer as a pest of corn, and the southwestern corn borer, in coöperation with the Texas and Oklahoma agricultural experiment stations and the Bureau of Biological Survey.

The laboratory at Salt Lake City, in coöperation with the Utah, Wyoming, Montana, Nebraska, Colorado, Idaho, Nevada, and Oregon agricultural experiment stations and the California Department of Agriculture, carries on investigations of the alfalfa weevil and its natural enemies.

Studies of cereal and forest insects are being made at a field station at Rosslyn, Virginia.

At the United States entomological laboratory at Charlottesville, Virginia, and at a branch laboratory at Richmond, investigations are being carried on, in coöperation with the Virginia and South Carolina agricultural experiment stations and the Bureau of Plant Industry, of the corn ear worm, the wheat

jointworm, and the larger cornstalk borer. Experimental plots are maintained for determining varietal reactions of corn to ear worm injury.

Sugar-Cane and Rice Insects Section. The Bureau's investigational work concerning sugar-cane and rice insects is carried on at field laboratories at New Orleans and Crowley, Louisiana, and Tucuman, Argentina. This work is being carried on in coöperation with the Louisiana Agricultural Experiment Station, the Bureau of Plant Industry, and the Sugar Cane League. At the New Orleans headquarters investigations to obtain control of the sugar-cane moth borer are being carried on, and parasites of this principal insect pest of sugar cane are being introduced from the Argentine where a laboratory for parasite investigations is being maintained at Tucuman. The relations of insects to sugar-cane diseases are also being investigated. At Crowley rice insects are being studied.

European Corn Borer Section. Investigational work with the European corn borer is being carried on by the Bureau at corn-borer research laboratories in this country and abroad. Corn-borer research, including biological and ecological investigations, and insecticide and parasite and other control experiments, are being carried on at an Arlington, Massachusetts, laboratory, with sub-laboratories at Silver Creek, New York, Sandusky and Toledo, Ohio, and Monroe, Michigan. Parasite investigations are also being carried on at Hyères, France, and Yokohama, Japan. Experimental plots for testing varieties of corn in relation to infestation are being maintained at three of the sub-laboratories. This work is carried on in coöperation with other bureaus of the Department of Agriculture, with state universities, state agricultural experiment stations, state departments of agriculture, private organizations and individuals, and with the dominion and provincial entomologists of Canada.

Cotton Insects Division. The cotton-insect work of the Bureau, which covers investigations of the boll weevil, the Arizona (Thurberia) weevil, the pink bollworm, and miscellaneous cot-

ton insects, is carried on at the laboratory headquarters in Tallulah, Louisiana, and at five other field stations in Arizona, South Carolina, and Texas. The entomologist at Tallulah has general direction of these investigations. In this work the Division coöperates with the Bureau of Public Roads and with the Louisiana, Texas, Mississippi, Alabama, Georgia, South Carolina, and North Carolina agricultural experiment stations.

At the Tallulah headquarters, there are an Administrative Office, and Sections on Mechanics and Aeronautics; Chemicals and Insecticides; Entomological Research; Field Plot Experiments; Toxicology and Biology; Migration and Chemotropism; the Cotton Flea Hopper; and Miscellaneous Cotton Insects. Some investigational work on the boll weevil and on miscellaneous cotton insects is also carried on at these headquarters.

Boll Weevil Section. Boll weevil investigations are being carried on in Florence, South Carolina.

Arizona Weevil Section. Investigations of the Arizona or Thurberia weevil with reference to the distribution of the native host plant, and its menace to the cotton-growing industry of Arizona are being carried on at Tucson.

Pink Bollworm Section. Pink bollworm work is being carried on by the Bureau at El Paso, Texas.

Miscellaneous Cotton Insects Section. Investigations of the cotton flea hopper and of other insects injurious to cotton are being carried on at the headquarters at Tallulah, Louisiana, and at Brownsville, Texas.

Forest Insects Division. The general supervision over the forest insects investigations is exercised at the central office in Washington, by a Principal Entomologist. Investigational work concerning forest-product insects and insects injurious to shade trees and hardy shrubs is carried on at the central office. The other forest insects investigations are carried on at seven field stations.

Forest-Tree Insects Section. Investigations of general forest-insect problems are being made at East Falls Church, Vir-

ginia, particularly laboratory problems, life-history work and experimental control of insects injurious to forest products. A station at Amherst, Massachusetts, is also engaged in studies of various forest-tree insects.

Gipsy Moth and Brown-tail Moth Section. Gipsy-moth and brown-tail moth research is being carried on at Melrose Highlands, Massachusetts, and at a foreign laboratory for the study of parasites at Budapest, Hungary. The work at Melrose Highlands comprises parasite investigations, which occupies the greater part of the attention of that station, insecticide investigations, and ecological studies.

Coöperative Insect Control Section. Investigations for the control of the Western bark beetle and other tree-killing insects are being carried on at Palo Alto and Berkeley, California, at Portland, Oregon, and at Coeur d'Alene, Idaho, in coöperation with the Forest Service, the National Park Service, the Office of Indian Affairs, the state forestry departments of California, Idaho, and Oregon, and with organizations of private owners of forest lands.

Truck-Crop Insects Division. The truck-crop insect work is organized into nine groups or sections: Sweet-potato weevil control; bean insects; tobacco insects; pea insects; mushroom insects; berry insects; sugar-beet insects; soil insects; and miscellaneous truck-crop insects. The Assistant Chief of the Bureau, who is also in charge of the general administration, is in general charge of these investigations.

Sweet-Potato-Weevil Control Section. The study of sweet-potato-weevil control is being carried on at a main laboratory at Biloxi, Mississippi, and at substations at Bay St. Louis and Picayune, Mississippi, and at Grand Bay, Alabama. A research laboratory is also being maintained at Sanford, Florida. This work is carried on with the coöperation of the State Plant Boards of Florida and Mississippi and the Alabama State Department of Agriculture.

Bean Insects Section. The headquarters of the bean insects investigations are located at Columbus, Ohio, with substations

at Geneva, New York; Norfolk, Virginia; Estancia, New Mexico; and Mexico City, Mexico. At these stations studies are being made of the life history and habits of the Mexican bean beetle and other bean insects, the ecological conditions, and the biological and other measures for their control. The Alabama, New York, and Ohio agricultural experiment stations coöperate in this work.

Tobacco Insects Section. Investigations for the control of insects injurious to tobacco, are being made at a field station in Clarksville, Tennessee, and at substations in Quincy, Florida; Tempe, Arizona; and Chadbourn, North Carolina.

Pea Insects Section. Biological and control studies are being made of the pea aphid at Madison, Wisconsin, in coöperation with state agricultural experiment stations and the National Canners' Association.

Mushroom Insects Section. Headquarters have been established at Arlington, Virginia, for investigating the life histories and control of several serious insect pests injurious to mushrooms, and for the study of the relation of insects to the transmission of mushroom diseases, the latter in coöperation with the Bureau of Plant Industry.

Berry Insects Section. Investigations of insect carriers of certain berry diseases are being made at Sligo, Maryland, in cooperation with the Bureau of Plant Industry and at a field laboratory at Chadbourn, North Carolina.

Sugar-Beet Insects Section. Studies of the sugar-beet leaf hopper and other sugar-beet insects are being carried on at Twin Falls, Idaho, and at substations at Richfield, Utah, Berkeley and Riverside, California, Grand Junction, Colorado, Hermiston, Oregon, State College, New Mexico, and Las Vegas, Nevada, in coöperation with the agricultural experiment stations of Idaho, Utah, Montana, and California.

Soil Insects Section. Studies are being made of injurious species of wireworms prevalent in the Rocky Mountains, at Walla Walla, Washington, with a substation at Toppenish,

Washington, and at Alhambra, California, with substations at Garden Grove and San José, California.

Miscellaneous Truck-Crop Insects Section. Under the project "Miscellaneous Truck-Crop Insects," five principal stations are maintained. At Puyallup, Washington, is maintained a station for the investigation of the imported European earwig, which has become established in the United States at localities on both the east and west coasts. At Philadelphia, in coöperation with the University of Pennsylvania, a laboratory is maintained in which investigations of the effects of various insecticides, particularly arsenicals, are determined with reference to the insect physiology and mechanism. At Gulfport, Mississippi, a recently imported vegetable weevil known as the brown vegetable weevil is a subject of investigation. At the Baton Rouge laboratory, studies of the corn ear worm in its attacks on tomatoes and beans, and studies of the life history of certain of the Southern cucumber beetles are being made. At Chadbourn, North Carolina, studies are being conducted on the Porto Rican mole cricket and the seed corn maggot in its attacks on early potatoes.

Bee Culture Division. The bee culture investigations of the Bureau are carried on under the direction of an Apiculturist at a laboratory and apiary in Somerset, Maryland, near Washington; at a field station in Laramie, Wyoming; and at Baton Rouge, Louisiana. The studies comprise bee behavior, bee diseases, physiology of bees, regional beekeeping methods, demonstrations in beekeeping, intermountain bee culture and Southern states bee culture.

All of these studies except the last two are being carried on at Somerset. The intermountain bee-culture work is done at Laramie, and the Southern states bee-culture work is carried on at Baton Rouge.

This Division is also concerned with the enforcement of the Act of August 31, 1922 (42, Stat. L., 833), which regulates foreign commerce in the importation into the United States of the adult honeybee.

Stored-Product Insects Division. The general supervision of the work in relation to stored-product and household insects is exercised from the central office in Washington. The field activities are organized into three groups: Stored-grain insects, bean weevils, and dried-fruit insects. They are carried on at five permanent stations.

Grain Insects Section. Field work on stored-grain insects is carried on in Thomasville, Georgia; Sligo, Maryland; and Manhattan, Kansas. In Thomasville, studies are being made in cooperation with state and county agents, of field conditions governing the abundance of rice weevils on Southern farms and of methods of control. At the laboratory in Sligo, an investigation is being made of the biology of the Angoumois grain, moth throughout the eastern winter wheat-growing region. At Manhattan, Kansas, investigations of insects infesting flour mills are being carried on.

Bean Weevil Section. Investigations of the weevil destruction to beans and peas are being conducted at Modesto, California, in coöperation with the Bean Growers' Association of California and with bean-weevil committees of farm bureaus in bean-growing areas.

Dried-Fruit Insects Section. Investigations of insects destructive to dried fruits on farms, in packing houses, and in warehouses, are being carried on in Fresno, in coöperation with the Dried Fruit Association of California.

Tropical, Subtropical, and Ornamental-Plant Insects Division. The work in connection with tropical, subtropical, and ornamental-plant insects is under the direction of an entomologist stationed at the central office in Washington. Some work is done with greenhouse insects at the central office, but all the rest of the experimental activities are carried on in the field.

The field work covers studies of citrus insects in the gulf region, in California and in South Malay; greenhouse insects; miscellaneous insects affecting ornamental plants; the Parlatoria date scale; bulb insects; the Mexican fruit worm; and fruit flies in the Canal Zone and in Hawaii.

Citrus Insects Sections. Investigations of insects affecting citrus fruits are being carried on at Lindsay and Whittier, California, Orlando, Florida, in coöperation with the Bureau of Plant Industry, and at Singapore, South Malay.

Greenhouse Insects Section. The work on greenhouse insects is carried on at the central office in Washington and at a field laboratory in Whittier, California.

Miscellaneous Ornamentals Section. A section devoted to the miscellaneous insects affecting ornamental plants is carrying on experimental work at the southcentral laboratory of the Bureau located at New Orleans. Much attention is here given to the camphor scale, a recent destructive importation.

Parlatoria Date Scale Section. Biological investigations of the Parlatoria date scale are being carried on at Indio, California.

Bulb Insects Section. Field laboratories for the study of bulb insects are located at Babylon, New York, Whittier, California, and at Sumner, Washington. The insects studied include the bulb fly, the lesser bulb flies, and the narcissus bulb fly.

Mexican Fruit Worm Section. Studies of the Mexican fruit worm are being made at a laboratory established in Mexico City, Mexico, and at a field laboratory in Whittier, California.

Fruit Flies Section. Work on fruit flies is being carried on in the Canal Zone, and in Honolulu. Investigations of fruit flies and other tropical insects are being made at Ancon in cooperation with the Plant Quarantine and Control Administration and the Bureau of Plant Industry. Scouting work is being done to determine the presence of dangerous insects liable to introduction in cargoes passing through the Panama Canal. Tests are being made of the effectiveness of chemicals and treated wood against termites. At the laboratory in Honolulu, work in connection with the Mediterranean and other fruit flies is being carried on in coöperation with the Territorial Board of Agriculture and Forestry. Since April, 1929 the laboratory at Orlando, Florida, has been devoting all its energy to research on the Mediterranean fruit fly.

Insects Affecting Man and Animals Division. The investigations of insects affecting the health of man and of animals are carried on under the immediate direction of an entomologist in Washington. Most of the investigations are carried on in the regions where different problems are most acute. At present this work is centered in Texas, Louisiana, Illinois, Maryland, and North Dakota. Certain phases of the work are being performed in coöperation with the Bureaus of Animal Industry and Chemistry and Soils, the Public Health Service, and with the Texas Agricultural Experiment Station.

Insects Affecting Cattle Section. Studies are being made of the screw worm, cattle grub, and of other insects affecting cattle at Beltsville, Maryland, Uvalde, and Menard, Texas, Galesburg, Illinois, and Fargo, North Dakota.

Insects Affecting Sheep and Goats Section. Investigations are being made at Dallas and Sonora, Texas, of goat lice, wool maggots, the sheep scab mite, and other insects injurious to sheep and goats.

Insects Affecting Man Section. Investigations of the malaria mosquito are being carried on at Mound, Louisiana.

Taxonomy and Interrelations of Insects Division. The units grouped under this head comprise Sections on Taxonomy of Insects; Bioclimatics; Insect Pathology; Exchange of Useful Insects and History of Economic Entomology; and Insect Pest Survey. The work on bioclimatics is being carried on at Mineral Wells, West Virginia, and that on insect morphology, which is associated with insect pathology, is carried on at Sligo, Maryland, but all the other sections of this division are located at the central office in Washington. All the work of this Division is at present under the general direction of the Chief of the Bureau.

Taxonomy of Insects Section. This is, by far, the largest unit in this Division. As has been indicated in more detail elsewhere, the taxonomic work consists of the identification and classification of insects, which is carried on in Washington. It is at pres-

ent organized into seven projects, which, in general, relate to the order or groups of insects under examination and classification. These are coleoptera, lepidoptera, hymenoptera, diptera, orthoptera and neuropteroides, ectoparasites and mites, and coccidae. The entomologists in each of these projects are independent workers, each being responsible directly to the entomologist in charge of the Taxonomic Section.

Bioclimatics Section. Studies of insects in relation to climate are being carried on at Mineral Wells, West Virginia, and include investigations to determine the relationship between the insects and the plants with which they are associated, and climatic conditions.

Insect Pathology and Morphology Sections. The work on insect pathology is carried on by a pathologist located at the central office in Washington, and that on insect morphology by an entomologist located at the field laboratory at Sligo, Maryland.

Exchange of Useful Insects and History of Economic Entomology Section. This work is being carried on at Washington by Dr. L. O. Howard, until recently Chief of the Bureau of Entomology. The work consists of investigations connected with the exchange of useful insects, including the recording of the parasitic enemies of injurious pests and the furnishing of this information to persons interested in introducing these parasites into areas infested by these pests. The Section furnishes basic advice on the control of pests by means of their natural enemies.

Insect Pest Survey Section. The insect pest survey is carried on at the central office in Washington, by an entomologist who receives, digests, correlates, and edits for publication information of insect outbreaks received from seventy five collaborators throughout the country, and issues a monthly bulletin of the survey, and special reports and telegrams in cases of emergency. He also issues an annual summary of insect conditions and maintains a card index of common names applied to insects.

APPENDIX 1

OUTLINE OF ORGANIZATION

Explanatory Note

The Outlines of Organization in this series of monographs have for their purpose to make known in detail the organization and personnel possessed by the several services of the national government to which they relate. They have been prepared in accordance with the plan followed by the President's Commission on Economy and Efficiency in the preparation of its outlines of the organization of the United States government.[1] They differ from those outlines, however, in that whereas the Commission's report showed only organization units, the presentation herein has been carried far enough to show the personnel embraced in each organization unit.

These outlines are of value not merely as an effective means of making known the organization of the several services. If kept revised to date by the services, they constitute exceedingly important tools of administration. They permit the directing personnel to see at a glance the organization and personnel at their disposition. They establish definitely the line of administrative authority and enable each employee to know his place in the system. They furnish the essential basis for making plans for determining costs by organization division and subdivision. They afford the data for a consideration of the problem of classifying and standardizing personnel and compensation. Collectively, they make it possible to determine the number and location of organization divisions of any particular kind, to what services they are attached and where they are located, or to de-

[1] House Doc. 458, 62d Congress 2d Session, 1912, 2 vols.

termine what services are maintaining stations at any city or point in the United States. The Institute hopes that upon the completion of the present series, it will be able to prepare a complete classified statement of the technical and other facilities at the disposal of the government. The present monographs will then furnish the details regarding the organization, equipment and work of the institutions so listed and classified.

OUTLINE OF ORGANIZATION

BUREAU OF ENTOMOLOGY
DEPARTMENT OF AGRICULTURE
MARCH 1, 1930

Units of Organization: *Classes of Employees*	*Number*[2]	*Annual Salary Rate*
1. General Administration		
1. Office of the Chief		
Chief	1	$8,000
2. Office of the Associate Chief		
Associate Chief	1	6,400
3. Office of the Assistant Chief		
Assistant Chief	1	6,000
Senior Administrative Assistant	1	3,600
Administrative Assistant and Budget Officer	1	3,300
Senior Clerk-Stenographer	1	2,100
4. Business Administrative Section		
Auditor	1	2,700
Purchasing Officer	1	2,700
Chief Accountant	1	2,600
Personnel Clerk	1	2,400
Administrative Clerk	1	2,400
Senior Clerk	1	2,300
	1	2,000
Clerk	1	2,100
Scientific Aid	1	2,100
Assistant Clerk	2	1,920

[2] This is the number of classified persons actually employed on March 1, 1930. In addition to the classified personnel there is a variable number of temporary unclassified field employees engaged from time to time as needed, and at some stations local collaborators render service without compensation.

Assistant Clerk-Stenographer	1	1,920
	1	1,800
	2	1,740
	2	1,620
Senior Operative	1	1,800
	1	1,620
Junior Clerk	1	1,740
Senior Typist	1	1,560
Senior Laborer	1	1,500
Head Messenger	1	1,620
Messenger	1	1,260
Junior Messenger	1	780
	3	600
Junior Laborer	1	1,320
	1	1,260
	1	1,140

5. Information and Editorial Work Section

Associate Entomologist in Charge	1	3,700
Assistant Editor	1	2,700
Principal Clerk (Junior Editor)	1	2,500
	1	2,300
Principal Clerk (Photographer)	1	2,700
Chief Scientific Illustrator	1	2,600
Assistant Clerk-Stenographer	1	1,960
	1	1,740

6. Library

Associate Librarian	1	3,400
Junior Librarian	1	2,300
Library Assistant	1	1,920

2. Deciduous-Fruit Insects Division

1. Administrative Office, Washington, D. C.

1. Office of Associate Chief of Bureau

Associate Chief in Charge		
Entomologist	1	4,400
Administrative Assistant	1	3,300
Clerk Stenographer	1	2,040
Assistant Clerk-Stenographer	1	1,740

2. Orchard Insecticides Section		
1. Central Office, Washington, D. C.		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,600
	1	3,200
Assistant Entomologist	1	2,900
Junior Entomologist	1	2,100
Assistant Biophysicist	1	2,600
Assistant Bibliographic Entomologist	1	2,600
Assistant Scientific Aid	1	620
2. Field Laboratory, Sligo, Maryland		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,600
3. Orchard Insect Survey		
1. Associate Entomologist	1	3,200
4. Apple Insects Section		
1. Field Laboratory, Bentonville, Arkansas		
1. Office of Entomologist in Charge		
Entomologist in Charge	1	4,000
Junior Entomologist	1	2,000
2. Field Laboratory, Vincennes, Indiana		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,800
Assistant Entomolgist	1	2,600
3. Field Laboratory, Wichita, Kansas		
1. Office of Associate Entomologist		
Associate Entomologist in Charge	1	3,400
Assistant Entomologist	1	2,700
4. Field Laboratory, Sligo, Maryland		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,600
Associate Entomologist	1	3,200

5. Field Laboratory, Yakima, Washington		
1. Office of Senior Entomologist in Charge		
Senior Entomologist in Charge	1	4,600
Associate Entomologist	1	3,400
Junior Stenographer (half-time)	1	660
5. Grape Insects Section		
1. Field Laboratory, Sandusky, Ohio		
1. Office of Associate Entomologist		
Associate Entomologist in Charge	1	3,400
6. Nut Insects Section		
1. Field Laboratory, Albany, Georgia		
1. Office of Entomologist in Charge		
Entomologist in Charge	1	4,000
Assistant Entomologist	1	2,600
2. Branch Field Laboratory, Brownwood, Texas		
Associate Entomologist	1	3,200
Junior Entomologist	1	2,000
2. Field Laboratory, Experiment, Georgia		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,900
2. Branch Field Laboratory, Shreveport, Louisiana		
Assistant Entomologist	1	2,600
3. Field Laboratory, French Creek, West Virginia		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,400

7. Blueberry Maggot Section		
1. Field Laboratory, Cherryfield, Maine		
1. Office of Assistant Entomologist in Charge		
Assistant Entomologist in Charge	1	2,600
8. Japanese and Asiatic Beetles Section		
1. Administrative Office, Moorestown, New Jersey		
1. Office of Principal Entomologist in Charge		
Principal Entomologist in Charge	1	5,600
Junior Administrative Assistant	1	2,800
Senior Clerk	1	2,200
2. Insecticide Investigations Subsection		
Associate Entomologist	1	3,700
	1	3,200
Associate Entomologist, one-half time	1	1,550
Assistant Entomologist	1	2,800
	1	2,600
3. Biological Investigations Subsection		
Associate Entomologist	1	3,400
	1	3,200
4. Parasite Investigations Subsection		
Senior Entomologist	1	4,600
Associate Entomologist	1	3,300
Assistant Entomologist	1	2,600
5. Foreign Parasite Investigations Subsection		
1. Field Station, Yokohama, Japan		
Associate Entomologist	1	3,600
Assistant Entomologist	1	3,100

9. Plant-Disinfection Investigations Section
   1. Field Laboratory, Moorestown, New Jersey
      1. Office of Entomologist

Entomologist in Charge	1	3,800
Assistant Entomologist	1	2,700
	2	2,600

10. Peach Insect Investigations Section
    1. Field Laboratory, Fort Valley, Georgia
       1. Office of Entomologist

Entomologist	1	4,200
Junior Entomologist	1	2,000
Junior Clerk Stenographer	1	1,400

3. Cereal and Forage Insects Division
   1. Administrative Office, Washington, D. C.
      1. Office of Principal Entomologist in Charge

Principal Entomologist in Charge	1	5,800
Senior Entomologist	1	5,000
Associate Entomologist	1	3,400
Principal Scientific Illustrator	1	2,300
Under Scientific Helper	1	1,500
Principal Clerk	1	2,400
Senior Clerk	1	2,100
Clerk Stenographer	1	1,800
Assistant Clerk Stenographer	1	1,800
	1	1,740

   2. General Cereal and Forage Insects Section
      1. Field Laboratory, Tempe, Arizona
         1. Office of Entomologist in Charge

Entomologist in Charge	1	4,200
Assistant Entomologist	1	3,000
	1	2,700
Junior Entomologist	1	2,400
Under Scientific Helper	1	1,260
Clerk Stenographer	1	1,860
Junior Laborer	1	1,140

2. Field Laboratory, Sacramento, California		
1. Office of Associate Entomologist in Charge		
Associate Entomologist in Charge	1	3,400
Assistant Entomologist	1	2,600
Clerk-Stenographer	1	1,920
3. Field Laboratory, West Fayette, Indiana		
1. Office of Senior Entomologist in Charge		
Senior Entomologist in Charge	1	4,600
Associate Entomologist	1	3,600
	1	3,200
Assistant Entomologist	1	3,000
Junior Entomologist	1	2,200
Assistant Clerk-Stenographer	1	1,620
Unskilled Laborer	1	240
4. Field Laboratory, Sioux City, Iowa		
1. Office of Assistant Entomologist in Charge		
Assistant Entomologist in Charge	1	3,000
5. Field Laboratory, Wichita, Kansas		
1. Office of Entomologist in Charge		
Entomologist in Charge	1	4,000
Assistant Entomologist	1	2,800
	1	2,600
Junior Entomologist	1	2,100
Assistant Clerk-Stenographer	1	1,680
Under Custodial Employee	1	1,440
6. Field Laboratory, Webster Groves, Missouri		
1. Office of Associate Entomologist in Charge		

	Associate Entomologist in Charge	1	3,600
	Assistant Scientific Aid	1	1,740
	Unskilled Laborer	1	300
7.	Field Laboratory, Bozeman, Montana		
	1. Office of Senior Entomologist in Charge		
	Senior Entomologist in Charge	1	4,600
	Assistant Entomologist	1	3,000
	Junior Clerk	1	1,440
8.	Field Laboratory, Forest Grove, Oregon		
	1. Office of Entomologist in Charge		
	Entomologist in Charge	1	4,000
	Associate Entomologist	1	3,300
	Assistant Entomologist	1	3,000
	Assistant Clerk-Stenographer	1	1,620
	Collaborator	1	(per mo.) 25
9.	Field Laboratory, Carlisle, Pennsylvania		
	1. Office of Associate Entomologist in Charge		
	Associate Entomologist in Charge	1	3,200
	Assistant Entomologist	1	2,600
	Junior Entomologist	1	2,000
	Assistant Clerk	1	1,680
10.	Field Laboratory, San Antonio, Texas		
	1. Office of Associate Entomologist in Charge		
	Associate Entomologist in Charge	1	3,500
	Assistant Entomologist	1	3,000
	Assistant Scientific Aid	1	1,620
	Junior Clerk-Stenographer	1	1,560
	Under Custodial Employee	1	1,140

2. Branch Field Laboratory, Beaumont, Texas		
Assistant Entomologist	1	2,600
11. Field Laboratory, Salt Lake City, Utah		
1. Office of Senior Entomologist in Charge		
Senior Entomologist in Charge	1	4,600
Senior Entomologist	1	4,600
Associate Entomologist	1	3,600
Assistant Entomologist	1	3,100
Junior Entomologist	1	2,100
	1	2,000
Assistant Scientific Aid	1	1,620
Clerk-Stenographer	1	1,860
12. Field Station, Rosslyn, Virginia		
1. Office of Senior Entomologist		
Senior Entomologist in Charge	1	4,600
Associate Entomologist	1	3,200
13. Field Station, Charlottesville, Va.		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,600
Assistant Entomologist	1	2,600
Junior Entomologist	1	2,200
Senior Clerk	1	2,000
Laborer	1	840
2. Branch Field Laboratory, Richmond, Virginia		
Associate Entomologist	1	3,200
3. Sugar-Cane and Rice Insects Section		
1. Field Laboratory, New Orleans, La.		
1. Office of Senior Entomologist		
Senior Entomologist in Charge	1	4,600
Assistant Entomologist	1	2,800
Chief Scientific Aid	1	2,800
Assistant Clerk-Stenographer	1	1,620

2. Field Laboratory, Crowley, Louisiana		
1. Office of Junior Entomologist		
Junior Entomologist	1	2,100
3. Field Laboratroy, Tucuman, Argentina		
1. Office of Associate Entomologist in Charge		
Associate Entomologist in Charge	1	4,100
4. European Corn Borer Section		
1. Field Laboratory, Arlington, Massachusetts		
1. Office of the Senior Entomologist in Charge		
Senior Entomologist in Charge	1	4,600
Assistant Entomologist	1	3,000
Junior Entomologist	1	2,000
Principal Clerk	1	2,200
Clerk-Stenographer	1	1,860
Assistant Clerk-Stenographer	1	1,620
Senior Scientific Aid	1	2,000
Senior Mechanic	1	2,040
Agent	1	1,860
2. Insecticide Investigations Subsection		
Associate Entomologist	1	3,500
Junior Entomologist	1	2,200
Agent	1	2,600
3. Parasite Investigations Subsection		
Entomologist	1	4,200
Associate Entomologist	1	3,400
Junior Entomologist	1	2,100
	1	2,000
4. Biological Investigations Subsection		
Associate Entomologist	1	3,200
Assistant Entomologist	2	2,600
Junior Entomologist	1	2,000

5. Branch Field Laboratory, Monroe, Michigan		
Associate Entomologist	1	3,700
Junior Entomologist	2	2,000
Associate Entomologist (Parasites)	1	3,400
Junior Entomologist (Parasites)	2	2,000
Associate Entomologist (Insecticides)	1	3,400
Junior Entomologist (Insecticides)	1	2,000
Assistant Clerk-Stenographer	1	1,620
6. Branch Field Laboratory, Silver Creek, New York		
Assistant Entomologist	1	3,100
Agent	1	2,000
Junior Clerk-Stenographer	1	1,440
7. Branch Laboratory, Sandusky, Ohio		
Associate Entomologist in Charge	1	3,400
Junior Entomologist	2	2,000
Agent	1	2,000
8. Branch Laboratory, Toledo, Ohio		
Assistant Entomologist in Charge	1	2,600
Entomologist	1	3,800
Assistant Entomologist	1	2,700
Junior Entomologist	1	2,000
2. Field Station, Hyères, France		
1. Office of Entomologist in Charge		
Entomologist in Charge	1	4,200
Assistant Entomologist	2	3,000
	1	2,600
3. Field Station, Yokohama, Japan		
1. Office of Entomologist in Charge		

Entomologist in Charge	1	4,200
Assistant Entomologist	1	3,000

4. Cotton Insects Division
   1. Administrative Office, Tallulah, Louisiana
      1. Office of Principal Entomologist

Principal Entomologist in Charge	1	5,600
Senior Entomologist	1	4,600
Associate Entomologist	1	3,700
	1	3,200
Senior Scientific Aid	1	2,400
Junior Administrative Assistant	1	2,900
Chief Photographer	1	3,000
Clerk, Photographer	1	1,920
Junior Clerk	1	1,920

      2. Mechanics and Aeronautics Section

Senior Airplane Pilot	2	5,200
Associate Airplane Machinist	1	3,700
Assistant Mechanical Superintendent	1	2,700
Principal Mechanic	1	2,400
	1	2,300
Machinist	1	2,300

      3. Chemicals and Insecticides Section

Senior Chemist	1	4,600
Assistant Microscopist	1	2,800
Junior Chemist	1	2,200
	1	2,000

      4. Entomological Research Section

Senior Entomologist	1	4,600

      5. Field Plot Experiments Section

Associate Entomologist	1	3,400
Junior Entomologist	1	2,400

      6. Cotton Flea Hopper Section

Assistant Entomologist	1	3,100
Junior Entomologist	1	2,000

      7. Toxicology and Biology Section

Assistant Entomologist	1	2,700

8. Migration and Chemotropism Section		
Associate Entomologist	1	3,400
2. Boll Weevil Section		
1. Field Laboratory, Stillwater, Oklahoma (Positions vacant)		
2. Field Laboratory, Florence, South Carolina		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,900
3. Arizona Weevil Section		
1. Field Laboratory, Tucson, Arizona		
1. Office of Entomologist		
Entomologist	1	3,800
Assistant Entomologist	1	2,900
Junior Entomologist	2	2,400
Junior Clerk	1	1,560
4. Pink Bollworm Section		
1. Field Laboratory, El Paso, Texas		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,600
Assistant Entomologist	1	2,800
Assistant Clerk	1	2,100
2. Field Laboratory, Presidio, Texas (Position Vacant)		
5. Miscellaneous Cotton Insects Section		
1. Field Laboratory, Tallulah, Louisiana		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	3,100
2. Laboratory, Brownsville, Texas		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,900

5. Forest Insects Division
   1. Administrative Office, Washington, D. C.
      1. Office of Principal Entomologist

Principal Entomologist in Charge	1	5,800
Senior Clerk	1	2,400
Assistant Clerk Stenographer	1	1,680
Junior Clerk	1	1,620

      2. Forest-Product Insects Section

Senior Entomologist	1	4,600

      3. Shade-Tree and Hardy-Shrub Insects Section

Associate Entomologist	1	3,500

   2. Forest-Tree Insects Section
      1. Field Station, East Falls Church, Virginia
         1. Office of Associate Entomologist

Associate Entomologist	1	3,500
Junior Scientific Assistant	1	1,560
Junior Clerk	1	1,800

      2. Field Station, Asheville, North Carolina
         (Position Vacant)
      3. Field Station, Amherst, Massachusetts

Assistant Entomologist	1	2,800

   3. Gipsy Moth and Brown-tail Moth Section
      1. Central Office, Melrose Highlands, Massachusetts
         1. Office of Senior Entomologist

Senior Entomologist	1	4,800
Senior Clerk	1	2,300
Clerk	1	1,800

         2. Parasite Investigations Subsection

Senior Entomologist in Charge	1	4,600
Senior Entomologist	1	4,600

Associate Entomologist	1	3,600
Assistant Entomologist	1	3,000
	2	2,900
Junior Entomologist	1	2,400
	1	2,100
	2	2,000
Principal Scientific Assistant	1	2,700
Senior Scientific Assistant	2	2,300
Scientific Aid	1	1,980
3. Insecticide Investigations Subsection		
Associate Entomologist	1	3,200
Assistant Entomologist	1	3,000
	1	2,700
Agent	1	1,920
4. Ecological Investigations Subsection		
Principal Scientific Aid	1	2,600
2. Foreign Parasite Investigations Subsection		
1. Field Laboratory, Budapest, Hungary		
Associate Entomologist	1	3,300
	1	2,600
4. Coöperative Insect Control Section		
1. Field Laboratory, Cœur d'Alene, Idaho		
1. Office of Entomologist		
Entomologist	1	4,400
Assistant Entomologist	1	2,800
	1	2,700
Senior Scientific Assistant	1	2,400
Assistant Clerk	1	1,800
2. Field Laboratory, Palo Alto, California		
Office of Senior Entomologist		
Senior Entomologist	2	4,600
Associate Entomologist	1	3,200
Senior Scientific Assistant	1	2,000
Assistant Clerk	1	1,680

3. Field Laboratory, Portland, Oregon
   1. Office of Entomologist in Charge

Entomologist in Charge	1	3,800
Assistant Entomologist	1	2,800
Scientific Aid	1	1,800

4. Field Laboratory, Berkeley, California
   1. Office of Assistant Entomologist

Assistant Entomologist	1	3,100

6. Truck Crop Insects Division
   1. Administrative Office, Washington, D. C.
      1. Office of Assistant Chief of Bureau

Assistant Chief of Bureau in Charge		
Entomologist	1	3,800
Assistant Entomologist	1	2,600
Scientific Illustrator	1	1,800
Gardener	1	1,560
Senior Clerk	1	2,400
Assistant Clerk Stenographer	1	1,860

   2. Sweet-Potato-Weevil Control Section
      1. Research Laboratory, Sanford, Florida

Assistant Entomologist	1	2,700
Junior Entomologist	1	2,100
Assistant Scientific Aid	1	1,620

      2. Field Laboratory, Biloxi, Mississippi
         1. Office of Associate Entomologist in Charge

Associate Entomologist	1	3,600
Junior Entomologist	1	2,300

         2. Field Station, Bay St. Louis, Mississippi

Junior Entomologist	1	2,400

4. Field Station, Chadbourn, North Carolina		
Assistant Entomologist	1	2,900
5. Pea Insect Section		
1. Field Laboratory, Madison, Wisconsin		
1. Office of Entomologist		
Entomologist	1	3,800
Assistant Entomologist	1	2,700
Field Agent	1	1,920
Assistant Clerk	1	1,680
6. Mushroom Insects Section		
1. Field Laboratory, Arlington, Virginia		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,600
7. Berry Insects Section		
1. Field Laboratory, Sligo, Maryland		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,600
2. Field Laboratory, Chadbourn, North Carolina		
1. Office of Entomologist		
Entomologist	1	3,800
8. Sugar-Beet Insects Section		
1. Field Laboratory, Twin Falls, Idaho		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,600
Associate Entomologist	2	3,600
Assistant Entomologist	1	2,800
Junior Entomologist	1	2,100
Field Agent	1	3,200
Clerk	1	2,000

3. Field Station, Picayune, Mississippi		
Junior Entomologist	1	2,300
	1	2,000
Temporary Assistant	1	(per mo.) 125
4. Field Station, Grand Bay, Alabama		
Senior Scientific Aid	1	2,300
3. Bean Insects Section		
1. Field Laboratory, Columbus, Ohio		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,600
Assistant Clerk	1	1,740
Senior Laborer	1	1,500
Field Agent	1	1,500
2. Field Station, Estancia, New Mexico		
Associate Entomologist	1	3,200
3. Field Station, Geneva, New York		
Assistant Entomologist	1	3,000
4. Field Station, Norfolk, Virginia		
Assistant Entomologist	1	2,800
5. Field Station, Mexico City, Mexico		
Assistant Entomologist	1	2,600
4. Tobacco Insects Section		
1. Field Laboratory, Clarksville, Tennessee		
1. Office of Entomologist		
Entomologist	1	3,800
Assistant Entomologist	1	2,900
Principal Scientific Aid	1	2,400
Assistant Clerk	1	1,620
Laborer	1	900
2. Field Station, Quincy, Florida		
Assistant Entomologist	1	3,000
3. Field Station, Tempe, Arizona		
Assistant Entomologist	1	3,000

4. Field Station, Chadbourn, North Carolina		
Assistant Entomologist	1	2,900
5. Pea Insect Section		
1. Field Laboratory, Madison, Wisconsin		
1. Office of Entomologist		
Entomologist	1	3,800
Assistant Entomologist	1	2,700
Field Agent	1	1,920
Assistant Clerk	1	1,680
6. Mushroom Insects Section		
1. Field Laboratory, Arlington, Virginia		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,600
7. Berry Insects Section		
1. Field Laboratory, Sligo, Maryland		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,600
2. Field Laboratory, Chadbourn, North Carolina		
1. Office of Entomologist		
Entomologist	1	3,800
8. Sugar-Beet Insects Section		
1. Field Laboratory, Twin Falls, Idaho		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,600
Associate Entomologist	2	3,600
Assistant Entomologist	1	2,800
Junior Entomologist	1	2,100
Field Agent	1	3,200
Senior Clerk	1	2,200
Assistant Clerk	1	1,620
Unskilled Laborer	1	1,620
2. Field Station, Richfield, Utah		
Assistant Entomologist	1	2,900
Junior Entomologist	1	2,000

3. Field Station, Berkeley, California		
Field Agent	1	1,800
	1	1,200
4. Field Station Riverside, California		
Assistant Entomologist	1	2,800
5. Field Station, Grand Junction, Colorado		
Assistant Entomologist	1	2,600
6. Field Station, Hermiston, Oregon		
Junior Entomologist	1	2,400
7. Field Station, State College, New Mexico		
Junior Entomologist	1	2,000
8. Field Station, Las Vegas, Nevada		
Field Agent	1	1,980
9. Soil Insects Section		
1. Field Laboratory, Walla Walla, Washington		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,500
Junior Entomologist	1	2,200
Junior Clerk	1	1,260
2. Field Station, Toppenish, Washington		
Assistant Entomologist	1	2,700
2. Field Laboratory, Alhambra, California		
1. Office of Entomologist		
Entomologist	1	3,800
Junior Entomologist	1	2,200
2. Field Station, Garden Grove, California		
Assistant Entomologist	1	2,600
Field Agent	1	(per mo.) 60
3. Field Station, San José, California		
Field Agent	1	600

10. Miscellaneous Truck-Crop Insects Section			
1. Field Laboratory, Puyallup, Washington			
1. Office of Entomologist			
Entomologist	1		3,800
Junior Entomologist	1		2,000
2. Field Laboratory, Philadelphia, Pennsylvania			
1. Office of Entomologist			
Entomologist	1		3,800
3. Field Laboratory, Gulfport, Mississippi			
1. Office of Associate Entomologist			
Associate Entomologist	1		3,400
Temporary Assistant	1	(per mo.)	150
4. Field Laboratory, Baton Rouge, Louisiana			
1. Office of Associate Entomologist			
Associate Entomologist	1		3,500
Junior Entomologist	1		2,400
Temporary Assistant	1	(per h.)	.50
5. Field Laboratory, Chadbourn, North Carolina			
1. Office of Assistant Entomologist			
Assistant Entomologist	1		3,000
	1		2,600
7. Bee Culture Division			
1. Administrative Office, Somerset, Maryland			
1. Office of Senior Apiculturist			
Senior Apiculturist	1		**5,000**
2. Bee Behavior Section			
1. Field Laboratory, Somerset, Maryland			
1. Office of Senior Apiculturist			
Senior Apiculturist	1		5,000
Apiculturist	1		4,000
Clerk	1		2,040

3. Bee Diseases Section			
1. Field Laboratory, Somerset, Maryland			
1. Office of Assistant Apiculturist			
Assistant Apiculturist	1		3,000
4. Physiology Section			
1. Field Laboratory, Somerset, Maryland			
(Positions vacant)			
5. Regional Beekeeping Methods Section			
1. Field Laboratory, Somerset, Maryland			
1. Office of Associate Apiculturist			
Associate Apiculturist	1		3,500
Junior Clerk Typist	1		1,500
6. Demonstrations in Beekeeping Section			
1. Field Laboratory, Somerset, Maryland			
1. Office of Library Assistant			
Library Assistant	1		2,040
7. Intermountain Bee Culture Section			
1. Field Station, Laramie, Wyoming			
Office of Associate Apiculturist			
Associate Apiculturist	1		3,600
	1		3,400
Junior Clerk-Stenographer (part time)	1		375
8. Southern States Bee Culture Section			
1. Field Station, Baton Rouge, Louisiana			
1. Office of Assistant Apiculturist			
Assistant Apiculturist	1		2,800
	1		2,700

8. Stored-Product Insects Division		
1. Administrative Office, Washington, D. C.		
1. Office of Principal Entomologist in Charge		
Principal Entomologist in Charge	1	5,600
Senior Entomologist	1	4,600
Chief Scientific Illustrator	1	2,600
Junior Scientific Aid	1	1,560
Senior Clerk	1	2,200
Assistant Clerk	1	1,740
2. Grain Insects Section		
1. Field Station, Thomasville, Georgia		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,900
2. Field Station, Sligo, Maryland		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,800
Junior Entomologist	1	2,000
3. Field Station, Manhattan, Kansas		
Agent	1	2,800
3. Bean Weevil Section		
1. Field Station, Modesto, California		
1. Office of Entomologist		
Entomologist	1	3,800
Assistant Entomologist	1	2,900
4. Dried-Fruit Insects Section		
1. Field Station, Fresno, California		
1. Office of Entomologist		
Entomologist	1	4,200
Associate Entomologist	1	3,300
Junior Entomologist	1	2,000

9. Tropical, Subtropical and Ornamental-Plant Insects Division		
1. Administrative Office, Washington, D. C.		
1. Office of Principal Entomologist		
Principal Entomologist	1	5,600
Senior Entomologist	1	4,600
Biometrician	1	2,000
Senior Scientific Aid	1	2,000
Senior Clerk	1	2,000
Assistant Clerk	1	1,740
2. Citrus Insects Section		
1. Field Laboratory, Orlando, Florida		
1. Office of Entomologist		
Entomologist	1	4,000
2. Field Laboratory, Lindsay, California		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,500
3. Field Laboratory, Whittier, California		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,700
4. Field Laboratory, Singapore, South Malay		
1. Office of Senior Entomologist		
Senior Entomologist	1	5,200
3. Greenhouse Insects Section		
1. Central Office, Washington, D. C.		
Gardener	1	1,800
2. Field Laboratory, Whittier, California		
Assistant Entomologist	2	2,700
4. Miscellaneous Ornamentals Section		
1. Field Laboratory, New Orleans, Louisiana		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,200

Senior Scientific Aid	1	2,000
Assistant Clerk	1	1,680
Custodial Employee	1	(per h.) .30

5. Parlatoria Date Scale Section
   1. Field Laboratory, Indio, California
      1. Office of Associate Entomologist

Associate Entomologist	1	3,700

6. Bulb Insects Section
   1. Field Laboratory, Babylon, New York
      1. Office of Assistant Entomologist

Assistant Entomologist	1	2,900
Junior Entomologist	1	2,000

   2. Field Laboratory, Sumner, Washington,
      1. Office of Associate Entomologist

Associate Entomologist	1	3,200

   3. Field Laboratory, Whittier, California

Junior Entomologist	1	2,100

7. Mexican Fruit Worm Section
   1. Field Laboratory, Mexico City, Mexico
      1. Office of Entomologist

Entomologist	1	4,000
Senior Scientific Aid	1	2,000
Assistant Clerk	1	1,680
Unskilled Laborer	1	(per mo.) 75

   2. Field Laboratory, Whittier, California

Entomologist	1	4,000

8. Fruit Flies Section
   1. Field Laboratory, Ancon, Canal Zone
      1. Office of Associate Entomologist

Associate Entomologist	1	3,500

   2. Field Laboratory, Honolulu, Hawaii

1. Office of Associate Entomologist		
Associate Entomologist	1	3,400
Assistant Clerk	1	1,620
10. *Insects Affecting Man and Animals* Division		
1. Administrative Office, Washington, D. C.		
1. Office of Principal Entomologist in Charge		
Principal Entomologist in Charge	1	5,600
Associate Entomologist	1	3,500
Senior Clerk	1	2,400
Clerk Stenographer	1	1,800
Assistant Clerk Stenographer	1	1,680
2. Insects Affecting Cattle Section		
1. Field Laboratory, Beltsville, Maryland		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,600
2. *Field Laboratory, Uvalde, Texas*		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,300
Assistant Entomologist	1	2,600
3. Field Laboratory, Menard, Texas		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,600
4. Field Laboratory, Fargo, North Dakota		
1. Office of Assistant Entomologist		
Assistant Entomologist	1	2,600
5. Field Laboratory, Galesburg, Illinois		
1. Office of Associate Entomologist		
Associate Entomologist	1	3,200

3. Insects Affecting Sheep and Goats Section
   1. Field Laboratory, Dallas, Texas
      1. Office of Associate Entomologist

Associate Entomologist	1	3,800
	1	3,700
Clerk	1	1,920
Principal Laborer	1	1,500

   2. Field Laboratory, *Sonora, Texas*
      1. Office of Assistant Entomologist

Assistant Entomologist	1	3,000
Clerk Stenographer (Temporary)	1	(per h.) .55
Laborer	1	(per h.) .25

4. Insects Affecting Man Section
   1. Field Laboratory, *Mound*, Louisiana
      1. Office of Senior Entomologist

Senior Entomologist	1	4,600
Associate Entomologist	1	3,200
Junior Entomologist	1	2,400
Junior Chemist	1	2,200
Temporary Assistant	1	(per d.) 2.50

11. Taxonomy and Interrelation of Insects Division
   1. Administrative Office, Washington, D. C.
      1. Office of Chief of Bureau
         Chief of Bureau in Charge
   2. Taxonomy of Insects Section
      1. Central Administration, Washington, D. C.
         1. Office of Senior Enomologist

Senior Entomologist	1	5,200
Senior Scientific Aid	1	2,200
	1	2,000
Senior Scientific Illustrator	1	2,300
Assistant Scientific Illustrator	1	1,860

Junior Scientific Aid	1	1,560
	1	1,440
Under Scientific Helper	1	1,500
	3	1,440
	3	1,380
	1	1,260
Clerk Stenographer	1	2,040
Assistant Clerk Stenographer	2	1,860
	3	1,800
	1	1,680
2. Coleoptera Subsection		
Senior Entomologist	1	4,600
Associate Entomologist	2	3,700
	1	3,400
	1	3,300
3. Lepidoptera Subsection		
Associate Entomologist	1	3,600
4. Hymenoptera Subsection		
Senior Entomologist	1	4,600
Associate Entomologist	1	3,600
Assistant Entomologist	1	2,700
5. Diptera Subsection		
Associate Entomologist	1	3,300
6. Orthoptera and Neuropteroides Subsection		
Associate Entomologist	1	3,700
7. Ectoparasites and Mites Subsection		
Associate Entomologist	1	3,600
8. Coccidae Subsection		
Senior Entomologist	1	5,200
Junior Entomologist	1	2,300
3. Bioclimatics Section		
1. Field Laboratory, Mineral Wells, West Virginia		
1. Office of Principal Entomologist		
Principal Entomologist	1	5,600
Principal Scientific Aid	1	2,400

4. Insect Pathology and Morphology Sections		
1. Central Office, Washington, D. C.		
Senior Entomologist	1	4,800
2. Field Laboratory, Sligo, Maryland		
Senior Entomologist	1	4,600
5. Exchange of Useful Insects and History of Economic Entomology Section		
1. Office of Principal Entomologist		
Principal Entomologist	1	6,400
Principal Clerk Stenographer	1	2,600
7. Insect Pest Survey Section		
1. Office of Senior Entomologist		
Senior Entomologist	1	4,800
Associate Entomologist	1	3,200
Assistant Clerk	1	1,860
Junior Clerk	1	1,440
Under Clerk	1	1,260

APPENDIX 2

CLASSIFICATION OF ACTIVITIES

Explanatory Note

The Classifications of Activities have for their purpose to list and classify in all practicable detail the specific activities engaged in by the several services of the national government. Such statements are of value from a number of standpoints. They furnish, in the first place, the most effective showing that can be made in brief compass of the character of the work performed by the service to which they relate. Secondly, they lay the basis for a system of accounting and reporting that will permit the showing of total expenditures classified according to activities. Finally, taken collectively, they make possible the preparation of a general or consolidated statement of the activities of the government as a whole. Such a statement will reveal in detail, not only what the government is doing, but the services in which the work is being performed. It is hardly necessary to point out the value of such information in planning for future work and in considering the problem of the better distribution and coördination of the work of the government. The Institute contemplates attempting such a general listing and classification of the activities of the government upon the completion of the present series.

Classification of Activities

1. Deciduous-Fruit Insect Investigations
    1. Apple insects
    2. Peach insects
    3. Blueberry maggots
    4. Grape insects

5. Nut insects
6. Japanese beetle
7. Asiatic beetle
8. Orchard insecticides

2. Cereal and Forage Insect Investigations
   1. European corn borer
   2. Grasshoppers
   3. Alfalfa weevil
   4. Hessian fly
   5. Chinch bug
   6. Sugar-cane insects
   7. Rice insects
   8. Other cereal and forage insects
3. Investigations of Insects Affecting Cotton
   1. Cotton-boll weevil
   2. Thurberia or Arizona weevil
   3. Pink bollworm
   4. Miscellaneous cotton insects
4. Forest and Shade-Tree Insect Investigations
   1. Insects affecting forest trees
   2. Coöperative forest-insect control work
   3. Insects affecting forest products
   4. Insects injurious to shade trees and hardy shrubs
   5. Gipsy moth and brown-tail moth
5. Truck-Crop Insect Investigations
   1. Sweet-potato weevil
   2. Bean insects
   3. Tobacco insects
   4. Pea insects
   5. Mushroom insects
   6. Berry insects
   7. Sugar-beet insects
   8. Soil insects
   9. Miscellaneous truck-crop insects

6. Bee-Culture Investigations
    1. Bee behavior
    2. Regional beekeeping methods
    3. Intermountain bee culture
    4. Physiology of bees
    5. Demonstration work in beekeeping
    6. Bee diseases
    7. Southern states bee culture
7. Stored-Product Insect Investigations
    1. Grain insects
    2. Bean weevils
    3. Dried-fruit insects
    4. Household insects
    5. Insects affecting confections, meat, hides, and tobacco
    6. Fumigation and cold storage experiments
8. Tropical, Subtropical, and Ornamental-Plant Insect Investigations
    1. Parlatoria date scale
    2. Greenhouse insects
    3. Bulb insects
    4. Citrus-fruit insects
    5. Citrus thrips
    6. Mediterranean fruit fly
    7. Other studies
9. Investigation of Insects Affecting the Health of Man and Animals
10. Taxonomy of Insects
11. Bioclimatic Studies
12. Insect Pathology Studies
13. Insect Morphology Studies
14. Exchange of Useful Insects
15. Preparation of History of Economic Entomology
16. Insect Pest Survey

APPENDIX 3

PUBLICATIONS[1]

The official publications of the Bureau of Entomology, except the annual reports of the Entomologist, were formerly issued in the name of the Bureau, but since July 1, 1913, these publications, like those of other units of the Department of Agriculture, have been superseded by new series of publications issued from the Secretary's Office.

Bureau Publications. During the period from the establishment of the Division of Entomology in 1863, until July 1, 1913 the results of the work of this government unit were published in the annual reports of the Entomologist and in other Bureau publications as well as in the Farmers' Bulletin and the Yearbook of the Department of Agriculture.

The Bureau publications issued in its own name prior to July 1, 1913, other than annual reports, were designated as Bulletins, Circulars, Insect Life, and Technical Series, and there were occasional miscellaneous unnumbered publications. Two series of Bulletins were issued by the Bureau, the old series being numbered from 1 to 33, issued from 1883 to 1895, and the new series, from 1 to 127 issued from 1895 to 1913. Of the circulars there were also two series, the first, comprising over forty numbers, were mostly circular letters; the second series, numbered from 1 to 173, were issued from 1891 to 1913. Insect Life, a monthly publication, was first issued in July, 1888, and was discontinued in July, 1895. A general index to this series

[1] These publications, when available, are sold by the Superintendent of Documents, Government Printing Office, Washington. With some exceptions, current issues are sent out, on application, by the Office of Information of the Department of Agriculture. New publications are announced in a "Monthly List of Publications," which is sent free to persons requesting it.

was issued in 1897. The volumes are numbered from 1 to 7. They consist of from five to twelve numbered parts each. The class of matter that appeared in this series was continued in the Bulletins and Technical Series. The Technical Series was begun on June 15, 1895, and was numbered from 1 to 27. All the series of Bureau publications, except the annual reports, were superseded in 1913 by new series issued from the Secretary's Office.

Monthly Bulletin of Insect Pest Survey. The Bureau issues on the first of each month, from March to December, a multigraphed "Monthly Bulletin of Insect Pest Survey," which is distributed gratis to entomologists, agricultural colleges, and agricultural experiment stations. The Bulletin gives, each month, the outstanding entomological features in the United States and in Canada, and a detailed statement of insect conditions in the United States.

Posters. The Bureau has issued posters, for free distribution, for the use of schools, showing insect pests and their work, and methods of control. The posters that have thus far been issued deal with grasshoppers, the garden cutworm, potato beetles, the wheat jointworm, the chalcis-fly, the Hessian fly, the gipsy moth, the corn borer, the Japanese beetle, spray potato fields and orchard spray schedules.

Department Publications. Since July 1, 1913, the Bureau of Entomology has published the results of its work in the annual reports of the Entomologist, and, like other bureaus of the Department of Agriculture, in the following series of Departmental pubications: Farmers' Bulletins, Department Leaflets, Technical Bulletins (formerly Department Bulletins), Circulars, and Miscellaneous Publications (formerly Miscellaneous Circulars), and in articles and reprints from articles in the Yearbook of the Department of Agriculture and in the Journal of Agricultural Research, and articles in the Official Record.

Annual Reports. Annual reports of the Entomologist have been included in the annual reports of the Department of Agri-

culture since 1863, except in 1878 when none was issued. Since 1879 the annual reports of the Entomologist have also been issued in separate form.

Farmers' Bulletins. The Farmers' Bulletins cover a wide range of subject matter and are of interest to a great many classes of persons. They are issued for general distribution among farmers, and are, therefore, written in simple, non-technical language, easily understood by the layman. Most of the recent publications of the Department of Agriculture dealing with entomological subjects are in this series, many of them, however, being reprints of previously issued Farmers' Bulletins.

Department Leaflets. The series of Departmental Leaflets which was started in 1927, carries popular material of the same general character as the Farmers' Bulletin series, except that the leaflets are confined to specific practical directions and recommendations, remedies, and methods. They are brief and concise, are written in informal, popular style, and are limited to not more than eight pages.

Technical Bulletins. The Technical Bulletins are a series of technical publications of the various Bureaus of the Department of Agriculture intended primarily for specialists and research workers. This series in 1927 superseded the Department Bulletin series, which was numbered from 1 to 1500. The Bulletins contain the results of the scientific and research work of these bureaus. In most cases only small editions are printed. A few issues each year are devoted to entomological subjects.

Circulars. The Circular series carries the less technical and more informational material of the same general nature as that in the Technical Bulletin series. This series in 1927 replaced the Department Circular Series numbered 1 to 425. Few of them are devoted to entomological subjects.

Miscellaneous Publications. The series, Miscellaneous Publications, includes those publications of a miscellaneous nature which do not fall within any of the other series issued by the Department of Agriculture. Very few of the publications of the

Bureau of Entomology appear in this form. This series in 1929 superseded the Miscellaneous Circulars, which were numbered from 1 to 110.

Yearbook. The Yearbook of the Department of Agriculture contains a general report of the operations of the Department during the preceding calendar year. Nearly all the articles in the Yearbook are reprinted in separate form. Occasional articles by the Bureau of Entomology appear in the Yearbook.

Journal of Agricultural Research. The Journal of Agricultural Research is a hundred-page semi-monthly periodical published by authority of the Secretary of Agriculture, with the coöperation of the Association of American Agricultural Colleges and Experiment Stations. It contains articles on technical agricultural research carried on by the Department of Agriculture or the state experiment stations and is, therefore, of primary interest only to agricultural scientists and advanced students. The editorial committee consists in part of employees of the Department of Agriculture and in part of members of the Association. It was originally published monthly, and then weekly, and is now issued semi-monthly. Each article is reprinted as a separate. A considerable proportion of the publications of the Bureau of Entomology appears in this journal.

Official Record. The Official Record is a weekly publication containing official orders and miscellaneous information concerning the activities of the Department, and other matters of special interest to employees and persons having to do with the Department's work. Occasionally an entomological subject is dealt with in this publication.

APPENDIX 4

LAWS

A. Index to Laws

(B) Compilation of Laws

R. S., Sec. 520—Establishment of the Department of Agriculture—[Act of May 15, 1862, Sec. 1; 12 Stat. L., 387].

Sec. 520. There shall be at the seat of Government a Department of Agriculture, the general design and duties of which shall be to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word. . . .

R. S., Secs. 522, 523—Officers and employees—[Act of May 15, 1862, Sec. 4; 12 Stat. L., 388, 17 Stat. L., 508].

Sec. 522. There shall be in the Department of Agriculture . . . one entomologist. . . .

SEC. 523. The Commissioner [Secretary] [1] of Agriculture shall appoint . . . such other employés as Congress may from time to time provide, with salaries corresponding to the salaries of similar officers in other Departments of the Government; and he shall, as Congress may from time to time provide, employ other persons for such time as their services may be needed, including chemists, botanists, entomologists, and other persons skilled in the natural sciences pertaining to agriculture.

R. S., Sec. 526—Duties of Commissioner [Secretary] [1]—[Act of May 15, 1862, Sec. 3; 12 Stat. L., 387].

SEC. 526. The Commissioner [Secretary] [1] of Agriculture shall procure and preserve all information concerning agriculture which he can obtain by means of books and correspondence, and by practical and scientific experiments, accurate records of which experiments shall be kept in his office, by the collection of statistics, and by any other appropriate means within his power; . . .

1889—Act of February 9, 1889 (25 Stat. L., 659)—An Act To enlarge the powers and duties of the Department of Agriculture and to create an Executive Department to be known as the Department of Agriculture.

[SECTION 1]. That the Department of Agriculture,[2] shall be an Executive Department, under the supervision and control of a Secretary of Agriculture, who shall be appointed by the President, by and with the advice and consent of the Senate; and section one hundred and fifty-eight of the Revised Statutes is hereby amended to include such Department, and the provisions of title four of the Revised Statutes, including all amendments thereto, are hereby made applicable to said Department.

* * * *

SEC. 4. That all laws and parts of laws relating to the Department of Agriculture now in existence, as far as the same are applicable and not in conflict with this act, and only so far, are continued in full force and effect.

1890—Act of July 14, 1890 (26 Stat. L., 282, 288)—An Act Making appropriation for the Department of Agriculture for fiscal year ending June thirtieth, anno Domini, eighteen hundred and ninety-one.

* * * *

The authority granted to the Commissioner of Agriculture by the act of May twenty-ninth, eighteen hundred and eighty-four, establishing the Bureau of Animal Industry [23 Stat. L., 31], and by the provisions

[1] Act of July 14, 1890. See also act of February 9, 1889.
[2] See act of July 14, 1890.

of the appropriation act for the Agricultural Department, approved July eighteenth, eighteen hundred and eighty-eight [25 Stat. L., 333] [3] relating to said Bureau, is hereby vested in the Secretary of Agriculture; and the said Secretary is hereby authorized and directed to perform all the duties named in said acts and all other acts of Congress in force on February eighth, eighteen hundred and eighty-nine, to be performed by the Commissioner of Agriculture.

1922—Act of August 31, 1922 (42 Stat. L., 833)—An Act To regulate foreign commerce in the importation into the United States of the adult honeybee (*Apis mellifica*).

[SECTION 1]. That, in order to prevent the introduction and spread of diseases dangerous to the adult honeybee, the importation into the United States of the honeybee (Apis mellifica) in its adult stage is hereby prohibited, and all adult honeybees offered for import into the United States shall be destroyed if not immediately exported: *Provided*, That such adult honeybees may be imported into the United States for experimental or scientific purposes by the United States Department of Agriculture: *And provided further*, That such adult honeybees may be imported into the United States from countries in which the Secretary of Agriculture shall determine that no diseases dangerous to adult honeybees exist, under rules and regulations prescribed by the Secretary of the Treasury and the Secretary of Agriculture.

SEC. 2. That any person who shall violate any of the provisions of this Act shall be deemed guilty of a misdemeanor and shall, upon conviction thereof, be punished by a fine not exceeding $500 or by imprisonment not exceeding one year, or both such fine and imprisonment, in the discretion of the court.

1928—Act of May 16, 1928 (45 Stat. L., 539, 565)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1929, and for other purposes.

* * * *

Hereafter the functions of the Federal Horticultural Board shall devolve upon and be exercised by the Plant Quarantine and Control Administration, the Chief of which shall serve ex officio as chairman of an advisory Federal Plant Quarantine Board of five members, the four additional members to be designated by the Secretary of Agriculture from existing bureaus and offices of the Department of Agriculture, including the Bureau of Entomology, the Bureau of Plant Industry, and the Forest Service, and who shall serve without additional compensation.

[3] Temporary provision, but substantially repeated in succeeding acts of appropriation.

1929—Act of February 16, 1929 (45 Stat. L., 1189, 1208)—An Act Making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1930, and for other purposes.

* * * *

BUREAU OF ENTOMOLOGY

Salaries and general expenses: For necessary expenses connected with the investigations, experiments, and demonstrations in reference to the items hereinafter enumerated for the promotion of economic entomology, independently or in cooperation with other branches of the Federal Government, States, counties, and municipalities, organizations and individuals concerned, including the employment of necessary persons and means in the city of Washington and elsewhere, rent outside of the District of Columbia and not to exceed $3,000 for the erection of insectaries and other buildings: *Provided*, That the cost of any such building shall not exceed $1,500, as follows:

For general administrative purposes, including the salary of chief of bureau and other personal services in the District of Columbia, $91,000.

Deciduous fruit insects: For insects affecting deciduous fruits, grapes, and nuts, and including research on the Japanese and Asiatic beetles, $352,790.

Subtropical plant insects: For insects affecting tropical, subtropical, and ornamental plants and including research on the Parlatoria date scale and the Mediterranean and other fruit flies, $130,500.

Truck crop insects: For insects affecting truck and garden crops and including insects affecting tobacco and sugar beets, $278,560.

Forest insects: For insects affecting forests and including research on the gipsy and brown-tail moths, $204,000.

Cereal and forage insects: For insects affecting cereal and forage crops, including sugar cane and rice, and including research on the European corn borer, $470,620, of which $8,000 shall be immediately available for the control of the cricket in northwestern Colorado.

Cotton insects: For insects affecting cotton and including research on the pink bollworm of cotton there is hereby made available $303,120 of the unexpended balance of the appropriation of $5,000,000 for establishing and enforcing noncotton zones, carried in the Second Deficiency Act, fiscal year 1928, of which amount $10,000 shall be immediately available for boll weevil research control work in Oklahoma.

For insects affecting man and animals, $83,900.

For insects affecting stored products, $71,900.

For taxonomy and interrelations of insects, and including the importation and exchange of useful insects and an insect pest survey, $145,000.

For bee culture, $54,400.

Total, Bureau of Entomology, $1,882,670, of which amount not to exceed $396,000 may be expended for personal services in the District of Columbia.

1929—Act of March 4, 1929 (45 Stat. L., 1623, 1634, 1677)—

An Act Making appropriations to supply deficiencies in certain appropriations for the fiscal year ending June 30, 1929, and prior fiscal years, to provide supplemental appropriations for the fiscal years ending June 30, 1929, and June 30, 1930, and for other purposes.

TITLE I. . . . DEPARTMENT OF AGRICULTURE

. . . Bureau of Entomology. Insects affecting man and animals: For an additional amount for necessary expenses connected with investigations, experiments, and demonstrations relating to insects affecting man and animals, including the same objects specified under this head in the Agricultural Appropriation Act for the fiscal year 1929, fiscal years 1929 and 1930, $12,000.

Insects affecting tropical and subtropical plants: For an additional amount for necessary expenses connected with investigations, experiments, and demonstrations relating to insects affecting tropical, subtropical, and ornamental plants, for cooperation with the Departments of Agriculture, Commerce, and Labor of the Republic of Cuba, including the same objects specified under this head in the Agricultural Appropriation Act for the fiscal year 1929, fiscal years 1929 and 1930, $6,000.

* * * *

TITLE II. SUPPLEMENTAL APPROPRIATIONS UNDER THE ACT OF MAY 28, 1928, AMENDING THE CLASSIFICATION ACT OF 1923

* * * *

Bureau of Entomology: For "Salaries and expenses, Bureau of Entomology, 1929," $80,788.

APPENDIX 5

FINANCIAL STATEMENT

Explanatory Note

Statements showing appropriations, receipts, expenditures and other financial data for a series of years constitute the most effective single means of exhibiting the growth and development of a service. Due to the fact that Congress has adopted no uniform plan of appropriation for the several services and that the latter employ no uniform plan in respect to the recording and reporting of their receipts and expenditures, it is impossible to present data of this character according to any standard scheme of presentation. In the case of some services the administrative reports contain tables showing financial conditions and operations of the service in considerable detail; in others financial data are almost wholly lacking. Careful study has in all cases been made of such data as are available and the effort has been made to present the results in such a form as will exhibit the financial operations of the services in the most effective way that circumstances permit.

ENTOMOLOGICAL DIVISION AND ENTOMOLOGICAL COMMISSION

APPROPRIATIONS, FISCAL YEARS 1878 TO 1885, BY FIVE YEAR INTERVALS, 1885 TO 1905

	1878	1879	1880	1881	1882	1883
Entomological Commission, Department of the Interior: [a]						
Expenses of (for study of Rocky Mountain locusts)	$18,000.00	$10,000.00	$10,000.00	$25,000.00	$1,086.00	.....
Investigating habits of insects injurious to cotton plants	.....	.....	5,000.00	.....	.....	.....
Total	$18,000.00	$10,000.00	$15,000.00	$25,000.00	$1,086.00	.....
Entomological Work of the Department of Agriculture:						
Salaries, Entomological Division	.....	[b] 1,900.00	1,900.00	2,000.00	3,200.00	$3,200.00
Investigating the history and habits of insects injurious to agriculture and other expenses	.....	5,000.00	5,000.00	5,000.00	[c] 20,000.00	20,000.00
Investigating the habits of insects injurious to cotton plants	.....	[d] 5,000.00	.....	.....	.....	.....
Total	.....	$11,900.00	$6,900.00	$7,000.00	$23,200.00	$23,200.00

	1884	1885	1890	1895	1900	1905
Entomological Work of the Department of Agriculture:						
Salaries, Entomological Division and Bureau of Entomology	$7,900.00	$7,900.00	$7,300.00	$9,500.00	$12,450.00	$12,450.00
General Expenses	.....	.....	.....	.....	70,000.00	70,000.00
Investigating the history and habits of insects injurious to agriculture and other expenses	20,000.00	20,000.00	20,000.00	[e] 20,300.00	.....	.....
Silk Culture	.....	.....	[f] 30,000.00	.....	.....	.....
Total	$27,900.00	$27,900.00	$57,300.00	$29,800.00	$82,450.00	$82,450.00

[a] Transferred to Department of Agriculture July 1, 1882.
[b] Not including $1,000 mentioned in note (d).
[c] Of this, $5,000 to be expended for the Entomological Commission.
[d] Of this, $1,000 to be paid to the Entomologist.
[e] Included in General Expenses after 1895.
[f] Of this, $5,000 to be expended for the use of the Women's Silk-Culture Association of the United States; $2,500 for the use of the Ladies' Silk Culture Society of California; and $2,500 for study and experiments by Joseph Newman of wild native silk-worms of California.

BUREAU OF ENTOMOLOGY

APPROPRIATIONS AND EXPENDITURES, FISCAL YEARS 1910 TO 1929, AND APPROPRIATIONS, FISCAL YEAR 1930

	1910		1911		1912		1913	
	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure
Salaries	$29,280.00	$29,179.23	$29,280.00	$29,146.09	$60,130.00	$59,903.27	$58,750.00	$57,333.60
General Expenses								
Investigations of insects affecting deciduous fruits	$43,600.00	$40,114.53	$40,600.00	$39,448.29	$41,200.00	$40,578.19	$40,600.00	$39,055.59
Investigations of insects affecting cereal and forage plants	22,500.00	22,093.38	25,000.00	24,916.15	50,000.00	49,780.53	75,000.00	73,725.30
Investigations of insects affecting Southern field crops	42,000.00	40,807.00	47,000.00	45,949.91	47,160.00	46,578.12	47,160.00	46,878.83
Investigations of insects affecting forests	13,500.00	13,400.64	15,400.00	15,127.13	43,250.00	42,935.64	44,750.00	44,432.74
Investigations of insects affecting truck crops and stored products	16,250.00	15,913.49	17,875.00	17,400.35	19,100.00	18,958.26	30,000.00	28,166.41
Investigations in bee culture	10,000.00	9,858.85	10,000.00	9,899.40	15,000.00	14,867.64	15,000.00	14,740.02
Investigations of insects affecting citrus fruits	16,500.00	15,315.75	19,875.00	17,437.89	21,500.00	21,043.67	21,500.00	21,415.86
Investigations of the Mediterranean fruit fly	.....	.....	.....	.....	.....	.....	35,000.00	15,967.77
Investigations of miscellaneous insects, etc.	34,050.00	31,261.78	27,150.00	26,363.76	19,740.00	19,420.31	19,740.00	19,514.63
Total General Expenses	$198,400.00	$188,765.42	$202,900.00	$196,542.88	$256,950.00	$254,162.36	$328,750.00	$303,897.15
Exterminating the armyworm	.....	.....	.....	.....	.....	.....	$5,000.00	$4,944.62
Preventing the spread of moths	$300,000.00	$268,194.44	$300,000.00	$297,614.91	$284,840.00	$261,751.18	284,840.00	258,414.05
Totals	$527,680.00	$486,139.09	$532,180.00	$523,303.88	$602,020.00	$575,816.81	$677,340.00	$624,589.42

APPROPRIATIONS AND EXPENDITURES, FISCAL YEARS 1910 TO 1929, AND APPROPRIATIONS, FISCAL YEAR 1930—*Continued*

	1914		1915		1916		1917	
	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure
Salaries	$60,960.00	$60,765.18	$69,050.00	$68,400.44	$69,530.00	$69,124.61	$99,180.00	$93,584.07
General Expenses								
Investigations of insects affecting deciduous fruits	$45,000.00	$44,349.84	$58,000.00	$56,293.41	$58,000.00	$57,148.40	$69,780.00	$59,681.72
Investigations of insects affecting cereal and forage plants	90,000.00	89,672.01	114,500.00	112,057.30	114,500.00	113,509.69	114,660.00	112,163.33
Investigations of insects affecting Southern field crops	50,000.00	49,940.04	59,000.00	57,286.47	59,000.00	58,680.96	64,400.00	64,391.34
Investigations of insects affecting forests	44,750.00	44,428.09	54,790.00	54,428.01	54,790.00	54,650.46	50,770.00	50,394.28
Investigations of insects affecting truck crops and stored products	35,000.00	34,669.24	41,500.00	39,824.83	41,500.00	41,183.62	43,756.00	42,939.65
Investigations in bee culture	15,000.00	14,980.93	15,000.00	14,978.79	15,000.00	14,940.00	20,000.00	19,946.96
Investigations of insects affecting tropical and sub-tropical plants	21,500.00	19,214.54	20,100.00	2,074.88	20,100.00	19,272.91	17,100.00	16,138.44
Investigations of the Mediterranean fruit fly	35,000.00	22,962.87	33,200.00	15,579.28	33,200.00	15,508.24	32,204.00	14,673.04
Identification and classification of insects	.....	.....	54,280.00	53,843.30	54,280.00	53,906.24	57,980.00	57,745.79
Miscellaneous expenses	45,000.00	44,479.66	.....	.....	.....	.....	3,000.00	2,998.45
Total General Expenses	$381,250.00	$364,697.22	$450,370.00	$424,366.27	$450,370.00	$428,800.52	$464,650.00	$441,073.00
Preventing the spread of moths	$300,000.00	$279,616.28	$310,000.00	$302,487.94	$310,000.00	$302,222.33	$305,050.00	$297,053.02
Totals	$742,210.00	$705,078.68	$829,420.00	$795,254.65	$829,900.00	$800,147.46	$868,880.00	$831,710.09

APPROPRIATIONS AND EXPENDITURES, FISCAL YEARS 1910 TO 1929, AND APPROPRIATIONS, FISCAL YEAR 1930—*Continued*

	1918		1919		1920		1921	
	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure
Salaries	$102,180.00	$94,006.48	$115,330.00	$96,752.30	$124,010.00	$116,895.85	$132,790.00	$122,744.95
Increase of compensation	17,061.40	17,061.40	31,605.29	31,605.29	90,216.62	90,216.62	90,112.40	90,112.40
Total Salaries	$119,241.40	$111,067.88	$146,935.29	$128,357.59	$214,226.62	$207,112.47	$222,902.40	$212,857.35
General Expenses								
Investigations of insects affecting deciduous fruits	$83,380.00	$80,884.98	$93,380.00	$92,237.56	$105,780.00	$102,187.21	$178,500.00	$170,586.99
Investigations of insects affecting cereal and forage plants	123,260.00	116,903.86	122,060.00	121,088.76	147,060.00	143,056.47	145,660.00	143,708.95
Investigations of insects affecting Southern field crops	89,400.00	84,517.33	89,400.00	87,966.19	100,400.00	100,040.00	125,000.00	124,781.04
Investigations of insects affecting forests	50,770.00	47,680.86	53,870.00	52,669.33	48,790.00	48,226.07	40,000.00	39,751.30
Investigations of insects affecting truck crops and stored products	47,760.00	45,808.23	63,760.00	54,389.42	134,960.00	133,055.09	110,000.00	107,175.65
Investigations in bee culture	20,000.00	19,873.95	35,000.00	30,959.83	35,000.00	32,541.50	33,800.00	33,286.52
Investigations of insects affecting tropical and sub-tropical plants [a]	17,100.00	13,426.08	16,500.00	15,740.51	16,500.00	15,924.57	51,500.00	49,773.15
Investigations of the Mediterranean fruit fly	33,200.00	23,369.28	32,000.00	27,868.34	32,000.00	29,590.11	.....	.....
Preventing the spread of the European corn borer	.....	.....	.....	.....	250,000.00	247,375.24	400,000.00	395,550.93
Investigations of the nature and habits of the camphor thrip	.....	.....	.....	.....	5,000.00	3,997.00	.....	.....
Identification and classification of insects	56,380.00	49,677.73	52,330.00	52,200.13	62,330.00	61,802.39	52,330.00	51,857.69
Miscellaneous expenses	3,000.00	2,918.19	9,000.00	8,984.57	5,480.00	5,443.17	3,880.00	3,605.88
Total General Expenses	$524,250.00	$485,060.49	$567,300.00	$544,104.64	$943,300.00	$923,238.82	$1,140,670.00	[b] $1,120,078.10
Preventing the spread of moths	$305,050.00	$295,142.51	$304,050.00	$291,526.87	$304,050.00	$293,500.41	$475,000.00	$468,170.19
Eradication of the sweet-potato weevil	.....	.....	20,000.00	15,790.57	.....	.....	.....	.....
Preventing the spread of the Japanese beetle	.....	.....	.....	.....	45,000.00	43,322.88	.....	.....
Eradication of the date scale	.....	.....	.....	.....	.....	.....	5,000.00	4,989.48
Preventing the spread of the Mexican bean beetle	.....	.....	.....	.....	.....	.....	25,000.00	24,959.18
Totals	$948,541.40	$891,270.88	$1,038,285.29	$979,779.67	$1,506,576.62	$1,467,174.58	$1,868,572.40	$1,831,054.30

[a] After 1920, this item includes investigations of the Mediterranean fruit fly and in 1921, of the camphor thrip.
[b] Includes a $55,000 appropriation for 1920-21, of which $8,268.04 was expended in 1920 but is included in the 1921 expenditure.

APPROPRIATIONS AND EXPENDITURES, FISCAL YEARS 1910 TO 1929, AND APPROPRIATIONS, FISCAL YEAR 1930—*Continued*

	1922		1923		1924		1925	
	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure
Salaries	$129,270.00	$125,768.68	$128,070.00	$123,855.07	$123,870.00	$121,564.67	[a] $144,508.00	$142,145.90
Increase of compensation	86,893.60	86,893.60	85,442.31	85,442.31	83,421.36	83,421.36	.....	.....
Total Salaries	$216,163.60	$212,662.28	$213,512.31	$209,297.38	$207,291.36	$204,986.03	$144,508.00	$142,145.90
General Expenses								
Investigations of insects affecting deciduous fruits	$178,500.00	$169,173.49	$178,500.00	$175,823.37	$203,500.00	$200,729.51	$320,000.00	$316,893.23
Investigations of insects affecting cereal and forage plants	190,000.00	161,903.19	170,000.00	167,275.41	170,000.00	166,034.09	176,400.00	169,163.90
Investigations of insects affecting Southern field crops	165,000.00	161,503.15	165,000.00	163,611.19	165,000.00	164,095.65	218,093.95	215,876.08
Investigations of insects affecting forests	55,000.00	50,018.17	55,000.00	53,628.70	55,000.00	54,602.25	57,100.00	56,500.33
Investigations of insects affecting truck crops and stored products	120,000.00	115,194.72	110,000.00	108,612.52	123,000.00	120,245.62	157,000.00	150,523.55
Investigations in bee culture	33,800.00	32,005.52	33,800.00	33,707.70	33,800.00	32,786.52	32,320.00	31,405.55
Investigations of insects affecting tropical and sub-tropical plants	56,500.00	55,174.00	71,500.00	69,770.24	71,500.00	68,769.68	68,055.00	64,246.45
Identification and classification of insects	62,330.00	62,234.01	62,330.00	60,164.74	62,330.00	61,690.09	64,630.00	63,971.91
Miscellaneous expenses	3,880.00	3,798.00	3,880.00	3,371.26	3,880.00	3,520.45	58,030.00	56,360.54
Total General Expenses	$865,010.00	$811,004.25	$850,010.00	$835,965.13	$888,010.00	$872,473.86	[b] $1,151,628.95	$1,124,941.54
Preventing the spread of moths	$400,000.00	$398,237.53	[c] $595,935.58	[c] $578,385.64	$601,000.00	$585,932.06	[d] $625,660.66	$622,316.72
Eradication of the date scale	10,000.00	9,825.57	13,000.00	12,639.96	.....	.....	.....	.....
Preventing the spread of the Mexican bean beetle	75,000.00	67,378.82	25,000.00	24,633.17	30,000.00	28,965.39	29,885.00	28,961.51
Preventing the spread of the European corn borer	275,000.00	253,098.82	200,000.00	198,423.80	225,000.00	219,174.75	[e] 233,673.56	230,638.06
Preventing the spread of the Japanese beetle	.....	.....	25,000.00	24,706.77	.....	.....	.....	.....
Boll weevil poisoning by airplane	.....	.....	[f] 33,308.00	32,848.42	.....	.....	.....	.....
Total	$1,841,173.60	$1,752,207.27	$1,955,765.89	$1,916,900.27	$1,951,301.36	$1,911,532.09	$2,185,356.17	$2,149,003.73

[a] Includes $6,780 field compensation (Act of December 6, 1924; 43 Stat. L., 705).
[b] Includes $54,150 field compensation (Act of December 6, 1924; 43 Stat. L., 705) and excludes $13,826.05 transferred to War Department and Commerce Department.
[c] Includes 1922-23 and 1923 accounts, but excludes $4,064.42 transferred to and expended by the War Department.
[d] Includes $35,500.66 of a 1925-26 appropriation of $100,000.00.
[e] Includes $10,043.56 of a 1925-26 appropriation of $50,000.00.
[f] Excludes $6,692 transferred to the War Department.

APPROPRIATIONS AND EXPENDITURES, FISCAL YEARS 1910 TO 1929, AND APPROPRIATIONS, FISCAL YEAR 1930—*Concluded*

	1926		1927		1928		1929		1930
	Appropriation	Expenditure	Appropriation	Expenditure	Appropriation	Expenditure	[a] Appropriation	Expenditure	Appropriation
Salaries	$137,818	$136,836	$136,438	$132,003	[b]	[b]	[b]	[b]	[b]
General Expenses									
Investigations of insects affecting diciduous fruits	107,200	103,731	114,500	114,205	$135,980	$134,735	$337,095	$334,162	$352,790
Investigations of insects affecting cereal and forage plants	197,700	188,863	200,835	193,149	[c] 186,570	183,275	[c] 461,137	453,311	466,008
Investigations of insects affecting Southern field crops	[d] 252,545	251,432	255,440	256,154	337,340	335,448	.....	.....	.....
Investigations of insects affecting forests	75,000	73,239	75,000	73,247	79,570	79,238	193,825	192,111	204,000
Investigations of insects affecting truck crops and stored products	171,250	165,086	186,250	184,644	196,480	193,964	240,985	240,300	278,560
Investigations in bee culture	32,380	31,410	42,380	38,895	42,380	41,873	54,045	53,504	54,400
Investigations of insects affecting tropical and and sub-tropical plants	71,385	67,226	71,385	69,455	108,163	102,356	117,975	117,002	136,500
Investigations of insects affecting cotton (including pink bollworm)	.....	.....	15,000	.....	.....	.....	286,065	280,478	303,120
Investigations of insects affecting man and domestic animals	.....	.....	.....	.....	.....	.....	83,438	82,988	95,900
Insects affecting stored products	.....	.....	.....	.....	.....	.....	54,455	53,364	71,900
Identification and classification of insects (includes importation and exportation and insect pest survey)	66,560	64,617	66,560	65,808	98,857	97,719	138,520	137,693	145,000
Miscellaneous expenses	3,880	3,596	3,880	3,878	90,305	89,456	87,518	87,501	91,000
Total General Expenses	[d] $977,900	$949,200	$1,031,230	$999,435	$1,275,645	$1,258,064	$2,055,058	$2,032,414	$2,199,178
Preventing the spread of moths	[e] $704,499	$693,886	$670,000	$656,921	$670,000	$615,000	.....	.....	.....
Preventing the spread of the Mexican bean beetle	32,500	31,510	32,500	31,726	32,500	31,500	.....	.....	.....
Preventing the spread of the European corn borer	373,586	365,844	485,000	474,145	685,120	627,728	.....	.....	.....
Preventing the spread of the Japanese beetle	280,000	277,318	335,000	334,212	465,000	432,759	.....	.....	.....
European corn borer control	.....	.....	10,000,000	9,351,564	.....	.....	.....	.....	.....
Total	$2,506,303	$2,454,594	$12,690,168	$11,980,006	$3,128,265	$2,965,051	$2,055,058	$2,032,414	$2,199,178

[a] Includes supplemental appropriation for salaries on account of the act of May 28, 1928.
[b] Salaries are included in "*Miscellaneous Expenses.*"
[c] Excludes in 1928 and includes in 1929, $4,612 appropriated for 1928.
[d] Excludes $2,895 transferred to War and Commerce Departments.
[e] Includes $64,499 of a 1925-6 appropriation of $100,000.

APPENDIX 6

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Explanatory Note

The bibliographies appended to the several monographs aim to list only those works which deal directly with the services to which they relate, their history, activities, organization, methods of business, problems, etc. They are intended primarily to meet the needs of those persons who desire to make a further study of the services from an administrative standpoint. They thus do not include the titles of publications of the services themselves, except in so far as they treat of the services, their work and problems. Nor do they include books or articles dealing merely with technical features other than administrative of the work of the services. In a few cases explanatory notes have been appended where it was thought they would aid in making known the character or value of the publication to which they relate.

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