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L. O. HOWARD, ENTOMOLOGIST.

PROCEEDINGS

OF THE

SEVENTEENTH ANNUAL MEETING

OF THE

ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

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LETTER OF TRANSMITTAL.

United States Department of Agriculture,
Bureau of Entomology,
Washington, D. C., March 20, 1905.

Sir: I have the honor to transmit herewith the manuscripts of the Proceedings of the Seventeenth Annual Meeting of the Association of Economic Entomologists, which was held at Philadelphia, Pa., December 29 and 30, 1904. As the papers presented at the meetings of this association are of very considerable economic importance, and as the Department of Agriculture has hitherto published the reports of the secretaries of these meetings as bulletins, I recommend the publication of the present report as bulletin No. 52 of this Bureau. The text figures are necessary for the illustration of the text.

Respectfully,
L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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* Withdrawn for publication elsewhere.

ILLUSTRATIONS.

THE SEVENTEENTH ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

MORNING SESSION, THURSDAY, DECEMBER 29, 1904.

The Association met in the laboratory of physiology and pathology of the University of Pennsylvania, Philadelphia, Pa., on December 29 and 30, 1904. The following were in attendance at the several sessions:

W. B. Alwood, Blacksburg, Va.; G. M. Bentley, Raleigh, N. C.; Frank Benton, Washington, D. C.; F. C. Bishopp, Washington, D. C.; W. E. Britton, New Haven, Conn.; A. F. Burgess, Columbus, Ohio; C. E. Chambliss, Clemson College, S. C.; M. T. Cook, Santiago de las Vegas, Cuba; E. B. Engle, Harrisburg, Pa.; E. P. Felt, Albany, N. Y.; H. T. Fernald, Amherst, Mass.; James Fletcher, Ottawa, Canada; S. A. Forbes, Urbana, Ill.; H. Garman, Lexington, Ky.; C. P. Gillette, Fort Collins, Colo.; L. O. Howard, Washington, D. C.; W. D. Hunter, Washington, D. C.; William Lochhead, Guelph, Ontario, Canada; A. D. MacGillivray, Ithaca, N. Y.; C. L. Marlatt, Washington, D. C.; G. W. Martin, Nashville, Tenn.; Leslie Martin, Washington, D. C.; Yasushi Nawa, Gifu, Japan; Herbert Osborn, Columbus, Ohio; J. L. Phillips, Blacksburg, Va.; A. L. Quaintance, Washington, D. C.; W. A. Riley, Ithaca, N. Y.; E. D. Sanderson, Durham, N. H.; William Saunders, London, Ontario, Canada; W. M. Scott, Washington, D. C.; Henry Skinner, Philadelphia, Pa.; M. V. Slingerland, Ithaca, N. Y.; J. B. Smith, New Brunswick N. J.; H. E. Summers, Ames, Iowa; H. A. Surface, Harrisburg, Pa.; E. S. G. Titus, Washington, D. C.; H. L. Viereck, New Haven, Conn.; F. L. Washburn, St. Anthony Park, Minn.; F. M. Webster, Urbana, Ill.

The meeting was called to order at 10 a. m. by the president, Mr. A. L. Quaintance, who delivered his annual address as follows:

SOME PRESENT-DAY FEATURES OF APPLIED ENTOMOLOGY IN AMERICA

By A. L. Quaintance, *Washington, D. C.*

It is one of the present-day beliefs that we are living in a period of unexampled scientific activity. A census of achievement during the past two or three decades would undoubtedly furnish evidence that this belief is well founded. This activity has been as notable in applied as in pure science. Indeed, the tendency toward almost immediate utilization of scientific discoveries in practical affairs has been characteristic of modern times, and to this must be attributed much of the advancement which, as a nation, we have made in agriculture, in commerce, and in manufacture.

Agriculture, especially, has benefited by this activity. Agricultural chemistry, plant pathology, horticulture, bacteriology, entomology, and other branches of pure and applied science have each made notable contributions. It would be to no purpose to discuss the relative importance of the contributions which these respective sciences have made and are making to agriculture, for they are as the links in a chain and are closely related in theory and in practice; but a prominent place must be conceded to economic entomology, which has, perhaps, been as productive of immediate practical results as any other. Although, in the United States, among the youngest of the sciences concerned with problems relating to agriculture, the results achieved have placed economic entomology in the front rank.

In explanation of its phenomenal growth it may be said that one of our necessities, as a rapidly developing country, has been the reduction of insect losses to permit the profitable cultivation of many of our important crops. With the constantly increasing population, new regions have been settled and the lands planted in crops, the more or less isolated farms of former days giving way to practically unbroken areas of corn, wheat, cotton, and other crops, often of many miles in extent, thus furnishing ideal conditions for the development and spread of noxious species. Being preeminently a practical people, we have devised ways and means as the demand has grown, and at the present time the status of economic entomology is quite in keeping with our agricultural conditions.

The rate and magnitude of our agricultural growth and the consequent stimulus to applied entomology may, perhaps, be fairly judged from certain statistics concerning the production of some of our staple crops during the decade covered by the Twelfth Census. The increase in plantings of corn from 1889 to 1899 in the United States was 22,829,159 acres, an increase of 31.7 per cent. In the decade from 1890 to 1900 the area of wheat in the country shows a gain of 56.6 per cent, or about 19,000,000 acres. The increase in the area of cotton from 1889 to 1899 was 4,099,831 acres, a gain of 20.3 per cent, and it bears on the subject to note that of this total increase Texas, Oklahoma, and Indian Territory furnished 3,637,398 acres, or 88.7 per cent. The State and Territories mentioned, it will be remembered, are at the present time suffering more severely from insect depredations on cotton than is any other part of the cotton belt.

The increase in plantings of deciduous fruits has been scarcely less remarkable. At the present time there are numerous orchards, of peach especially, with from 2,000 to 3,000 acres in practically unbroken rows of trees. Orchards of still larger size are planned and are being planted at the present time. In the following table, compiled from the reports of the Twelfth Census, is indicated the increase in bearing trees, during the decade 1890 to 1900, of the more important pomaceous and drupaceous fruits:

TABLE I.—*Number of bearing trees in orchards in 1900 as compared with those in 1890.*

Class.	Bearing trees.		Increase during decade.
	1900.	1890.	
Apples	201,749,764	120,152,795	81,841,969
Peaches and nectarines	99,919,428	53,885,597	46,033,831
Pears	17,716,184	5,115,055	12,601,129
Plums and prunes	30,780,892	7,078,191	23,702,701
Cherries	11,943,287	5,638,759	6,304,528
Apricots	5,010,139	1,582,191	3,429,948
Total	367,164,694	193,452,588	153,712,106

The total increase in plantings of fruit trees of this class is thus seen to have been 153,712,106 trees, a number sufficient to plant a solid orchard, with trees 20 by 20 feet apart, of somewhat more than 1,400,000 acres. More recent information indicates a still greater proportionate increase during the present decade. Thus, in the State of Georgia I am informed that the present estimated plantings of peach trees are aproximately 18,000,000, both young and old. Leaving out of account the unreported young trees of the census of 1900, this shows the enormous gain of about 7,500,000 trees in four years. The increased plantings of apple, notably in Missouri, are also remarkable. In that State alone over 20,000,000 trees are reported for 1900 as against 8,000,000 for 1890.

These figures, I think, explain one of the principal causes for the rapid development of economic entomology in America. The sudden and wide disturbance of nature's balance between insects and their food plants by the cultivation of large areas of crops has resulted in insect depredations, both from native and introduced species, of such proportions as to render relief immediately necessary.

Our problems have been, therefore, largely of a character to demand earnest and instant effort for their solution, and the rapidity with which one problem has succeeded another has utilized to the fullest extent our capacity for work. The results of investigations have been of a character to justify the public in providing for their continuance and extension, and the demand for workers has been greater than the supply. This continued activity has brought about a considerable accumulation of knowledge concerning injurious species, and our economic literature to-day is doubtless more extensive than that of any other country.

Most fortunately traditions and theories have had but little place in applied entomology. The accuracy of published statements concerning the life and habits of insects and the value of remedial measures proposed have often been at once put to practical test and their soundness or futility determined. Investigations by several different workers over a considerable range of territory have been a most fertile means of rapid accumulation of knowledge concerning the biology of a given species and of the means to be used in reducing its ravages. Much of error, in theory and in practice, which might otherwise have lived for many years with a corresponding baneful influence on the standing of the science has thus been quickly eliminated.

Our official existence has been strenuous, and, were it not for the considerable number of investigators often engaged on the same problem and the immediate practical test of conclusions, our rate of progress could but mean superficial work. Many of the problems with which economic entomology concerns itself must be worked out from the beginning, and many of our economic workers have been forced to do strictly systematic work as a basis for contemplated work along economic lines. The common observation that applied science does not wait, in its development, on the theoretically necessary precedence of the pure science on which it is dependent is perhaps nowhere so well illustrated as in the case of applied entomology. Of necessity many of our workers are systematists, and their accomplishments in this field are scarcely less than in the domain of practical entomology. In addition to having an acquaintance with the details of insect classification and with fundamental biologic facts, an economic entomologist must be versed in the details of agricultural and horticultural practices, in chemistry, in botany, in forestry, in plant pathology, in animal husbandry, and in business methods.

Under conditions and requirements such as these has applied entomology grown to its present condition; and, although young in years, there is probably no branch of the utilitarian sciences which so nearly touches every human interest.

There are at the present time some features of applied entomology in the United States which are significant of its increasing scope and importance and which appear to me appropriate for consideration on an occasion of this kind. The very existence of this association, with its present membership of 175, is but one of the signs of the times. The writer doubts if there are similar scientific bodies which can show a higher average attendance or which are pervaded with a greater degree of professional interest than are the meetings of this

Association. Its influence, directly and indirectly, for the betterment of applied entomology has been most important and is increasing from year to year. The bulletins which contain the proceedings of the 16 annual meetings of the association, and which cover in all 1,541 pages, are a most valuable feature of our literature.

It must be a matter of much satisfaction to all entomologists to note the increasing appreciation in which the work of the economic entomologist is held, both by his constituents and the general public. In the earlier days of the science his work was often far from appreciated at its true worth. Experience, however, has been a constant teacher. Certain injurious insects, by their widespread injury to important farm and orchard crops, have served to bring prominently before the people the importance of the rôle which insects play, not only in the matter of crop production, but in influencing the price of staple articles of food and clothing in the markets of the world. The recently established fact of the transmission and carriage of diseases of man by mosquitoes and flies has arrested the attention of people of many classes, and, along with other discoveries of scarcely less importance, has been the means of exciting the interest and attention of many who previously were largely ignorant of the work and aims of the science. The considerable alarm following the announcement of the establishment of the San Jose scale in the East had scarcely begun to wane before the increasing ravages of the Mexican cotton boll weevil brought this species into wide notoriety, and probably never in the history of the world has an insect species been more generally the subject of comment than has the latter.

The present recognized importance of insect control in its relation to the welfare of our agricultural classes can not be better indicated than by calling attention to the prominent mention given to entomological matters by the President in his recent message to the Congress of the United States. The following are his words:

> The cotton crop of the country is threatened with root rot and with bollworm and the boll weevil. Our pathologists will find immune varieties that will resist the root rot, and the bollworm can be dealt with, but the boll weevil is a serious menace to the cotton crop. It is a Central American insect that has become acclimated in Texas and has done great damage. A scientist of the Department of Agriculture has found the weevil at home in Guatemala, being kept in check by an ant which has been brought to our cotton fields for observation. It is hoped that it may serve a good purpose. * * *
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> The insect friends and enemies of the farmer are getting attention. The enemy of the San Jose scale was found near the Great Wall of China and is now cleaning up our orchards. The fig-fertilizing insect imported from Turkey has helped to establish an industry in California that amounts to from 50 to 100 tons of dried figs annually, and is extending over the Pacific coast. A parasitic fly from South Africa is keeping in subjection the black scale, the worst pest of the orange and lemon industry in California.

Careful preliminary work is being done toward producing our own silk. The mulberry is being distributed in large numbers; eggs are being imported and distributed; improved reels were imported from Europe last year, and two expert reelers were brought to Washington to reel the crop of cocoons and teach the art to our own people.

However, in this general awakening of the public the importance of other factors than widespread insect ravages must not be overlooked. The numerous well-illustrated books, more or less popular in character, and the frequent magazine articles dealing with general or economic aspects of the science have brought the subject, in this day of much reading, to the attention of a much larger number of people than could have been possible even a few years ago. Nature study in schools, which usually includes work with insects, has awakened many an American youth, and through them their parents, to the presence of these interesting creatures. Many of our agricultural colleges and other institutions giving courses in agriculture have now for some years been giving instruction in applied entomology, and students have returned to their homes and put in practice the methods learned for reducing insect losses. In many communities there have thus been object lessons which have been the means of inducing others to take up the fight against insects. But probably the most important single factor in awakening this widespread interest in insects remains to be mentioned, namely, the influence of the economic entomologist himself. In the lecture room, at farmers' institutes, at horticultural and agricultural meetings and elsewhere, in season and out of season, it has been his custom to speak from the text of injurious insects.

I would not convey the impression that I believe the farmers, fruit growers, and others are availing themselves to the fullest extent of the means placed at their disposal for mitigating insect losses. While most commendable progress has been made in this direction, yet our most important problem still consists in inducing utilization, by those in need of them, of the means known to be of value in reducing insect injuries. Emergencies such as those brought about by the ravages of the San Jose scale or the boll weevil leave but little alternative to the sufferer, and while the experience is costly, the lesson is well learned. In the writer's opinion, the notable improvement in this direction during recent years may be held to prophesy a rapid increase in the adoption of insect remedies and preventives in the future.

The extent of increase in the number of workers in economic entomology during recent years may not, perhaps, be generally realized. As nearly as I have been able to ascertain, there are at present, in the United States and Canada, 145 persons trained in methods of entomological research, devoting the whole or a part of their time to the study of injurious insects. If account be taken of the many inspectors employed by various States and State horticultural organizations in the enforcement of crop pest and nursery inspection laws, the number of persons officially engaged in work pertaining to insect control would be easily doubled.

Investigations in economic entomology are made leading lines of work in 43 out of 48 of the agricultural experiment stations, and this subject is taught in practically as many of the agricultural colleges. Much valuable work is being done by several of the State departments of agriculture and State boards of horticulture. In the Bureau of Entomology of the United States Department of Agriculture the force now engaged in strictly entomological work numbers 59 as compared with 14 under the division organization of 1900.

The increase in workers has naturally been dependent on an increased financial support. At no previous time has so large a sum of money been devoted to the study of injurious insects. The sum total of money annually devoted to work of this character may be only approximately indicated, for separate accounts are not kept in most of the agricultural colleges and experiment stations of the money spent in entomological research. However, from actual figures, in many cases, and from conservative estimates, I would place the amount at not less than $285,000. This, of course, does not include special appropriations, as, for instance, that by the Federal Government of $250,000 for work against the boll weevil and other cotton insects and diseases, the $25,000 appropriated by the State of Louisiana for the same purpose, and notable emergency appropriations of the past, such as that for the gypsy moth.

Viewed from a business standpoint, it is pertinent to inquire what economic entomology has done in the way of returns in dollars and cents for the money invested by the public. A balance sheet which would show the present status of the account and be even approximately correct can not be prepared, owing to the difficulty of accurately estimating the credits. We can, however, make estimates so well within the bounds of reason as to run no possible risk of overstating the case. I have therefore gone over the literature with a view to deciding how far economic entomology has been instrumental in increasing the output of some of our staple crops and fruits. The original estimates were cut in half, and there still remains a credit sufficiently large to satisfy the ideas of profit of some of our present-day multimillionaire corporations.

The following table shows the value of certain classes of crops in the United States for the year 1899, as reported in the Twelfth Census, with the estimated benefits resulting from the teachings of economic entomology stated in percentage and also in dollars and cents. The writer believes this to be a most conservative estimate of the annual saving, to the producers of the crops mentioned, resulting directly or indirectly from the efforts of economic entomologists:

TABLE II.—*Values of certain crops in the United States, and the percentage and value of the increased production due to economic entomology.*

Class of crops.	Value in 1899.	Percentage of increased production.	Value of increase.
Orchard fruits	$83,751,840	25	$20,937,960
Grapes	14,090,937	20	2,818,187
Subtropical fruits	8,549,863	10	854,986
Truck crops and small fruits	98,894,319	20	19,778,863
Cereals	1,484,231,038	5	74,211,551
Cotton	370,708,746	10	37,070,874
Total annual increase			155,672,421

Notwithstanding the progress which has been made in reducing loss from insects, this loss, by reason of our increased plantings of crops of all kinds, continues to be very great. Estimates have been made from time to time indicating, in dollars and cents, the losses caused by one or more species over a greater or less territory. Recently, interesting comparisons have been made by Professors Webster and Slingerland of losses to crops in certain States and the country at large as compared with the amounts of money required for the support of our various institutions. Thus we are told that the annual loss occasioned by insects in the United States amounts to more than is required for all educational purposes; nearly twice as much as is required for the support of our Army and Navy; over twice the losses from fire, and nearly three times the estimated value of the products of all fruit orchards, vineyards, and small fruit farms in our country.

Careful estimates have shown that the total annual loss from insect depredations in the United States at the present time is not less than $300,000,000. In the face of such figures it would appear that we have scarcely entered the threshold of achievement in conquering injurious species. It may not, however, be argued from the figures given that little has thus far been accomplished. It will be remembered that years ago, in 1860, insect losses in the country at large were placed by Walsh at not less than $300,000,000 annually. If these estimates are correct the losses appear to have been held stationary, notwithstanding our great agricultural development during the forty years intervening. Present-day estimates are based on a 10 per cent reduction of all crops by the combined attack of the various species which prey upon them. In Walsh's time the percentage of injury must have been much higher, as determined by the value of farm products at that time.

It has been pointed out by Doctor Howard, and possibly others, that widespread injury, such as that from the Hessian fly or the chinch bug, while undoubtedly resulting in a great diminution in the output of the crop attacked, does not represent a corresponding loss in money to the growers, for the resulting scarcity of the commodity brings about an increased valuation which may really leave the farmer little, if any, the worse off financially. Taking this into account, present-day estimates of insect injuries may, on the whole, be too high, but it should be noted that the burden is simply transferred to the consumer, who pays the farmer, or more often the speculator, for the ravages suffered.

Present resources in the ways and means of reducing insect ravages place a much greater responsibility on the farmer, fruit grower, and others subject to injury than heretofore. In the case of many of our prominently injurious species their life histories have been worked out, their most vulnerable points of attack shown, and appropriate means for reaching them indicated. A mere list of the various insecticides and mechanical methods employed in insect warfare would require more time than is here available and would serve no useful purpose, for the tendency at the present time is mainly toward the use of certain few substances to the exclusion of others formerly in considerable repute.

Paris green and other arsenites, kerosene emulsion, hydrocyanic-acid gas, carbon bisulphid, and the lime, sulphur, and salt wash comprise the more important insecticides used to-day. To the three principal periods in the evolution of insecticides in the United States must now be added, in the writer's opinion, that in which was discovered the efficiency of the lime, sulphur, and salt wash in the East. The demonstration of the value of this wash, made almost simultaneously by several workers, ranks among the most important of the notable advances in economic entomology in recent times. The extensive experiments made with this wash under varying weather conditions in Illinois, Georgia, Ohio, Maryland, New York, Connecticut, and other States now permit no reasonable doubt as to its efficiency in controlling the San Jose and other scales in orchards, and it has already been largely adopted by commercial orchardists. It is possible that further experiments may reduce the inconvenience at present involved in its preparation, and may modify its disagreeable character. Should this be accomplished, the two features which now constitute a ground for objection to its use would be eliminated.

The importance of purely agricultural methods in reducing insect losses, especially to some of our staple crops, is becoming much more generally realized than heretofore. A series of demonstrations of this character during the past few years may be held to mark another era in the evolution of methods of insect control. Such a simple expedient as delaying the time of planting wheat so as to avoid injury from the fall swarm of the Hessian fly has been the means of saving millions of dollars to the wheat growers in the territory infested with this insect. The important work on this species by Doctor Hopkins permits the determination of the normal time of appearance of the fall brood for any latitude or altitude. Professor Webster, by observations extending over many years, has been able to chart the State of Ohio into belts indicating the safe periods for the planting of this crop.

The recognition of the value of late fall or winter plowing, of rotation of crops, of certain classes of fertilizers, and of better cultivation in the control of noxious species will make this class of work very important in the future. During the last few years the importance of improved cultural methods has been demonstrated on a large scale in the control of two serious pests of the cotton plant, namely, the boll weevil and the bollworm.

In the case of the cotton boll weevil its advent in the cotton fields of Texas coincided with conditions of cotton culture which greatly aggravated its destructiveness. The natural fertility of the land and the tenant system largely in vogue had brought about an indifference to those economical methods of farming found necessary in older sections, where the fertility of the land is less and the difficulty of producing profitable crops is greater. Indifferent preparation and cultivation of the land, the use of unselected and more or less run-down seed—often from the public ginneries and of absolutely unknown variety—had placed the cotton-growing industry in a condition to be seriously threatened by the introduction of any inimical factor. The remedial measures now found necessary are along the line of better farming, and we have the not unusual case of entomologists showing the farmer how to farm. The success with which this work has been carried out must in part be attributed to the readiness of landowners to adopt methods which they recognized as practicable and desirable in themselves, to say nothing of their value in circumventing weevil injury. In a recent communication from Mr. W. D. Hunter, in charge of the cotton boll weevil investigations of the Bureau of Entomology, he mentions certain phases of his work which are pertinent here as bearing on the methods and extent of this cultural work as applied to what is one of our most important present day insect problems. He writes as follows:

During the several years that the Bureau of Entomology of the United States Department of Agriculture has carried on investigations of the Mexican cotton boll weevil it has been possible to perfect a system of avoiding damage by the pest. This system, founded upon a careful study of all the habits of the insect, is now generally known as the "cultural system." Its basis is in the fact that a very small percentage of weevils survive the winter. Consequently, in the fall it is possible to practice a strictly remedial step, namely, the destruction of the plants in toto as soon as the possibility of obtaining any more cotton becomes remote. Experiments have shown that a very high percentage of weevils which would hibernate to damage the crop during the next season can be destroyed. Following this all-important step, the work of the Bureau of Entomology has shown the necessity of obtaining an early crop. The remarkable powers of reproduction of the pest allow such an increase by the middle of summer that the progeny of a very few hibernated individuals is sufficient to practically destroy all new fruit as it is set upon the plants. The fall destruction of the plants can be practiced without important modifications in any quarter. However, there are many modifications of the system of hastening the maturity of the crop that must be practiced in different regions, owing to diverse climatic and soil conditions. During the season of 1904 the Bureau has established a number of experimental farms to ascertain definitely what these modifications must be. In Texas and Louisiana at present there is a weevil-infested region of at least 9,000,000 acres of cotton land. This extends from Brownsville northward a distance of 500 miles over very diversified soil formations, with their consequent diversity in plantation practices.

The extent of the infested territory, from west to east, is also in the neighborhood of 500 miles. In this territory the rainfall varies from such a small amount as to make irrigation absolutely necessary, in the west, to the Red River in Louisiana, where the normal annual precipitation is in the neighborhood of 60 inches. These two variations in soil, involving the essential farm operations, and in rainfall, changing the development of the weevil very considerably, are the factors that have made it necessary to establish experimental farms at a number of points. Fifteen of these farms have been in operation. In most cases in the neighborhood of 100 acres is devoted to each one. In the aggregate about 1,800 acres are involved. Although the work on these farms is strictly experimental, they have an incidental value as demonstration farms. From the experimental standpoint it has been necessary to evolve a careful system of checks. Consequently, whenever a plat is planted with the seed of a certain variety, or with certain fertilizers, or cultivated in some certain way, one alongside of it is treated in all respects according to the ordinary methods in vogue among the planters of the locality. It is fortunate for the performance of such work that the boll weevil moves about but little in the fields until at least as late as midsummer. Were this not the case, it would be necessary to have the plats far removed from one another. However, sufficient separation is brought about by simply planting a few rows of sorghum or some similar crop between the different plats. The actual weevil conditions in each plat are determined by careful observations each week or ten days. Early in the season the number of adult weevils per plant is estimated by the examination of a fixed number in the plats. Later, when the fruit is being damaged, the exact status is determined by the figuring of the percentage of infested fruit on groups of ten or more plants in three different locations in a plat. Of course the yield of cotton is important, but from an entomological standpoint the tables showing percentages of infestation are the exact indication of the effects of the work.

All this field work is carried on under an original system, which relieves the Bureau of the trouble and expense of running the land and working the crop, but at the same time gives it absolute charge of as much area of cotton land as it is desired to utilize for experiments. Contracts are entered into with reputable planters. This contract binds the planter to follow the directions of the Bureau in all respects, from the preparation of the soil through to the marketing of the crop. In consideration of this agreement on the part of the planter, the Department guarantees him a certain yield per acre. The amount of this guaranty is determined as far as possible upon the competitive bid basis, although the personal attitude of the planter is considered to be fully as important as the lowness of the proposal. This system has been found to work in a very satisfactory manner. On seven of the fifteen farms in operation during the past season the crop produced has been more than the amount guaranteed. The work on about 700 acres, therefore, cost the Department nothing. On some of the remaining farms, owing to intentional late planting, or to other conditions, the yield has been much below the amount guaranteed. In such cases the contract binds the Department to pay the planter for the difference between the amount actually produced and the amount guaranteed at the average price received for what crop the land did produce.

A novel method for securing the subjugation of an insect was adopted by the State of Texas. The legislature of that State voted a reward of $50,000 to the person or persons who should devise a practicable, cheap, and effective plan for the control of the boll weevil. A commission of farmers was appointed to pass upon claimants for the reward and to put the various plans to a practical test.

The chairman of this commission, Hon. Jefferson Johnson, of Austin, Tex., has kindly furnished a brief statement, which may be of interest, concerning the varieties of remedies proposed.

This work has involved an outlay of considerable time. There were more than 300 claimants for the reward. Not all of these, however, complied with the requirements of the law. Three thousand letters have been received from people who believed that they knew something that would be of value to the commission.

It would be hard to determine how many principles were depended upon to support these various claims. The majority of them trusted to cultural methods. A large number presented some form of poisoning. There was quite a number of theories for fumigation either to kill the weevil or drive it from the field. Several claims depended upon placing in the soil some ingredients or poison that would be taken up by the plant and thus make the plant distasteful or poisonous. Others along the same line proposed methods to make the plant immune. There were several claimants who depended upon inoculation of the weevil with some contagious disease, and in this manner so destroying the powers of propagation as to rid the country of the pest in this way. Several claimants insisted that Providence had sent the insect, and that Providence alone could remove it, and these trusted in supplication. Not a few advanced the theory that noxious plants could be grown with the cotton, thus either destroying the weevil or keeping it from the field. One claimant submitted a proposition to plant poppies, thus destroying the weevil by the opium that the insect would get from this plant.

Many ingenious machines were made for catching weevils and for picking up by mechanical process the squares from the ground. Other machines were invented and tried for burning the squares on the ground, and others for passing the squares between rollers.

These claimants came from every quarter of the globe, and letters were addressed to the commission in the language of almost all of the civilized world.

Some of these letters were not answered because of the fact that we were not able to get a proper translation. No adequate conception of the difference of these plans and the range covered by them can be given in so brief a statement. None of the plans were found satisfactory.

Anyone who has attempted to keep up with the present-day literature of economic entomology must have been impressed with its increasingly heterogeneous character. Possibly nothing so well illustrates the widening scope of the field of applied entomology as the great range of subjects treated, covering, for instance, such subjects as:

Smyrna Fig Culture in the United States.

Extermination of Malaria-Breeding Mosquitoes.

Aquatic insects of New York State [as bearing on the food supply of fishes].

Insect Enemies of Forests and Forest Products.

Contributions to a Study of the Insect Fauna of Human Excrement, with especial reference to the spread of Typhoid Fever by Flies.

Combating Insects with Fungous Diseases.

Intraradical Nutrition of Diseased Trees for the Purpose of Curing them and Destroying Parasites.

A long list of titles might be presented, but it is unnecessary. In so fertile a field the literature of economic entomology must become more and more diverse in the future. A very important question arises, namely, How may one keep reasonably well informed as to the results obtained by his co-workers in lines somewhat different from his own? This point has been referred to during previous meetings of this association. Doctor Smith, in his presidential address before this society on the occasion of its seventh annual meeting, expressed himself in reference to this matter as follows:

> Can we not devise some plan by means of which we can keep informed of what is going on without the necessity of wasting time by examining everything and then missing it all?

Perhaps the writer feels more strongly on this point than the situation warrants, but in his efforts to catch up with economic literature after about two years of work in the field under conditions discouraging to efforts of this character, he has been impressed with the desirability of some scheme, as suggested by Doctor Smith. The whole matter has appeared to be of sufficient importance to warrant the consideration of some plan whereby the desired results might be secured. Simply to put the matter in more definite shape for consideration, I would propose that a person be annually designated for each of the principal natural divisions of the general subject whose duty it will be to present, at the following meeting, a résumé of the principal results achieved in that particular branch during the year. The reports of these several persons would become a part of our proceedings and could be referred to at will by workers in other lines.

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To further promote the end in view I would suggest the following division of the general subject:

(1) Staple and miscellaneous crop insects.
(2) Small fruit and truck crop insects.
(3) Deciduous fruit tree insects, including those infesting nursery stock.
(4) Citrus and subtropical fruit insects.
(5) Ornamental plant and greenhouse insects.
(6) Shade tree and forest insects.
(7) Insects injurious to stored foods, dwellings, clothes, books, and miscellaneous substances.
(8) Insects affecting man and the domestic animals.
(9) Insects concerned in the transmission and carriage of disease.
(10) Beneficial parasitic and predaceous insects.
(11) Insects useful to man as furnishing food, clothing, etc.
(12) Insecticides and machinery.

A most commendable feature of our present-day literature is the increasing amount of thorough and painstaking work on the biology of insects. Shortly after the establishment of the several agricultural experiment stations entomological publications were, probably of necessity, largely compilations, owing to the fact that there was need for placing before the public for immediate use such information covering injurious species as had already been obtained. As information of this character has become more and more familiar, its presentation and repetition have become less necessary, and more original work has been brought forth. Revised bulletins on insecticides and spraying machinery must of necessity be gotten out from time to time as progress is made along these lines, but the notable decrease of purely compiled bulletins and papers concerning insects is a most favorable indication.

Many recent entomological publications, in the quality of subject-matter, character of illustrations, and wealth of detailed observations leave little to be desired. Improved facilities for careful life-history work have rendered possible the many excellent papers which are at once a credit to the literature of the science and an inspiration to other workers. Careful life-history studies have been an important means of separating two or more species long held to represent but one. Witness the case of the aphids designated as *Aphis mali*, which Sanderson has shown represent several species. Similarly, Morrill has been able to separate *Aleyrodes packardi* from *Aleyrodes vaporariorum*. Certain species may only be distinguished by a comparative study of their respective larval stages, as in the case of *Chilocorus bivulnerus* and *C. similis*.

In addition to careful biologic studies of insects, the consideration of life zones, of effective temperatures, and of the number of generations in various parts of the country, of forms widely distributed should be given more attention than has been the case in the past.

The value of a knowledge of effective temperatures is well illustrated in the case of the Hessian fly, and if we had more exact data of this character concerning many of our pests it is not improbable that valuable suggestions in their control would result. The paucity of exact knowledge on some of these points with so common a species as the cotton bollworm was brought to my attention recently in the course of an attempt to determine the number of generations of this species throughout the United States and Canada. Insects of such wide distribution offer exceptional opportunities for studying the laws of temperature limitations and other factors of the greatest interest and probable value. On such problems cooperation must necessarily be secured. The desirability of this has often been the occasion of remark in the proceedings of this Association and elsewhere, but its accomplishment appears no nearer realization than during the early days of the society.

Recent years have witnessed an important change of sentiment with regard to insect legislation, and its extent at the present day may doubtless be held as proof of its recognized value. However this may be, the fact remains that, with few exceptions, the various States have adopted laws which have for their end the restriction of one or more species and, in numerous instances, the enforced control of pests already established.

A recent census of legislation in the United States bearing on the control of insect pests shows that of the forty-eight States and Territories the following only are yet without operative laws, and some of these have bills in preparation for passage at coming legislative assemblies: Arizona, Florida, Kansas, Nebraska, Nevada, New Mexico, Oklahoma, South Dakota, Texas, Vermont, and Wyoming. The following insects are mentioned as coming under the operation of various laws, and in many cases provision is made for the designation of other species which at any time it may be judged desirable to quarantine or whose control should be enforced.

PHYTOPTIDÆ.

Pear blister mite (*Eriophyes pyri* Pagenst.).

ORTHOPTERA.

Grasshoppers (*Melanoplus spretus* Thos.; *M. atlanis* Riley; *M. bivittatus* Say, etc.).

HEMIPTERA.

San Jose scale (*Aspidiotus perniciosus* Comst.).
Cherry scale (*Aspidiotus forbesi* Johns.).
European fruit-scale (*Aspidiotus ostreæformis* Curt.).
Greedy scale (*Aspidiotus rapax* Comst.).
Walnut scale (*Aspidiotus juglans-regiæ* Comst.).

Gloomy scale (*Chrysomphalus tenebricosus* Comst.).
West Indian peach scale (*Diaspis pentagona* Targ.).
Scurfy scale (*Chionaspis furfura* Fitch).
Euonymus scale (*Chionaspis euonymi* Comst.).
Oyster-shell scale (*Lepidosaphes ulmi* Linn.).
Peach scale (*Eulecanium persicæ* Fab.).
Plum Lecanium (*Eulecanium prunastri* Fonsc.).
Pine Chermes (*Chermes pinicorticis* Fitch).
Strawberry root-aphis (*Aphis forbesi* Weed).
Black peach aphis (*Aphis persicæ-niger* Erwin Smith).
Woolly apple aphis (*Schizoneura lanigera* Hausm.).
Pear Psylla (*Psylla pyri* Linn.).

LEPIDOPTERA.

Gypsy moth (*Porthetria dispar* Linn.).
Brown-tail moth (*Euproctis chrysorrhœa* Linn.).
Canker-worms (*Paleacrita vernata* Peck; *Alsophila pometaria* Harr.).
Fall webworm (*Hyphantria cunea* Drury).
Apple-tree tent-caterpillar (*Malacosoma americana* Harris).

COLEOPTERA.

Cotton boll weevil (*Anthonomus grandis* Boh.).
Sinuate pear borer (*Agrilus sinuatus* Ol.).
Imported willow borer (*Cryptorhynchus lapathi* Linn.).
Strawberry crown-borer (*Tyloderma fragariæ* Riley).

When it is stated that of this list only the San Jose scale is common to all States which have enacted laws for insect control, the diversity of the requirements of the different States is plain. In a country so diverse, climatically and industrially, as ours the legislation adopted must needs be more or less dissimilar, but the lack of uniformity in legislation of this character greatly interferes with the attainment of results the accomplishment of which has been the principal excuse for its establishment. The principal exciting cause of the enactment of laws has been and still is the control of the San Jose scale, and the hasty manner in which many of these were called into existence following the discovery of this pest in the East must be largely held responsible for their present diversity.

A crisis of a somewhat similar character is now facing the cotton growers of the South, and several States have made provision for the restriction of the cotton boll weevil. There has, however, been a notable improvement in the details of this work, in that the entomologists of the several States interested have agreed on a certain uniformity in the measures to be adopted which will add much to their possible effectiveness.

A most stupendous attempt at insect control is now being contemplated by the State of Texas, designed to reduce injury from the cotton boll weevil by the enforced adoption of certain radical changes in the agricultural practices of their cotton planters. The extent and difficulty of the proposed plan can only be appreciated in connection with a knowledge of the enormous territory affected and the peculiar farming conditions which are there in vogue. According to the Twelfth Census the cotton interests of Texas are approximately equal to one-fourth of those of all cotton States combined, covering in 1899 6,960,367 acres. It has been determined by the investigations of the Bureau of Entomology that probably the most important single way in which the wholesale destruction of the weevil may be obtained is by the early destruction of the cotton plants in the fall before the weevils are ready to go into hibernation quarters. The difficulty of enforcing destruction of fields of cotton over so wide a territory and at a time when the prospects for continued yield are good need not be commented upon before an audience many individuals of which have had experience in the execution of laws requiring the destruction of a greater or less number of comparatively worthless infested fruit and other plants.

The present status of our knowledge concerning our destructive insects and the efficiency of present methods of control is a subject that might well be enlarged upon did time permit. Undoubtedly the three dominant entomological events of the past few years have been the establishment of the San Jose scale in the East, the invasion of Texas by the cotton boll weevil, and the widespread interest aroused in mosquitoes following the discovery of the rôle which these insects play in the transmission of malarial and yellow fever.

Since about 1894 the San Jose scale has occupied the attention of many of our Eastern entomologists to the practical exclusion of everything else. The matter of control of the insect in nurseries was early solved by a system of inspection and fumigation. Its control in orchards has until recently continued to be a most perplexing problem. The unsatisfactory results following the early experiments with the lime, sulphur, and salt wash practically eliminated this insecticide from consideration among possible remedies. Attention was therefore directed to other means of control. Kerosene and crude petroleum, pure and in mechanical mixture with water and in soap emulsions of varying strengths, various soap washes, hydrocyanic-acid gas, parasitic fungi, and, in fact, almost the whole gamut of insecticides was run through only to discover, after some years, that the lime, sulphur, and salt wash was, after all, a most satisfactory treatment. The establishment of this fact came, so to speak, in the nick of time. While there is abundant testimony as to the safeness and efficiency of the mineral oils in the control of this insect on such fruit trees as the peach and plum, yet the trouble lies in the danger following the injudicious applications which persons inexperienced in such work are likely to make. The many instances of severe and often fatal injury are calculated to bring the recommendations of the entomologist into disrepute. However, the question of a safe and efficient treatment of this insect in orchards appears now to be settled, and, aside from questions of convenience in preparation and the time of application, the experimental stage is practically passed.

There is a tendency, however, in the recent literature on the lime, sulphur, and salt wash, the advisability of which is perhaps open to question. I refer to the publication for the use of the fruit grower of the various formulæ known in its preparation. He is scarcely able to know what is best; consequently he must simply pay the money and take his choice. As a matter of fact, there appears to be room for great latitude in the proportions of the ingredients used and in the manner of preparation without injuriously affecting the efficiency of the wash. The tendency is perhaps to adopt the so-called even-quantity formula, namely, one part each of the lime, sulphur, and salt to three parts of water. It would appear highly desirable that a standard formula be adopted for the convenience of fruit growers, as the directions for its preparation at the present time differ more or less for almost every State. Or is it, perhaps, true that climatic and other conditions vary so much in the Eastern States that a formula found effective in Virginia, for instance, would not necessarily be as effective in Maryland, Ohio, or Connecticut?

The interest in mosquitoes, which had been steadily growing from about 1894, as a result, primarily, of the work of Doctor Howard, was given a great stimulus in the latter part of that decade by the demonstration by a group of medical men of the rôle which these insects play in the transmission of malarial and yellow fever. Immediately these insects became objects of the greatest interest, and entomologists were called upon to furnish information concerning their life histories, habits, and classification. The mosquito has been studied in many quarters, and the contributions of American entomologists have been very important. Since 1900 a remarkably large amount of work has been done, as the following partial list of publications treating of the Culicidæ testifies:

Notes on the Mosquitoes of the United States. Howard, 1900, pp. 70.
Gnats and Mosquitoes. Giles, 1900, pp. 314.
Malaria. Eyre, 1900, pp. 275.
Monograph of the Culicidæ. Theobald, Vols. I and II, 1900, pp. 817, plates 59.
Mosquitoes. Howard, 1901, pp. 241.
Our Near Neighbor, the Mosquito. Rich, 1901, pp. 58.
Gnats and Mosquitoes. Giles, 2d ed., 1902, pp. 530.
Laboratory Work with Mosquitoes. Berkely, 1902, pp. 112.
Mosquito Extermination, North Shore, Long Island. 1902, pp. 125.
Mosquito Brigades. Ross, 1902, pp. 98.
First Anti-Mosquito Convention. 1903, pp. 83.
Monograph of the Culicidæ. Theobald, Vol. III, 1903, pp. 539.
Common Mosquitoes of New Jersey. Smith, 1904, pp. 40.

The astonishing total of 3,383 pages is shown by the works mentioned. Probably no group of insects has so quickly sprung from comparative obscurity as has this family. The great importance of their control in the lessening and prevention of diseases and in adding to the comfort of our citizens warrants the belief that these insects must receive considerable attention at the hands of economic entomologists in the future.

Along with the work on the San Jose scale, the boll weevil, and mosquitoes, much other important and good work has been accomplished. On a closer examination many of our old-time pests are still disclosing new facts. Native or introduced species, previously of but little importance, have, under favorable conditions, become so numerous and injurious that their prompt and thorough study has become necessary. The efficiency of insecticides and remedial practices has been constantly improved. Recent experiments with arsenate of lead for the codling moth give promise of a still greater reduction of the percentage of wormy fruit. The evolution of our knowledge concerning the life and manners of almost any insect species and the development of measures for its control would furnish an interesting chapter in the history of economic entomology in this country, and the gradual accumulation of facts and improvements in remedial measures may properly be compared to the evolution of a harvester or sewing machine. Looking back over the subject, points in life history which at the time of their discovery appeared trivial enough, are seen, in the light of the completed record, to have been the key to the situation. The determination of all points connected with the life and habits of an injurious species is not only warranted for scientific reasons, but we are only able to judge of the importance of any point after all the facts concerning it have been completely rounded up.

The growing efficiency of our battery for insect warfare and the increasing familiarity of growers of crops with its use must result in the important lessening of insect injuries. With numerous species, as the Colorado potato beetle, cankerworms, cabbage worms, and other species feeding on exposed portions of plants, the arsenites are practically specifics, and the question of preventing losses resolves itself largely into inducing the utilization of these remedies. The successful control of other species is frequently more complicated and requires the exercise of considerable judgment. Thus spraying for the codling moth must be done with reference to the stage of development of the young fruit. The sowing of fall wheat, to avoid injury from the Hessian fly, must be timed with nicety. Poisoning cotton for the cotton boll worm must be done with reference to the condition of adjacent corn.

It has perhaps been a standing excuse with us, in accounting for the failure of growers to get satisfactory results in the employment of the recommended measures, that directions had not been properly followed. Operations against certain pests, to be successful, must be done with exactness. The requirements are sometimes too complicated, involving considerable familiarity with entomology, so that the average man is unable to properly carry out directions. For such cases demonstration work has a legitimate field. It is perhaps an open question whether the responsibilities of the economic entomologist go any further than to study the life and habits of a given pest and to point out the appropriate remedy, leaving the matter of its utilization entirely with those directly concerned; but it has been much to the good of the cause that many workers have demonstrated, sometimes over and over again, the benefits to be derived from insecticidal applications. Indeed, this has been no small part of the work thus far.

Future problems will probably not materially differ in character from those of the past, but more and more should methods of prevention replace the actual application of insecticides. If there is anything in the idea that varieties differ with respect to their susceptibility to insect attack, this matter should be thoroughly investigated. Certain facts might be adduced that seem to indicate that this is, in a limited way, true. Certain of our native vines are more resistant to Phylloxera than European varieties descended from Vinifera. The Northern Spy apple is said to be much less subject to attack from the woolly aphis than other varieties, and its roots are often used as grafting stock on this account. The immunity of the Kieffer pear from the attack of the San Jose scale is a matter familiar to most of you. The different varieties of plums vary much with respect to their susceptibility to the curculio. Other similar instances might be given. The possibility of protecting trees and plants from insect attack by the use of certain fertilizers or the introduction into the circulation, through the roots or otherwise, of substances objectionable to insects, has often been suggested. Recent investigations abroad indicate success in this method of preventing insect injury. Doctor Smith, in this country, has been able to reduce the injuries of the pear midge by the use of kainit, and this same fertilizer is considered valuable in protecting cabbage, onions, and numerous other plants from certain of their insect enemies. Thorough detailed life-history studies must replace the often scant remarks concerning the four principal stages of insects, and this improvement is already well under way. The interrelations between insects and their environment, e. g., their parasites, and the influence of climate, altitude, and soil, is as yet almost an untrodden field. A more accurate knowledge of the laws governing the distribution and successful existence of insects must furnish much of practical value.

Along these various lines will the economic entomologist find opportunity for valuable work in the future. At the present rate of progress the next two or three decades must witness many important discoveries and improvements, and it may be safely predicted that the science will not fail to respond to the demands made upon it with the increasing material development of our people.

After the conclusion of the president's address the report of the secretary-treasurer was read and referred to an auditing committee consisting of Messrs. Fletcher and Sanderson. On motion, an assessment of 25 cents was levied on all members present at the meeting.

On motion of Mr. Burgess the following committees were appointed:

Nominations: Messrs. Slingerland, Osborn, and Phillips.
Membership: Messrs. Smith, Chambliss, and Titus.
Resolutions: Messrs. Felt, Burgess, and Washburn.
Programme: Messrs. Summers, Marlatt, and Skinner.

The following paper was presented:

EXPERIMENTS WITH LIME-SULPHUR WASHES.

By E. P. Felt, *Albany, N. Y.*

Experiments with lime-sulphur washes were continued last season largely for the purpose of testing their efficiency and also to gain an idea as to the relative merits of different methods of preparation and the best quantities to use. Several formulæ, which gave good results last year (1903), were further tested the past season (1904), the principal ones being 25 pounds of lime and 20 pounds of sulphur to 50 gallons of water; 25 pounds of lime to 12 pounds of sulphur, and 30 pounds of lime to 15 pounds of sulphur, respectively, to 50 gallons. All of the washes were prepared as in previous years, the lime being slaked in a few gallons of hot water in a kettle over a fire, the sulphur added, the whole stirred, and the boiling continued actively from half an hour to an hour and a half. Our observations failed to show that the long boiling gave a more effective wash than the one produced by the quicker method. Our experiments confirmed previous conclusions that a little more lime than sulphur was an advantage, and, after consultation and comparison of data with Prof. P. J. Parrott, of the Agricultural Experiment Station at Geneva, N. Y., we both decided to recommend 20 pounds of lime and 15 pounds of sulphur, with at least thirty minutes active boiling, the use of salt being optional. A wash wherein a large amount of lime is used for the purpose of generating heat, so that boiling is not necessary, can be made as recommended by Mr. A. N. Brown, of Delaware, and this preparation undoubtedly kills a considerable proportion of the scale insects upon a tree, but the results are not equal to those obtained where a boiled wash is employed, and we confess to feeling that in the end it will prove unsatisfactory, though we have known of instances where very fair results were secured.

We have developed a new lime-sulphur wash in which sal soda is used to assist in bringing about the chemical combination instead of caustic soda. Our results with this were most gratifying. Several formulæ were employed, and as the outcome of our experiments we have decided to recommend for further experimental work the same amounts of lime and sulphur as before mentioned and 10 pounds of sal soda to 50 gallons of wash. This may be prepared by placing five or six pails of hot water in a barrel, preferably a thick pork or oil barrel, adding the lime, and quickly following that with the sulphur and sal soda, and then stirring till the slaking is practically completed. It may be necessary to add cold water at intervals to keep the mixture from boiling over. After the rapid bubbling or boiling is practically completed cover the open barrel with burlap and allow it to stand thirty minutes or more. A caution regarding stirring should be made here, since it seems to affect the composition of the mixture. There should be enough agitation to keep the materials from caking at the bottom, and yet not so much as to seriously hinder the slaking of the lime and accompanying chemical changes. This method of preparation gives an excellent compound, so far as deep color and little sediment is concerned, provided it is properly prepared, and one of the essentials in making it appears to be thorough stirring at the outset in order to intimately mix the lime, sal soda, and sulphur. A deep red or even pea-green color should be secured. This wash sprays nicely, and in experiments commenced last spring has given as good results in killing the San Jose scale as any of the lime-sulphur washes. It has several advantages. It requires no boiling, and the sal soda is a common material, easily handled and obtainable in almost every locality. It is also a little cheaper, as the amount of sal soda necessary costs less than the quantity of caustic soda advised for preparing 50 gallons of wash. This material has been used but one season, though it was tried in several localities. Professor Lochhead, of the Ontario Agricultural College, states that in his hands it was just as successful as other lime-sulphur washes, and a few others obtained from good to excellent results in spite of their inability to give it a thorough trial.

In this connection it might be well to add that experiments were tried with the caustic soda solution, using about 1 pound to 6 gallons of water, and also with a bordeaux mixture to which 2 ounces of corrosive sublimate were added to each 50 gallons. The results showed that at the end of the season the treated trees were very little better than the checks, and consequently neither material can be considered as valuable in checking the San Jose scale.

Recent disquieting reports, emanating from New Jersey, as to the poor success obtained with lime-sulphur washes led us to inquire rather closely into New York conditions, with the result that, so far as we could learn, wherever the trees were thoroughly sprayed with a lime-sulphur wash the scale was kept in control in a very satisfactory manner. This does not reflect in the slightest upon the work done in New Jersey, but refers simply to our New York conditions, and the statement is made at this time because we can not help feeling that lime-sulphur washes at present afford the most practical method of controlling the San Jose scale, despite the fact that their preparation is laborious and their application exceedingly disagreeable.

Mr. Smith stated that lime-sulphur mixtures have not been as successful in New Jersey during the past season as in former years. On apple and plum they were especially ineffective. In 1903–4, after a thorough examination of certain areas, the lime-sulphur washes were recommended quite extensively. Several persons made a business of spraying, and careful examination showed that they were doing thorough work. Caustic soda was used in some cases, but no good results were obtained. Lime-sulphur mixtures were made in all ways, but uniformly poor results followed their use. When apple and peach were planted alternately the results on peach might be excellent, while on the apple failure resulted. One grower who had been using petroleum for years in 1903–4 used lime-sulphur wash on half his trees, consisting of apple and pear. A large share of the pears sprayed with the lime-sulphur-salt mixture were so badly infested as to be unsalable, while the fruit on the oil-sprayed trees was clean. In the case of apples, it seemed as if the pubescence kept the wash from touching the scales, and these get out on the fruit, although the twigs might be practically free from them. While no very marked difference was observed, the boiled wash seemed on the whole to be better than the unboiled.

Mr. Gillette said that perhaps climatic conditions might have been responsible for the failure in these cases.

Mr. Smith said that it had been an excessively cold winter.

Mr. Phillips stated that if carefully prepared the so-called uncooked lime-sulphur mixture really boiled from fifteen to thirty minutes, but in order to secure a long boiling period it is necessary to husband the heat from the slaking lime very carefully. The method suggested was to put the lime and sulphur in the barrel together and use sufficient boiling water to slake the lime, being very careful not to let it get dry. The whole mass is stirred until it is reduced to a thin paste, and the barrel is then covered to retain the heat, but should be opened and the preparation stirred about every five minutes to prevent it from caking at the bottom. Considerable experience is necessary to make a wash by this method, and the strength of the product is very uncertain. The specific gravity indicates that quite a good deal of the sulphur is left undissolved. The results with this wash in Virginia have not been good, and it is not recommended. They are recommending the regular boiled preparation, which, he states, should be boiled vigorously for from thirty to forty minutes.

Mr. Surface said that in Pennsylvania, with conditions quite similar to those in New York, about the same results had been reached. Climatic conditions, however, were certainly not wholly responsible for such differences in results as were reported by Professor Smith, of New Jersey. Occasionally some persons would get entirely satisfactory results, while others would fail in the same county. The greatest factor in producing unsatisfactory results is lack of care in boiling and preparation. In some cases the lime-sulphur-soda mixture prepared without boiling has given excellent results.

AFTERNOON SESSION, THURSDAY, DECEMBER 29, 1904.

The meeting was called to order by the president at 2.30 p. m., and the following papers were presented:

NOTES ON CUBAN INSECTS.

By Mel. T. Cook, *Santiago de las Vegas, Cuba.*

[Abstract.]

The short time the writer has been in Cuba makes it impossible to give more than a preliminary report. Natural conditions are favorable to a multitude of insects, and this report will be confined to those of economic importance. Lepidoptera are among the most conspicuous and many are very destructive. Cutworms are very numerous, especially on corn and tobacco. They are frequently parasitized by dipterous and hymenopterous insects. Leaf-miners are very abundant on both wild and cultivated plants. The coffee leaf-miner (*Leucoptera coffeella* Stain.) is of greatest importance. Many of the Lepidoptera have very short periods of pupation. From 15 species we have the following figures:

	Species.
In pupa five days	1
In pupa nine to thirteen days	9
In pupa sixteen days	1
In pupa twenty-two to twenty-three days	2
In pupa twenty-seven days	1
In pupa twenty-nine days	1

Hymenopterous insects are very numerous and many are undoubtedly valuable in destroying lepidopterous larvæ. Thus far, however, only one Hymenopter (*Atta insularis* Guer.) has been studied. These ants are polymorphic leaf-cutters which construct large underground chambers and galleries. They are very destructive and cut great quantities of leaves which they carry into their galleries and use for cultivating fungus gardens. These galleries extend from 4 to 8 feet underground and frequently cover large areas.

The Coccidæ are very numerous, but are well parasitized both by hymenopterous insects and by fungi. For this reason they are not of such great economic importance as in the United States.

Coleopterous insects are very numerous and frequently very injurious in orange groves. The cotton boll weevil (*Anthonomus grandis* Boh.) is very abundant.

Gall-producing insects are very abundant. At the present time the writer is inclined to consider the Phytoptus galls the most abundant. A Coccid gall was found on the twigs of the fig and the native anonas.

SOME OBSERVATIONS ON THE COTTON BOLL WEEVIL.

By E. Dwight Sanderson, *Durham, N. H.*

In the following paper the writer wishes to give but a brief summary of the more important conclusions resulting from two years' study of the cotton boll weevil and its relation to cotton production in Texas.

Inasmuch as the most important means of control have to do with the hibernating weevils, and as the mortality of those hibernating and the time of their emergence in the spring is a most important factor in the injury during the subsequent season, we have given considerable attention to all phenomena connected with their hibernation.

Messrs. Hunter and Hinds have stated that the weevils enter hibernation when the mean average temperature falls to between 55° and 60° F. Our observations entirely corroborate this rule. By confining several hundred weevils in cages once a week after October 1 we ascertained that in 1903 none hibernated until about November 18, when there was a freeze; and about that time the mean average temperature dropped below 60°. Furthermore, those confined some time before this died before hibernating, almost without exception, showing that they can not be forced into hibernation; that the time of hibernating depends on the average temperature; and that by depriving the weevils of all food early in the fall they can be starved to death in large numbers.

By platting the temperature curves for different points it will be seen that the mean daily temperature falls below 60 about December 1 at Victoria, Tex. (which agrees with the observations of Hunter and Hinds), at College Station about November 10 to 15, at Dallas several days earlier, and for the northeastern part of Texas about November 5. From a brief study of the available data, which we are having tabulated and expressed graphically, we believe that these dates will be found to coincide very closely with those of the first killing frosts for these sections, although the frost dates will fluctuate much more widely from year to year than does the mean daily temperature.

In carefully observing the numbers and activity of the weevils every day during the fall, it was interesting to note that the activity was immediately arrested whenever the mean daily temperature dropped below 60°, and a comparison of this daily record with the temperature curve platted for College Station shows this strikingly.

The number of weevils entering hibernation will depend almost entirely upon the food supply during the fall. Whether there are one or two more broods in one part of the State than another matters not, for after the third brood the weevils become so abundant that their numbers are limited only by the available food supply. Therefore, with a normal or excessive rainfall during September and early October, which would cause the plants to square freely, there would be an abundant food supply and many more weevils entering hibernation than in a dry year when but few squares are formed. The weather of the fall, then, has a considerable influence on the number of weevils which commence reproduction the next spring.

At present one of the most important natural factors in reducing the food supply of the weevils in the fall is the leaf worm, or so-called "army worm" (*Alabama argillacea*, Hübn.). It is a most interesting entomological phenomenon that this insect, which formerly did so many million dollars' worth of damage to the cotton of the South and which was the subject of much investigation, has now become one of the Texas cotton planter's most valued allies and is welcomed by him wherever the weevil occurs. That the defoliation of the plant by these caterpillars has an important influence on the number of weevils hibernating is certain.

Of course, the same results are accomplished by thoroughly grazing the cotton, or better, by cutting and pulling the stalks, and the latter forms the most important feature in the fight against the pest, as discussed hereafter. As far as we can ascertain, the number of weevils entering hibernation will average about one per stalk; in badly infested fields it will often be two per stalk, and it may be as low as one to two stalks, with cotton planted an average distance apart.

Where the stalks are allowed to stand, many of the injured bolls remain on them unopened during the winter, and in these the immature stages continue to develop after frost. At College Station we were unable to ascertain that any of these come to maturity or survive the winter under normal conditions, and we believe this to be the case generally in central and northern Texas. In southern Texas, especially the more southwestern part, the conditions are different, however. In February and March, 1903, we received a large number of bolls from Devine, Tex., containing larvæ, pupæ, and adult weevils, mostly newly transformed. Some of these were found within the seeds, but there is comparatively no danger that they would ever be disseminated in the seed, since practically none of the cotton in which they entered the seeds would ever be picked and ginned. Many of these weevils were alive early in April, and in southern Texas would have emerged before that time. Out of 200 bolls picked at random 20 per cent contained living or dead weevils in some stage, and of these 55 per cent were alive. Mr. W. P. Allgood, who sent the bolls, at the writer's request, made careful counts, which showed that in the fields from which the bolls were secured there were about 10,500 weevils per acre. If but 20 per cent of these had survived and had emerged in the spring, there would have been 2,100 per acre, and this is approximately the number which survived during the last winter (1903-4) in Lavaca County, when the number surviving hibernation was unprecedented. Furthermore, the rainfall at Devine was nearly double the normal during this winter and weather conditions were exceedingly unfavorable for the hibernation of weevils had they been hibernating in the fields in the usual situations; but inside the bolls they were well protected from dampness and the temperature was never so low as to injure them. The importance of the absolute destruction of the stalks in southern Texas, even if deferred until midwinter, is therefore apparent, although in the rest of the State it is valueless after killing frost.

Regarding the places of hibernation we have been able to secure but little direct evidence. Just after hibernation commenced Mr. Conradi was able to find four weevils under leaves in a cotton field and under bark of a log adjoining it, but later in the winter absolutely none were found. Though many days have been spent in the most careful examination of the places where the weevils are supposed to hibernate, we have found but one individual in midwinter. As this has been our experience in hunting for other hibernating insects, however, we are not surprised. There is, nevertheless, abundant indirect evidence that most of the weevils hibernate in the cotton fields and in adjoining woodlands. Infestation usually commences in the spring along a woodland or hedge row, and is worse in a field which has been in cotton than one in corn. It is worse where sorghum adjoins cotton, as the sorghum stubble or stacks seem to form a safe shelter for the weevils. Furthermore, we are compelled to believe that the exceedingly small number of weevils on Brazos bottom plantations in 1903 must have been due to the flood late in the winter preceding, which undoubtedly killed large numbers of the weevils hibernating on the ground below the water level in the fields or elsewhere. Had this flood occurred after the emergence of the weevils it would probably not have materially reduced their numbers. A larger number of weevils always appear about outbuildings and barns and, very noticeably, near gins.

The mortality of the hibernating weevils is a matter of considerable importance, for, were it not for the large number which fail to survive the winter, it would be impossible to grow cotton in the infested region. Of 500 weevils going into hibernation in cages where they were largely protected 7 per cent survived. Hunter and Hinds have indicated that about 15 per cent survive at Victoria, and the data available would indicate that this is usually about the percentage for southern Texas. At College Station, however, extensive observations show that normally only about 2 per cent, and rarely over 5 per cent, survive in the field; or, in other words, but one-fifth as many as in southern Texas. That this is a most important factor in determining the possible amount and time of damage the next season is apparent. If a similar difference is found between central and northern Texas it will be a matter of great importance for the latter section of the State and other portions of the cotton belt. Careful estimates of the number surviving in southern Texas during the last winter show that in Lavaca County fully 30 per cent, or twice as many as usual, survived. With this number appearing in the spring, amounting to about 2,500 per acre by actual count, it is impossible to raise a profitable cotton crop by any means now known. As a result, for the first time since they have been infested, the counties of southern Texas, which have heretofore showed no marked decrease in production owing to the weevil, produced almost no crop.

The method used for determining the number of weevils surviving was to count a large number of stalks in the fall at time of hibernation and determine the number of weevils per stalk; then, in the spring, to count them in a similar way until the first summer brood commenced to emerge. In this way the number of weevils per acre, both in fall and spring, can be very accurately determined, provided large numbers of stalks are counted in several fields in one vicinity; and we believe this to be the most accurate method of determining the actual mortality which takes place in the field under natural conditions.

The time of the greatest mortality is a matter of some interest. As nearly as can be judged from the meager data now available, the largest number died in December coincident with the greatest rainfall of the winter, which was above normal for that month. Usually the greatest rainfall is in January at College Station, and probably the largest number usually succumb in that month.

That the rainfall is probably the most important factor in determining the mortality of the hibernating brood is very apparent upon studying the platted curves for rainfall and temperature for different points where we have made observations as to the abundance of the weevil for several years. After a wet winter weevils are fewer, and after an open dry one they are exceedingly abundant. This has never been more strikingly illustrated than last winter, which in southern Texas was unusually dry and open, whereas during the previous winter there had been a marked excess of rainfall. As a result, in the spring of 1904 the weevils appeared in enormous numbers and a crop failure resulted, whereas in 1903 this section made a crop in many cases above the average, although this was partially due to weather conditions in summer. A study of the normal mean temperature and rainfall of southwestern, southern, and central Texas shows that undoubtedly the larger mortality in the last section is due to the more unfavorable winter weather.

Hunter and Hinds have stated that the weevils usually emerge from hibernation after the temperature has been over 60° for some time, and that in 1903 they emerged after it had been at 68° for some time. After studying the available data with the aid of temperature curves, platted for various points where the time of emergence was known, I am convinced that this is approximately correct and that when the mean daily temperature becomes 68° the first weevils commence to emerge. Thus the weevils would normally commence to emerge at Victoria about April 1 and at College Station April 15. Usually the weevils will commence to emerge ten days earlier in southwestern and coast counties than in central and eastern Texas, and about twenty days earlier than in northern and northwestern counties.

The weevils do not all emerge at once, however, but continue to appear for from four to six weeks. Usually the greatest number of weevils appear about the time the cotton commences to square, and the beginning of oviposition is but a few days later, as it has been shown by Hunter and Hinds that a female must feed upon the squares before she will commence oviposition. After this time very few of the hibernating brood appear. That the time of this maximum emergence, as well as the squaring of the cotton plant with which it seems to be largely coincident, is dependent upon weather conditions may be taken for granted. But what are these conditions? Hunter and Hinds have shown that the average mean temperature at which the weevil is active and reproduces throughout the season is about 78° F. Thus it might seem that when the mean daily temperature had become 78° the maximum emergence would take place, but comparing the dates upon which the maximum emergence was known to have taken place at different points in different years with a curve of the mean monthly temperature for that year and the normal mean monthly temperature for a series of years, it was found that such was not the case. In some years the time of maximum emergence was before the normal date at which the mean daily temperature became 78°, and in others later, depending upon the departure from normal of that individual season. But the date of maximum emergence did not depart from the normal theoretical date upon which the mean daily temperature becomes 78° to the same extent as the departure from normal was indicated by the mean monthly temperature curve for that year. The temperature may have reached 78° on June 1, for instance, where nominally it would have reached that point May 1, and still in that year the weevils emerged in maximum numbers but a few days after the normal time. Sufficient accurate data are not at present available to make a positive statement as to what governs this date of maximum emergence, but, from all data available and from a careful study of the temperature curves, I wish to offer the following hypothesis, which I believe will be found to come very close to determining this date and possibly that of other insects hibernating as adults.[a]

The date of maximum emergence from hibernation, or the date of oviposition, will depart from the normal date—which for the boll weevil may be considered the date when the temperature reaches 78° F. or thereabouts—by the amount of the accumulated difference in temperature between the normal daily mean and the daily mean for that year; or we might term it the accumulated departure from normal for that year during the period commencing one month prior to the point of departure of the yearly line from the normal after the point of first emergence and the date upon which the total accumulated temperature for that year will equal the amount of accumulated temperature in the normal year between the first date of this period and the date of maximum emergence.[b]

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[a] The writer proposes to make studies of other insects to determine whether any general laws may be defined upon this point, and will be glad of any cooperation possible from others, as observations at several points distant from one another are necessary to make such work of value.

[b] It seems desirable to insert a figure illustrating the hypothesis proposed, as was done with drawings before the Association. For this the normal monthly mean temperature curve for Victoria, Tex., and the monthly mean temperature curve for the same place for 1904 have been selected. The figures are those of the United States Weather Bureau. In platting the curves we have used the 15th of the months for which the mean temperature is given. The "mean monthly temperature" as reported is the average for the whole month. It is evident that in most cases the 15th of the month would more correctly approximate this temperature than the 30th, upon which date it is

The period of time prior to the date of normal maximum emergence during which the accumulated temperature must be ascertained in order to determine the total amount of accumulated temperature

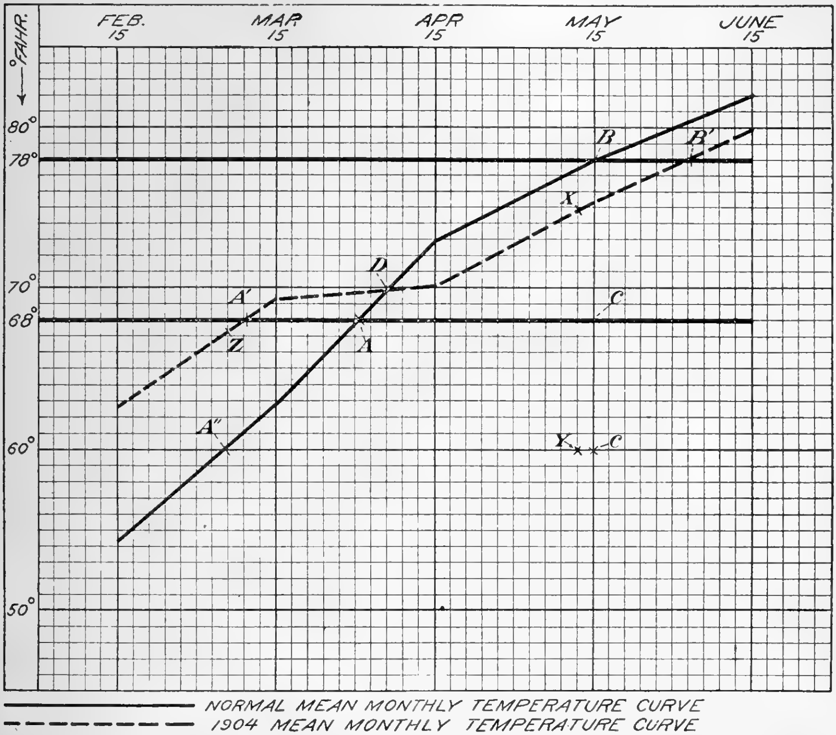

FIG. 1.—Diagram showing normal mean monthly temperature and the mean monthly temperature during 1904 at Victoria, Tex. (original).

necessary for maximum emergence, and the average temperature of the date on which this accumulation must begin both for the normal and any individual year, must be determined and will doubtless

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estimated, for in the spring the latter half of the month will be warmer and in the fall cooler than the first half. An examination of the daily temperature curves for any year corroborates this view.

Considering that the weevils first commence to emerge normally at 68° F., and that the maximum emergence is normally at 78° F., then the amount of temperature necessary to accumulate after the first emergence before the maximum emergence will be represented by the area ABC, and the maximum emergence will be at the point B, where the normal mean temperature line crosses 78° F., or, approximately, May 15. In 1904 the first emergence would theoretically have taken place at A′, where the mean temperature crosses 68° F., or about March 12. After that for about a month there was an excess of temperature and then a deficiency until July. The mean temperature line did not cross 78° F. until about June 3.

But if we ascertain the date of maximum emergence in 1904 by the hypothesis proposed we would proceed as follows: The point of departure of the differ with species. Assuming this hypothesis to be true we can readily determine the date of the appearance of an insect in the spring by keeping record of the accumulated temperature and its departure from the normal with the aid of the formula worked out for that insect. By considering the degrees of temperature per day as heat units the desired date can be readily computed by mathematical formulæ; or if the temperatures be platted the determination may be made more readily with the aid of a planimeter.

If this hypothesis be true, we can readily see that a marked excess of temperature for a week or two after the daily mean had passed 68° F., at which time the first weevils would commence to appear, followed by a slight deficiency in temperature subsequently until the mean daily temperature had reached 78° F., would result in the date of maximum appearance occurring before the normal rather than after it, and vice versa, in a case with the opposite conditions. These conditions are much more readily appreciable by the study of temperature platted in curves.

That the rainfall is also a factor governing the time of emergence is probable, but it will be largely reflected in the temperature. Undoubtedly the proper combination of the departure from normal of temperature and rainfall reduced to a formula in which both were included in a single "unit of weather" would give us the exact method of computation.

I offer this hypothesis merely tentatively. It may be old for aught I know, although I have never seen it applied to insects. However, in fish hatcheries the time of hatching of the eggs is deter-

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1904 curve from the normal after passing the point of first emergence (68° F.) is at D. One month prior to that would be A″ on the normal curve and Z on the 1904 curve. The normal temperature accumulated between this date and the normal date of maximum emergence (where the normal curve crosses 78° F.) at B would be the area A″BC′. Then the date of maximum emergence in 1904 would be that date on which temperature had been accumulated equivalent to that represented by A″BC′, which would be determined by an area A″ZXY, in which the position of the line XY must be determined by computation, with mathematical formulæ; and upon establishing its position so that it confines an area in A″ZXY equal to A″BC′, the point X will be the date of maximum emergence for 1904, which in 1904 was X′Y′, or May 12. This may be readily done by the aid of a planimeter.

The curves given are of interest in that prior to the presentation of this paper the date of maximum emergence in 1904 had been determined by the above method as being between May 9 and 12, according to slight variation from above in method of determining. Since then, in January, 1905, the author has received Farmers' Bulletin 211, in which Mr. W. D. Hunter shows, on page 21, that the maximum emergence of the weevils in 1904 was on May 11, which fact was previously unknown to the writer. The close approximation seems to lend support to the probability of the hypothesis in general, as it has similarly proven correct in at least three other instances.

mined by the amount of accumulated temperature during their development, and, according to a recent report of the Fish Commission, the time of hatching can be predicted or controlled to a considerable extent in this way. There can be no doubt that the time of emergence of insects from hibernation and the date upon which they begin oviposition or normal activity is dependent upon certain well-defined physical laws which can be determined only by many careful observations and a judicious interpretation of the data collected. It seems to the writer that this offers a promising field for entomological investigation and one which may very possibly be of much practical importance in our warfare against insect pests.

Though a much larger number of weevils survive the winter in southern Texas, the hot dry summers kill the larvæ in the fallen squares so that the rate of increase is slower, and often a good crop is made in spite of them. This shows that the rate of increase and the factors governing the mortality of the summer broods are of importance.

In the study of an insect pest we must first secure as accurate and elaborate a knowledge as possible of its life and habits under laboratory or insectary conditions. Then, it seems to me, we must go into the field and ascertain what are the conditions; whether or not our artificial environment has changed the life history, rate of reproduction, etc., and what factors influence these phenomena in the open. This is what we have essayed to do in as far as our limited means would permit, assuming, for the most part, the correctness of the most excellent and careful laboratory studies of Messrs. Hunter and Hinds at Victoria. Our method in field work has been to make frequent counts of large numbers of plants in the same fields through the season, making note of the number of weevils on each plant and the numbers of squares, bolls, and blooms, and the percentage of these which are perfect, or injured by the weevil, and the number of squares fallen as a result of weevil injury. Counts were also made of thousands of fallen squares at different times to determine the percentage injured by the weevil and the stage of the insects contained. Of course, as the season advanced we were compelled to examine a smaller number of stalks owing to the size of the plants, but always a sufficient number to give several thousand squares from each plot. In this way hundreds of thousands of plants have been carefully counted and the results tabulated, during the last two years.

The first three summer broods seem to be fairly well defined, the first occurring during the last half of June, the second about the middle of July, and the third about the second week in August in central Texas. There is an interesting relation between the normal rate of formation of squares on the cotton plant and the increase of the weevil. The rate of formation of squares is so exceedingly variable and dependent upon so many factors that it is difficult to make any generalizations regarding it, but from the many observations made we have drawn the following conclusions: Under the conditions for the last two years at College Station the critical period in the relation between the natural increase of squares and the increase of injury by the weevil is during the first six to eight weeks after squaring commences, which usually coincides more or less closely with the time between the second and third broods of weevils. Therefore, if we consider six weeks as the average time for cotton to square after planting, the bulk of the bolls must be set between eighty-five and ninety days after the time of planting. In other words, to escape injury by the weevil cotton must be grown so that the first bolls will commence to open about one hundred days after planting, and that all the fruit which will probably be secured must be set forty-five days after the squares form. The advantages of early varieties, other things being equal, is therefore apparent.

But should the weevil increase more rapidly than observed we would have injury even though the cotton were early. The rate of increase of the weevil is therefore most important. From the studies of Hunter and Hinds we learn that a female normally lays about 150 eggs in about fifty-four days (average figures), and that nearly half are deposited during the first third of the period. Allowing twenty-four days for development, they estimate the total normal period for a generation to be forty-two days. By counts of thousands of squares at different seasons we have determined the average rate of mortality of weevils in squares to be about 65 per cent. The sexes are practically equal in numbers. With these facts it is easy to compute that if there be 2 weevils per 100 stalks on June 1—about the number at College Station—on the appearance of the second brood in mid-July there would be 50 weevils, and these would produce by September 1 1,250 adults. In other words, the second brood would be twenty-five times and the third six hundred and twenty-five times the number of the first. But although we have three broods in the field during this time the increase is by no means so great. Were it so no cotton could be raised. The increase of the second brood over the hibernated brood is considerably less than twenty-five times, usually not over fifteen times, and the total increase from June 1 to September 1 is only about fifty times—certainly not over sixty-five times—instead of six hundred and twenty-five times, as it should be theoretically. The reason for this discrepancy is unknown to the writer, but for it the planter may be exceedingly thankful. It may be that (1) the mortality of the immature stages is greater than determined, which we decidedly doubt; (2) many of the adult weevils die or are destroyed before reproducing; or (3) the number of eggs laid and the length of period of oviposition actually occurring in the field are much less than observed in the laboratory. We are inclined to the view that it is due either to the last two factors or to some other factor which has not been recognized. This discrepancy emphasizes the necessity for accurately observing the actual conditions on a large scale in different fields in different sections of the State, constantly throughout the season, if we are to obtain accurate knowledge of the true habits and rate of increase of the boll weevil and the amount of injury wrought by it; and I doubt not the same principle will apply to the study of many other insects.

Regarding remedies there is but little new to say. A great furore has been raised over the alleged discovery that Paris green is a remedy for the weevil when dusted, but extensive experiments have failed to show that it may be of any great value in the control of the weevil. Where the weevils are abundant enough for it to be of benefit—for it will kill weevils when they are thick enough in the spring before the cotton begins squaring—they could better have been prevented by destruction the previous fall, and where the weevils are few in number it is of no value at all, so far as we can ascertain, and the progeny of but two weevils on June 1 will be numerous enough by early in August to stop blooming and prevent further fruiting. The fact is that Paris green appeals to the farmer because it is claimed to be a "remedy." Now, the average farmer, the country over, cries for a remedy, when by the use of a simple and inexpensive preventive he would have no need for it. Therefore, although Paris green may be of some value when weevils occur in enormous numbers on stubble cotton allowed to stand, or where the stalks have not been removed, it seems to me that the less said as to its partial efficacy the better. Neither Paris green nor any other poison will ever control the weevil, but with slight encouragement the farmer will waste much money in trying some one of them. We need in such cases more entomological hygiene and less remedial treatment It seems to the writer, therefore, that the holding out of any hope to the planter that a "remedy" for the weevil may be discovered is doing him an injury. The press is ever ready to magnify any possibility of a "remedy." I have yet to meet the entomologist who thinks the finding of a "remedy" other than those now known probable or possible. It does seem, therefore, that the quicker everyone in an official position authoritatively states that he is not working to find new "remedies" but to perfect the methods of control already known, the better it will be for the farmer.

The past season has demonstrated to me that the "cultural methods," by which we mean growing cotton so early that a crop will be made before the serious injury occurs, are not alone sufficient to insure a crop. If the previous winter be dry and open and an unusual number of weevils survive the winter, unless the stalks have been destroyed the previous fall and the number going into hibernation has thus been reduced, I doubt if the best cultural methods will avail to make an average crop. On the other hand, if midsummer be wet and the fruit formed drops, the best of methods can not make a crop. With normal weather conditions—if there be such in Texas—a crop can be made simply by the best so-called cultural methods, but it is absolute folly to rely on them alone. The only real means of checking the weevil economically is by the destruction of the stalks in the fall. When this is generally done the weevil will cease to be feared in Texas. That it has not been done before is because it has never been demonstrated to the planters on a scale large enough so that they could clearly see the resulting benefit. We entomologists may be satisfied from our field studies and small experiments that it is of value, but we have not as yet convinced the average planter sufficiently to secure his adoption of our recommendations. It will take a demonstration on a scale so large as to secure the cooperation and subsequent indorsement of a whole community before it can be entirely demonstrated to the unbelieving that the destruction of stalks in the fall is a necessity for the entire State. I am persuaded that the only real method for controlling the spread of the boll weevil is by this fall destruction of the stalks. Were it generally practiced in Texas and in the infested spots in Louisiana, I can see no reason why any large number of weevils should spread to uninfested territory, and the few spreading could be prevented from becoming numerous by adopting the same method. But all the laws of the Medes and Persians will not stop the spread of the boll weevil or any other similar insect by any method of quarantine yet devised, much as I sympathize with the adoption of these measures in the Southern States. If the natural conditions are such as to permit and encourage its gradual spread along the Gulf coast, it will spread in spite of all that man can do. All he can do is to deter its spread and control its injury. But if unchecked at its source and throughout the infested region, it will spread at a maximum speed, and it will be much more difficult to bring it under control. It seems, therefore, that the greatest benefit to the uninfested States would come from the passage in Texas and Louisiana of laws compelling the destruction of the stalks in the fall, and any influence that other States can bring to bear toward this end will do more than anything else to prevent the weevil's entry and subsequent depredations in their States.

And, in closing, permit a brief digression to consider a more general aspect of the case. The boll weevil in Texas and the gypsy and brown-tail moths in New England are raising some points in the relations between States which before long will need careful discussion and broad-minded treatment. Here we have insects which the infested States fail to control, either through inability or neglect, and they spread beyond their boundaries. Quarantines against them are comparatively useless unless the insects are controlled in the badly infested region. The National Government makes appropriations partly to aid in study of the pests for the information of the inhabitants of uninfested States and partly to prevent spread, but it can have no authority in the latter respect without State legislation. Undoubtedly at least one of the two moths in New England—the gypsy moth—might be controlled were the States infested willing to spend sufficient money to confine it within their borders; and the same is largely true of the boll weevil, were it generally controlled by destruction of the stalks as outlined. But why should one State tax itself to subdue a pest which is causing it loss and others gain from increased prices, as in the case of the weevil, to prevent it from spreading to them? On the other hand, if it is possible for the State to do so, is the General Government justified in assuming the task if it had the authority? These are questions of a broad nature which it seems to the writer are rather new and which must be met sooner or later. In their solution an association such as this should take a leading part.

Mr. Skinner remarked that certain newspapers had published a statement that an attempt was being made among cotton growers of the South to combine and destroy a portion of this year's crop in order to raise the price of cotton. In view of this, might we not look upon the boll weevil as a beneficial insect in years like the present, when the crop is larger than usual?

Mr. Hunter said that the results reached by the Department of Agriculture agreed fully with those presented in Mr. Sanderson's paper. Climatic conditions are so important that methods that fail to take account of their influence are likely to give widely different results in different seasons. A fairly good remedy is at hand, viz, the actual destruction of large numbers of the weevils in the fall; but the general indifference of the people to suggestions makes it difficult to get cooperation in this. They grasp at any possibility, such as the use of mineral paint, attracting to cotton-seed meal, and other quack nostrums which have been shown to be of no use whatever. As to the suggestion that the boll weevil might be a benefit in raising the price of cotton, it is a fallacy to suppose that the increase in price was due to the boll weevil. It seems an important possibility that predictions of great commercial value in regard to prospective injury may be based on the principle suggested by Mr. Sanderson.

Mr. Howard said that the Department frequently had great difficulty in counteracting the influence of men prominent locally, who come to believe from accidental causes in some method of no general value, and because of their belief in it strongly advocate its use in their own section. A promulgation of the idea of Paris green as of use against the boll weevil was mostly the work of one prominent man. During the past season a very considerable amount of money was spent in Texas for the purchase of Paris green by people who were impressed by the standing of the individual in question and by his forcible claims. At the recent national cotton convention at Shreveport, La., however, so strong a presentation of the case was made by an equally prominent gentleman, who had conducted a large experiment with the substance and with negative results, that no further verbal statements were necessary from members of the force of the Bureau of Entomology, which, however, has published a bulletin devoted to this specific subject, under the authorship of Mr. W. D. Hunter.

The following paper was read:

THE FALL WEBWORM PARTIALLY DOUBLE-BROODED IN CONNECTICUT.

By W. E. Britton, *New Haven, Conn.*

In 1901 the fall webworm (*Hyphantria cunea* Drury) was more abundant in Connecticut than for many years, and, although still present in destructive numbers, has decreased each year since. For some time I have considered the species to be double-brooded, or partially so, in Connecticut, but had not been able to make any definite observations that would help to settle the matter. A statement to this effect was made in my first report as State Entomologist.[a] A similar statement was made at the annual meeting of the Connecticut Pomological Society, at Hartford, Conn., February 4, 1902.[b]

In the Yearbook of the Department of Agriculture for 1895, page 376, and also in Farmers' Bulletin No. 99, page 20, Howard states that the species is double brooded south of New York City.

According to Fernald, there is no satisfactory evidence of more than one brood in Massachusetts,[c] and Mr. Kirkland informs me that the insect has been carefully studied at Amherst and that only one brood occurs.

On June 23, 1904, the first nest of the season was found in a pear tree in Westville, near New Haven. The nest was small, and the

[a] First Report State Entomologist of Connecticut, p. 271.

[b] Fourth Report Connecticut Pomological Society, p. 20.

[c] Hatch Experiment Station, Bulletin No. 20, p. 11, 1893.

larvæ had evidently been hatched but a few days. They were taken to the laboratory and fed upon pear leaves. We were too busy with other work to watch them closely, therefore I have no record or descriptions of the different molting stages. On July 29 all but three of the caterpillars had pupated, and two adults emerged August 1. The moths continued to emerge until August 5, when there were 30 in the breeding cage, and two masses of small greenish eggs had been deposited on the side of the cage. Most writers refer to the eggs as being golden yellow in color, but these were quite a brilliant light green. All of the adults, including both sexes, had immaculate wings.

August 15 the eggs had hatched. We fed the larvæ until about the middle of September, when we had to go out inspecting nurseries and could not give them the food needed, and all died before pupating. I do not believe there were two complete broods of the insect throughout the State, because the early nests were extremely rare, most of the nests appearing about a month later. The latitude of New Haven, while not very different from that of New York City, varies by over half of 1° and probably marks about the northern limit of the double-brooded occurrence of the fall webworm.

Mr. Felt said that the first nests were found in New York the latter part of June. He was convinced that there was a partial double brood.

Mr. Smith said that throughout New Jersey it is fully double brooded.

The following paper was presented:

PRELIMINARY REPORT UPON WORK AGAINST A DESTRUCTIVE LEAF-HOPPER (EMPOASCA MALI Le B.).

By F. L. Washburn, *St. Anthony Park, Minn.*

I came to the last meeting of the Association, at St. Louis, with an unsolved problem in my mind as to how we could control this leaf-hopper, which was making its presence felt in a very destructive way in the nurseries of Minnesota. I have found it on many trees other than the apple. The assistant under whom the work was conducted last summer reports that its attacks are least apparent on the Northwestern Greening and most evident on the Repka, Charlamoff, Lyman, Minnesota, and Transcendent varieties. After the Repka, according to his observations, comes Scott's Winter, which appears to be quite badly affected, and in a diminishing ratio Patten's Greening, Early Strawberry, Sweet Russet, Malinda, Longfield, Duchess, Hibernal, Wealthy, Whitney, Peerless, Anisim.

So far as I know, the life history of *Empoasca mali* has not been thoroughly worked out. As far as the apple is concerned, it would appear that the egg is laid by the adult in the tissue of the leaf, for young of such a tender age as to preclude the possibility of their having migrated after hatching are found on the under side of the leaf. In the absence of conclusive evidence, however, I hesitate to regard the above probability in the light of a fact. As you all know, the leaves of nursery trees, as well as the more tender leaves in orchards, are curled by this pest, and the growth of the tree checked for the time being. Last summer in Minnesota the insects began their work early in July and soon grew very abundant.

Mr. Stedman, of Missouri, who was present at the meeting in St. Louis, chanced to remark upon his work along this line in his State. This coincidence was a great help to me, for I at once proceeded to get suggestions from him, which were most cheerfully given. The general plan of his spraying machine I carried home with me, finding, upon considering the matter, that this plan should be changed somewhat to better subserve our purpose in Minnesota.

It is to be noted that 3- and 4-year-old trees in Minnesota are not as tall as they are in Missouri, hence we were not obliged to have the cart quite so high above the ground. We found it best, also, to bring the container off the platform which stood above the wheels in order to make the cart more stable. The wheels of this cart are $5\frac{1}{2}$ feet in diameter, with 4-inch tires, and the platform, which is 8 by $4\frac{1}{4}$ feet in size, is 14 inches above the wheels and firmly balanced on the axle, so that practically all the weight comes on the axle and not on the horse.

A glance at the accompanying illustration (fig. 2) will give one an idea of the details. The pipe (*D*) is a 1-inch pipe 10 feet long. On this pipe four nozzles are attached, pointing directly downward and so placed as to be $3\frac{1}{2}$ feet distant from each other. This spacing brings each of the nozzles directly over a nursery row, where, as in Minnesota, the rows are usually $3\frac{1}{2}$ feet apart. This pipe can be raised or lowered mechanically to suit high or low trees. The horizontal pipe (*C*) is 14 feet long and projects 10 inches back of the platform, thus clearing the wheels. The five verticals from this pipe (*E*) are made of $\frac{3}{8}$-inch piping, 5 feet 4 inches long, and there is also a $3\frac{1}{2}$-foot space between these. The crosspieces at the bottom are so arranged that a nozzle in each end of each piece points up at an angle of about 45°. This spacing and arrangement of the nozzles on both pipes results in a copious spray coming both from above upon the tops of the trees and from below against the lower surface of the leaves—the latter, as you know, being very important. In actual practice the trees are completely surrounded by a fine spray, so that the insects, whether upon the upper or lower surface, or whether, disturbed by the spraying, they seek to fly away, are sure to be caught by the deadly mist. Two pumps were used, one with kerosene emulsion and the other with kero-water—not at the same time, of course. These pumps were placed on a small raised platform in order to bring the handles within easy reach of the man pumping. The hose can be so connected with the horizontal pipes as to throw all the liquid forced up by one pump into the two

FIG. 2.—Outfit used for spraying young apple trees for *Empoasca mali* (original).

horizontals when one pump is used alone, or into one horizontal under the same condition; or when both pumps are used the liquid is forced equally into the entire system of piping. As a matter of fact, we found that in using kerosene emulsion one pump could easily make a good spray from all the nozzles. It is evident that this outfit can be used with any spraying compound. The tank, resting on the platform between the wheels, was made of strong galvanized iron and was 2 feet 10 inches in diameter and 3½ feet high, holding about 165 gallons. The faucet in the bottom behind permitted the emptying of the tank at any time, and there was a hole 14 inches square in the top for filling it. We used a heavy horse, and placed on the back of the animal an old saddle, which seemed to relieve his back of any undue strain. However, as before stated, the weight was so well balanced on the axle that the outfit was not at all severe on the horse and was drawn with apparent ease when the tank was from one-half to two-thirds full.

We had planned to spray early in July, but owing to delay in getting the cart completed the first spraying was not given until July 14. At that time kerosene emulsion was used at the rate of 1 part of stock emulsion to 12 parts of water. The machine worked perfectly, one man and one pump being sufficient to envelop each tree in the row in a complete fog. In this fog were thousands of hoppers flying from the trees, but unable to escape the spray. This strength of emulsion, however, while it killed the young hoppers, did not permanently affect the adults. On July 19, therefore, we increased the strength, using 1 part emulsion to 10 of water. This in no way injured the trees, nor did it, unfortunately, kill the adults, which were very numerous at that date.

Learning from the Missouri station that they were using a mechanical mixture of kerosene (10 per cent) and water with considerable success, I sent for a kero-water pump, which is shown in figure 2 (at the right) fitted to the platform. The writer has yet to see one of these kero-water machines which pumps true to the indicator. Our experience has been that if the indicator points at 10 per cent one is not at all sure of obtaining that percentage of oil in the water; in fact, he is quite sure not to. When the indicator of our pump "indicated" 20 per cent we found by actual test that we were pumping 10 per cent, and 25 per cent indicated gave only 15 per cent. With the indicator at 30 per cent we obtained 25 per cent, while 50 per cent on the indicator gave nearly 50 per cent by actual test as it came from the nozzles. The indicator's 10 per cent and 15 per cent gave such a small percentage of oil, far below the figure indicated, as to be practically worthless for our purpose. We found, further, that when the oil in the oil tank got quite low the percentage materially changed. For instance, with the indicator at 25 per cent we pumped 15 per cent steadily until the tank was nearly empty, when test showed that we were getting only 5 per cent. This inaccuracy and variation is common to all the kero-water pumps with which I have had experience, and is a serious objection to their use. Nevertheless, once understood, and frequently tested in the field, these machines may do good service.

Our kero-water outfit arrived too late in the season to be of real practical benefit. It was used August 5 for the first time, and kero-water with 15 per cent of kerosene was applied. At that date the hoppers were becoming decidedly less in number, and, further, the pump could only supply liquid sufficient to fill the lower nozzles. This difficulty was overcome by obtaining another pump, so that next season we will be prepared at the very outset to put up a good and, I hope, a successful fight against this pest, which is costing the nurserymen several hundreds of dollars loss annually.

At Adrian, Minn., Mr. Fred Mohl, proprietor of a large nursery, has kindly cooperated with the Entomologist, and has been making a series of experiments with the dust spray. Mr. Mohl sprayed twice with the "caustic lime" mixture, and once with the "general formula." At the date of my visit, July 12, the trees were looking very well, though they were not free from leaf-hoppers. Mr. Mohl is of the opinion that, if he had begun earlier, "before the hoppers appeared," as he expressed it, and sprayed three times, he could have kept them well under control. While the writer is quite willing to be convinced, he has not absolute confidence in the efficacy of dust spraying in this connection.

I believe the possibilities foreshadowed in the success of the cart as a sprayer are almost unlimited. A cart to straddle one row and spray the straddled row and the two adjoining rows could be easily constructed. These carts, too, including the one we are now using, could be made automatic by connecting the pumps with the wheels by proper gearing.

Mr. Smith concurred in the view that kero-water pumps were in general unreliable. He hoped that experiments already under way on the production of so-called "soluble petroleum" would solve the difficulty.

Mr. Slingerland said that in New York they had gone through similar experiments for the leaf-hopper on grape vines. With diluted kerosene emulsion or whale-oil soap the young hoppers were easily killed, but the only way to kill the adults was to first get them off the vines. They were knocked down by a 5 per cent kerosene spray, but they would recover from this; consequently it was necessary, while they were on the ground, to spray again with a 25 per cent mixture.

Mr. Sanderson said that he had failed to find any satisfactory form of kero-water pump.

Mr. Osborn said that he had killed some species of hoppers on potatoes with 5 per cent emulsion, but it was necessary to keep them in the air for this to be effective.

Mr. Fletcher called attention to the fact that hoppers might often be fatally injured even though they appeared all right for a time after the spraying, death occurring later. He said that Mr. Lugger had killed grasshoppers by dipping one leg in kerosene.

The following paper was read:

ADDITIONS TO OUR KNOWLEDGE OF THE CABINET BEETLE (ANTHRENUS VERBASCI Linn.).

By Henry L. Viereck, *New Haven, Conn.*

While at the Connecticut Agricultural Experiment Station the writer made some observations on this species which seem to be new. Larvæ of *Anthrenus verbasci* had been kept in a tube with cotton fibers during the winter. After subsisting on the cotton the specimens were transferred, in the spring, to Syracuse watch glasses, lined with black woolen cloth, where they could be readily watched and fed with dried insects.

One day a female specimen was observed with an egg partly protruding from its ovipositor. When first seen it had the ovipositor, with the egg, inserted in the woolen cloth; then it seemed disturbed, for it walked around with the egg nearly all the way out, but made no apparent effort to drop it. A short time after this observation the egg had been dropped. The laying of this egg could not have taken more than five minutes. Eggs were first noticed about March 1. On March 15 four eggs were put on a piece of cloth, which was pinned into a Schmitt box with no insecticide in it; another lot of four eggs was put on a piece of cloth and pinned into a box containing three naphthalin cones. April 7 the eggs in the box without naphthalin had hatched and the larvæ were lively. In the box with the naphthalin two eggs had matured embryos or young larvæ; one larva had eaten the end off the egg preparatory to emerging, but there died; the other did not succeed in cutting through the cover, though it was apparently as far advanced in development as the first specimen. The second embryo had evidently inhaled the fumes of the naphthalin through the thin membrane or the micropyle. This experiment seems to demonstrate that naphthalin does not retard the growth of the embryo in the egg, but does prevent the young larva from emerging. When laid, the eggs are soft, with a membranous covering containing the whitish granular fluid, and measures 0.60 mm. in length and 0.29 mm. in width. They are bare, except at the blunt end, where hairs occur. At the time the larva emerges everything in the egg has been taken up and only the thin outer membrane or skin remains as a wrinkled tissue. The accompanying sketch (fig. 3) will help to convey an idea of the characters presented by the egg.

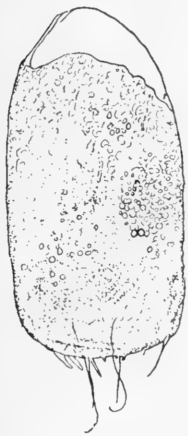

Fig. 3.—Egg of *Anthrenus verbasci*, greatly enlarged (original).

Mr. Smith said that he had placed naphthalin in boxes that were well infested with Anthrenus; this prevented development so long as any of the material remained, but after it all disappeared, which in one case took over a year, the larvæ developed.

The following papers were then presented:

SPRAYING APPLES AGAINST THE PLUM CURCULIO.

By S. A. Forbes, *Urbana, Ill.*

[Withdrawn for publication elsewhere.]

VALUE OF COPPER SULPHATE AGAINST MOSQUITO LARVÆ.

By C. L. Marlatt, *Washington, D. C.*

[Withdrawn for publication elsewhere.]

MORNING SESSION, FRIDAY, DECEMBER 30, 1904.

The meeting was called to order at 10 a. m. by President Quaintance. On motion it was decided to defer the discussion on the following series of papers on miscellaneous insects until all of them had been read. The following papers were then presented, the last two by title:

BRIEF NOTES ON OHIO INSECTS FOR 1904.

By Herbert Osborn, *Columbus, Ohio.*

No particularly serious or widespread insect outbreaks have been noted in Ohio during the past season, but there have been a number of cases of local abundance and destruction, some of which may well be placed on record.

The pear slug (*Eriocampoides limacina* Retz.) was noticed in Huron, near the lake shore, in small orchards of cherry trees, in which many of the trees were so seriously infested as to appear quite brown and burned. This condition was noticeable from a considerable distance, and closer inspection of the trees showed the foliage to be almost completely destroyed by the numerous larvæ. This occurrence was during the latter part of July, and at this time the larvæ were apparently reaching maturity.

The willow weevil (*Cryptorhynchus lapathi* Linn.). Specimens of this introduced species have been handed to me by Prof. E. H. Edwards, of Cleveland, who tells me that the insect occurred in large numbers on willows and probably also on poplars in the vicinity of Cleveland. Both larvæ and adults were observed and the damage occasioned was quite noticeable. It will be remembered that the appearance of this species in this State was recorded by Professor Webster three years ago, and it would seem from this occurrence that the species has been spreading and that it is likely to prove of considerable importance where the trees it infests are of any value.

The elm leaf-beetle (*Galerucella luteola* Müll.). This species, which has been so injurious in different parts of the eastern United States, has been reported as introduced at Dayton, Ohio, specimens in considerable numbers being secured by Mr. A. F. Burgess, chief inspector of orchards and nurseries. This is the first occurrence of this species in the State, and its appearance at a point so distant from any of the other localities where it occurs is a matter of considerable interest.

The peach borer (*Sanninoidea exitiosa* Say). This common enemy of peaches has apparently been somewhat more numerous than usual during the past season, although regularly a common species in peach orchards.

The occurrence of the screw worm (*Chrysomyia macellaria* Fab.) is perhaps worthy of notice, although it has doubtless been a common species in the State for many years. It has been found on the beach at Cedar Point as one of the most abundant species, feeding on the dead fish that are thrown ashore. No instances of its attack on man have come to our notice. The species seems at that point fully adapted to the particular food supply which is furnished it in the drift from the lake.

The Hessian fly (*Mayetiola destructor* Say), which has been somewhat less destructive the last two or three years, seems this year, from reports, to be on the increase. I have not myself had much opportunity of noting its abundance in the fields, and therefore judge simply from reports which have been sent to me.

The chinch bug (*Blissus leucopterus* Say), while present and coming to light in collections during the year, has not, so far as I know, caused any considerable destruction. No reports of its serious abundance have come to me.

The squash bug (*Anasa tristis* De G.) has put in its regular appearance, and I have noticed some quite destructive work on squash vines during the latter part of the season. This species is doubtless locally abundant almost every year and must be responsible for no small amount of damage.

The bagworm (*Thyridopteryx ephemeræformis* Steph.) has not, perhaps, been much more abundant than in former years, but has attracted attention. It does not appear to multiply very greatly and its range is probably not changing materially.

The fall web-worm (*Hyphantria cunea* Dru.) has again been noticed as quite abundant, the webs being formed as early as in the first part of July in the vicinity of Sandusky.

The northern corn rootworm (*Diabrotica longicornis* Say) is apparently increasing in numbers, the adult beetles being quite plentiful during autumn of the present season.

The plum curculio (*Conotrachelus nenuphar* Hbst.) was probably less abundant than in average years and the crop of plums was abundant and quite free from injury.

The apple maggot (*Rhagoletis pomonella* Walsh) has not been more abundant than in previous years, so far as observations would indicate. It may be considered, however, as a well-established species in this section and some damage may be expected from it every year.

The codling moth (*Carpocapsa pomonella* Linn.) has not been noticed in detail, but fruit has shown its presence in the usual months and there has doubtless been an average amount of loss except where orchards have been sprayed.

NOTES FOR THE YEAR—NEW YORK.

By E. P. Felt, *Albany, N. Y.*

The season of 1904 has been notable because of the remarkably small amount of insect injury to agricultural crops. Plant lice and the pear Psylla (*Psylla pyri* Linn.), so abundant in 1903, hardly attracted attention last year. The San Jose scale (*Aspidiotus perniciosus* Comst.) has become thoroughly established in a number of localities in the State, and the best method of controlling it in commercial orchards is now an urgent problem. The elm leaf-beetle (*Galerucella luteola* Müll.) has been remarkable for its scarcity, and the only thing worthy of special note in this connection is its occurrence in considerable numbers in the village of Glens Falls, which, so far as known to us, is its northernmost locality. The violet sawfly (*Emphytus canadensis* Kirby) attracted some attention about the middle of June, because of its depredations on pansies at Nassau. The stalk borer (*Papaipema nitela* Guen.) has been unusually abundant in some sections of the State, working as usual in thick-stalked plants and injuring tomatoes, potatoes, and corn in particular. An interesting injury by young of what were probably buffalo tree hoppers (*Ceresa bubalus* Fab.) was brought to notice. They established themselves upon the stems of the common balsam and sucked the juices therefrom to such an extent that the plant was unable to support itself, and the part above the point of injury lopped over and eventually died.

A third shipment of the Chinese lady beetles (*Chilocorus similis* Rossi) was obtained last June through the kindness of Prof. Wilmon Newell, State entomologist of Georgia, and established in a badly infested orchard at Kinderhook, Columbia County. Unfortunately we were unable to find larvæ or signs of breeding, as had been the case with earlier shipments in the years 1902–3, and it is possible that most of the insects availed themselves of their freedom and spread to other trees. It is sincerely hoped that some have found conditions to their liking, where they have bred freely, and that the species will become established in that section and prove of considerable service in controlling the San Jose scale.

It will be well, in this connection, to allude to some recent work done in continuation of the investigations begun in 1902 upon the grapevine rootworm (*Fidia viticida* Walsh). This insect was not nearly so abundant in the Chautauqua grape region during the season of 1904 as it was the preceding year, and it was somewhat difficult to obtain suitable conditions for experimental work. A badly infested area was most thoroughly sprayed June 30, and a second time, July 6, with arsenate of lead at the rate of 4 pounds to 50 gallons of water. The treated section was the subject of close observation, and repeated collections with a hand catcher were made for the purpose of determining the number of beetles present upon the vines. Collections July 11 resulted in taking from 5 to 39 from single vines, on the 14th from 15 to 46, and on the 20th from 5 to 19. Similar collections on an adjacent untreated area gave on the 11th from 18 to 77, on the 14th from 34 to 60, and on the 20th from 9 to 14 beetles per vine. It will be seen that there were more beetles upon the unsprayed than upon the poisoned vines, but there was not a very marked difference, and nearly the same proportions held later in the case of egg clusters and also for grubs. We are inclined to believe that the spraying reduced the numbers of the pest about 50 per cent. Supplementary indoor experiments showed that many of the beetles taken from the sprayed vines and fed foliage from the same appeared to die as much from starvation as from poisoning. The resistance of this creature to arsenical poisons is somewhat remarkable. There is no doubt that spraying is of some service in keeping the pest in check, though it is not so effective as one could wish.

SOME ECONOMIC INSECTS FOR THE YEAR 1904 IN OHIO.

By A. F. Burgess, *Columbus, Ohio.*

The colony of Asiatic ladybirds (*Chilocorus similis* Rossi), which was started in an orchard infested with San Jose scale in southern

Ohio, survived the winter, but the beetles disappeared early in the summer and none have been found since that time. The codling moth (*Carpocapsa pomonella* Linn.) has not been as destructive this year as usual, the spring cankerworm (*Paleacrita vernata* Peck) seems to be on the increase in many sections, and the tent caterpillar (*Malacosoma americana* Fab.) was abundant and injurious in the northwestern part of the State.

Early in May a report was received from Mr. E. E. Richards, who is the owner of a large orchard in Adams County, southern Ohio, that his peach trees were being defoliated by insects. An investigation made by my assistant, Mr. Swezey, on May 15, showed that the buds and young leaves in one part of the 3-year-old peach orchard were being seriously injured by the red-legged flea-beetle (*Crepidodera rufipes* Linn.), while other parts of the orchard were not attacked. Black-locust thickets are very common in the vicinity of the orchard, and an examination showed that large numbers of the beetles were present in them and were feeding on the young leaves. From the foreman of the farm it was learned that during March a fire ran through the locust thicket nearest the peach trees that were being attacked, and it was found that the leaves had not begun to reappear on the trees in the burned area. This evidently accounts for the injury—the beetles feeding on the peach, owing to the fact that there was no foilage on their natural food plant. Subsequent examinations made in widely separated localities in the State have shown that the beetles were present in greater or less numbers. They have been observed feeding on hazel, dogwood, and plum sprouts that were growing in locust thickets, but the latter foliage was most seriously injured. The larval and pupal stages are still unknown, but there seems to be no doubt that the insect hibernates at or beneath the surface of the ground, from which the beetles emerge early in the spring. The infested trees were sprayed with disparene late in April, but, as there was practically no foliage to hold the poison, very little good resulted. Later in the season the beetles disappeared and the trees were able to put out a crop of leaves. Outbreaks of this insect were reported in Virginia and Maryland several years ago, and were investigated by Mr. E. A. Schwarz, assistant entomologist of the Bureau of Entomology. His report was published in Insect Life for the year 1893.[a]

In June, 1904, a complaint was received from the Steubenville Traction and Light Company that some of their electric cars were being destroyed by insects. An investigation by Mr. Swezey showed that four cars which had been bought in 1902 had been somewhat

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[a] Vol. V, pp. 334–342.

injured by the powder post beetle (*Lyctus striatus* Mels.).[a] White ash panels and trimmings were infested and quite a number of small holes were visible. On removing a section of the wood, both beetles and larvæ were found. Cars constructed with the same kind of wood and received from other companies showed no signs of injury by this insect. The infested parts had been treated with creosote and corrosive sublimate, but without beneficial results. Evidently the cars were infested when purchased, and the only remedy seemed to be to replace the infested parts with new wood.

At the request of Mr. C. L. Marlatt, assistant entomologist of the Bureau of Entomology, an investigation was made to determine whether the record of Dr. G. B. Smith, indicating that Brood XII of the seventeen-year locust (*Tibicen septendecim* Linn.) would appear in Vinton County, Ohio, in 1904, was correct. Letters requesting information were sent to the crop correspondents of that county, and my assistant, Mr. E. C. Cotton, interviewed several people in each township and made examinations early in June, but no trace of the insect could be found. Larvæ were found by one man several feet below the surface of the ground while stripping a coal bank on a hillside, but they were only partially grown and evidently belonged to the brood due to appear in 1914.

An examination of the vineyards along Lake Erie made during the early summer showed that the grapevine rootworm (*Fidia viticida* Walsh) was not as injurious this year as in the past. This was found to be true in sprayed as well as unsprayed vineyards, and also where the vines had been totally neglected. Some growers are of the opinion that the one reason for the small number of beetles present is that all the roots near the surface of the ground have been destroyed, hence the larvæ on hatching have nothing to feed upon and die before burrowing a sufficient distance to reach the vigorous roots. As the worst infested spots are found where the soil is of a sandy character, and as examinations have shown that considerable digging is required before any tender roots are reached, this may offer a partial explanation of the small number of beetles that developed this year.

The grape fruit-moth (*Polychrosis viteana* Clem.) continues to do considerable damage, especially to vineyards that are not sprayed with poison early in the season.

About June 10 Mr. John Maxwell, of Euclid, noticed that some of the blossom buds on his vines had become somewhat enlarged and were turning red; also that on opening such buds several white or yellowish larvæ were found within. Other growers had noticed the

[a] Synonymous with *Lyctus unipunctatus* Hbst.—Ed.

same thing in the past, but, supposing that these larvæ were a stage of the berry moth, had taken no further notice of them. The attention of Mr. Swezey was called to the matter by Mr. Maxwell, on June 20, and the insects proved to be a new enemy to the grape and probably one hitherto unknown to science. As affected buds are ruined the clusters are made irregular, and as one-fifth of the buds were found infested in some cases it resulted in considerable loss. Fifteen larvæ have been found in a single bud and as high as twenty-five infested buds have been found in a cluster. The larvæ undoubtedly complete their transformations in the ground, which makes it very difficult to trace their complete life history, but from their structure it is evident that they belong to the dipterous family Cecidomyiidæ, and are closely related to the Hessian fly. Later it was learned that this insect had been found also in the Chautauqua grape belt in New York on June 12, 1904, by Mr. Fred Johnson, who was working on grape pests with Prof. M. V. Slingerland. I am informed also by Dr. E. P. Felt that he has found it in New York vineyards this year.

An outbreak of the elm leaf-beetle (*Galerucella luteola* Müll.) was discovered by Mr. George A. Runner at Dayton, late in August. European elms were badly infested, and, in some parts of the city, American elms were being defoliated. It was impossible to determine how long the insect had been present, but a subsequent examination showed that it was attacking elms in many different sections of the city. This is the first record of its occurrence in Ohio, and careful search in other cities in the State has failed to reveal its presence.

The Hessian fly (*Mayetiola* [*Cecidomyia*] *destructor* Say) has made its appearance in the wheat fields this fall, and according to some of the crop correspondents is more abundant than usual. The present prospect is that considerable damage will result to the next wheat crop.

INJURIOUS INSECTS IN MINNESOTA IN 1904.

By F. L. Washburn, *St. Anthony Park, Minn.*

While the year has been uneventful as regards insect outbreaks in the usual looked-for directions, it has nevertheless contained some surprises. There has been practically no trouble from the Hessian fly (*Mayetiola* [*Cecidomyia*] *destructor* Say) in any part of the State, as far as the entomologist can learn, the preceding year, 1903, witnessing the culmination of its increase. We have every reason to believe that it will gradually grow more abundant in the next few years, weather conditions being favorable. Owing to its very general absence in localities formerly infested we have been unable, as we did last year, to secure puparia (flaxseeds) in volunteer wheat, showing the occurrence of an extra brood in this State. Two lots of volunteer wheat plants, from 8 to 10 inches high, were sent us in November, one lot from Marshall County and one from Big Stone County, in both of which counties the fly was thought to be present. Several hundred of these plants were carefully examined, but contrary to last year's experience we found no puparia.[a]

My attention has not been called directly to the presence of the frit-fly (*Oscinis soror* Macq.) or the wheat-stem maggot (*Meromyza americana* Fitch) although, from reports of certain ill-defined injury to wheat from time to time, we have good reason to suspect that both of these are in Minnesota at present. Professor Lugger reported the frit-fly as injurious in 1893 and 1896.

Chinch bugs (*Blissus leucopterus* Say) have been conspicuous for their absence during the year, no injury whatever being reported in any county. During the wet weather of last fall I found a large number of dead and dying chinch bugs on the station grounds, evidently killed by a fungous growth. This condittion, prevailing in most of the chinch-bug areas, is possibly, in part, the reason why we have been free the past season.

The Mediterranean flour moth (*Ephestia kuehniella* Zell.), undoubtedly present and increasing in numbers for the past several years in Minnesota, has this year made its presence so conspicuous in certain mills as to call for some special work on the part of the Entomologist, and the publication of a special report on the subject for the benefit of the four hundred or more flour mills in Minnesota.

The leaf-hopper (*Empoasca mali* LeB.) is becoming more and more evident in nurseries, and causing losses annually. We have done some special work against this pest this season, an account of which forms the subject of a previous paper. The work is purely preliminary, but may prove interesting as illustrating what may be done with certain field apparatus.

The plum curculio (*Conotrachelus nenuphar* Hbst.) is proving itself almost as great a foe to apples in Minnesota as it is to plums, and is as much of a pest in this particular as is the codling moth.

We have been startled by finding the imported willow curculio (*Cryptorhynchus lapathi* Linn.) in poplars shipped from New York State with the inspector's certificate to nurserymen in Minnesota,

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[a] Since the above paper was delivered it has been stated to me by a carefully observant entomologist in this State that he found a number of puparia of Hessian fly in volunteer barley plants on Thanksgiving Day, 1904.—F. L. W.

and then forwarded to parties in the extreme northwestern part of North Dakota. Twenty-five poplar trees were killed in one locality by these borers, and I have no doubt, although I can not obtain absolutely accurate information, that some of the shipment was distributed within our own State boundary. The nurseryman importing this stock, of course, was in no way to blame in helping on the westward progress of this unwelcome immigrant, since the certificate of the inspector was supposed to be an absolute guaranty that the stock was all right. In complaining of this to the New York commissioner of agriculture I was met with the statement that, while it seems impossible to eradicate this beetle in New York State, measures can and will be taken to prevent infested stock from being sent to other States. Our nurseries in Minnesota have been carefully inspected and found to be practically free from insect or fungous pests. It should be said in this connection, however, that inspection is not compulsory for all nurseries, and not more than two-thirds desire it, namely, those who ship to other States, and others who do not export, yet value the entomologist's certificate as an advertisement of clean stock. Occasional occurrences of woolly aphis in limited numbers are the only especially undesirable features discovered in connection with nursery stock.

Our shade trees, the soft maple and the elm, have been alarmingly affected with the cottony maple scale (*Pulvinaria innumerabilis* Rathv.) in many of our towns and cities, as well as in those of some of the neighboring States. It has been present in such large numbers as to check the growth of maple trees and weaken their vitality.

Our attention has been called particularly to cecidomyiid gall-makers on the box elder, the soft maple, and a locust, the variety of which could not be given me. Specialists in this group at Washington, D. C., identified specimens mailed them as evidently *C. negundis* Gill., *C. aceris* Shimer, and *C. robiniæ* Hald., respectively. From *C. aceris* we reared two parasites, *Tetrastichus* sp. and *Meraporus* sp.; from *C. robiniæ* we reared a pteromaline, which Doctor Ashmead pronounces an apparently undescribed genus.

A species of Lecanium has occurred for several years on the conifers in the experiment station forest, and this year has been particularly troublesome on Scotch and jack pines. It evidently can be controlled by spraying with kero-water or kerosene emulsion. After one or two insecticide applications we found a coccinellid (*Hyperaspis* sp.) in such large numbers, both larvæ and imagoes, that we deemed it wise to leave the question of the "survival of the fittest" to it and the scale upon which it fed.

INSECTS OF THE YEAR IN COLORADO.

By C. P. Gillette, *Fort Collins, Colo.*

ORCHARD ENEMIES.

THE CODLING MOTH.

(*Carpocapsa pomonella* Linn.)

Our experiments and studies with this insect for the past two years have been chiefly for the purpose of determining the comparative values of early and late spraying, the number of times that it is advisable to spray, and the best poison to use. Besides conducting experiments in orchards near Fort Collins, the writer has visited many orchards in the different apple-growing sections of the State and has made counts of many thousands of apples in orchards sprayed in different ways to determine percentages of wormy fruit. I have found no reason to change the advice already given out to the orchardists of the State, namely, to spray first as soon as the petals are fairly well off, to repeat the spray in one week, and then make a third spraying about the 4th of July. If the first and second sprayings are thorough the third will hardly be needed. The first spraying, if thoroughly done at the right time, seems to be worth more than all the applications that are made afterward.

An examination of the fruit in October in many orchards that were sprayed two or three times, as above directed, indicated that less than 5 per cent of the fruit in such orchards was wormy at that date. Unsprayed orchards near by would have from 50 to 95 per cent wormy.

Arsenate of lead has been used quite extensively in Colorado the past season and with splendid results. Almost without exception, those who used this poison the past summer say they will continue to use it even if it is more expensive. Many orchardists have told me that they no longer fear any serious losses from the codling moth.

PLANT-LICE.

There are a few plant-lice that are serious orchard pests in Colorado every year. The woolly apple aphis (*Schizoneura lanigera* Hausm.) is one of these. At the present time almost as much complaint is made of it as of the codling moth. Treatment by orchardists seems seldom to be satisfactory. Many who use tobacco about the roots of the trees think they do not get good results. I should like very much to hear of the experiences of the members of this society in fighting this insect both on the roots and the branches of the trees. What have you found to be the best treatment?

The black cherry aphis (*Myzus cerasi* Fab.) and the green plum aphis (*Aphis prunifolia* Fitch) are much complained of nearly every year; and the same is true of the green apple aphis (*Aphis pomi* De G.), which is sometimes so abundant as to kill young trees. Mr. H. E. Mathews, horticultural inspector for Delta County, considers these lice as the most serious pests to fruit in his section, and Mr. Thurston White, horticultural inspector for Fremont County, says the black peach aphis (*Aphis persicæ-niger* Sm.) is one of the most serious insect enemies he has to deal with.

Gooseberries and currants suffered quite severely in the northern portion of the State the past summer from the attacks of the gooseberry fruit-fly (*Epochra canadensis* Loew) and from a fruit-worm closely allied to *Zophodia grossulariæ* Riley, but apparently different from that species.

Aulacaspis rosæ Bouché was taken for the first time in Colorado last October upon blackberry canes, where it seems to have been fairly common.

The cherry scale (*Aspidiotus forbesi* Johns.) was reported to me by Professor Cockerell, who took examples near Colorado Springs. I believe this scale has not been taken before in Colorado.

The San Jose scale (*Aspidiotus perniciosus* Comst.) is still unknown in the State. The scale that gives most promise of being a serious orchard pest is *Aspidiotus howardi* Ckll. It is partial to pears and plums and attacks the fruit badly, but does not produce the red discoloration that is so characteristic of *perniciosus*.

SHADE-TREE PESTS.

The cottony maple-scale (*Pulvinaria innumerabilis* Rathv.) is probably our worst shade-tree pest and is about equally bad each year, but Mr. S. Arthur Johnson has a paper upon this insect, and I will not say more about it.

The so-called oak borer (*Prionoxystus robiniæ* Peck) is a serious enemy to our poplar and cottonwood trees and is especially destructive to Balm of Gilead. A phytoptus mite (*Eriophyes populi* Nal.[a]) greatly disfigures our poplars and cottonwoods by the production of irregular knot-like swelling upon twigs and smaller limbs, particularly about the buds.

ENEMIES TO GARDEN VEGETABLES.

A radish maggot that I have taken to be *Anthomyia radicum*, but which does not seem to the writer to answer very well to Doctor Riley's description of this species, has been troublesome in radishes in Colorado for a few years past and seems to be on the increase. There were at least two broods of the flies at Fort Collins the past

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[a] Determined by Mr. Nathan Banks, through the courtesy of Dr. L. O. Howard.

summer. The maggots commonly enter at the center of the crown of the radish and, after burrowing about until full-fed, make their exits at the side. The accompanying illustrations (figs. 4 and 5), by Miss Miriam Palmer, show the injuries of the maggot to a radish in cross and vertical sections.

The destructive pea aphis (*Nectarophora pisi* Kalt.) was sent me last fall by Mr. J. H. Empson, of the Empson Packing Company, Longmont, Colo. The lice were noticed in a few fields only, and they seemed to be entirely destroyed by their enemies before the season closed. It is my first record of this insect in Colorado. We shall doubtless hear more from it later.

FIG. 4.—Section of radish, showing injury from maggot of *Anthomyia* sp. (original).

The melon aphis (*Aphis gossypii Glover*) is troublesome every year in the melon-growing districts, especially about Rockyford. The growers are fighting the louse by covering the vines with dirt as soon as they find lice upon them.

ENEMIES TO FARM CROPS.

The sugar-beet webworm (*Loxostege sticticalis Linn.*) has been a very abundant moth at electric lights in northern Colorado for years, but this year was the first that it has done extensive injury to sugar beets. It did some injury in a few limited localities in 1903, but not enough to occasion much alarm. This year a midsummer brood, the first week in July, did considerable injury to beets about Rockyford, and a later brood was more destructive about Rockyford, Sugar City, and Lamar from the 10th to the 20th of September. The first brood did no perceptible harm in northern Colorado, but the September brood caused thousands of dollars of loss in beet fields about Fort Collins, Greeley, and Sterling. Hundreds of acres of beets during September had all their leaves eaten away except the midribs and a little cluster of new leaves at the center. Wherever the injuries became severe the larvæ matured rapidly. A farmer might think his beets all right on Monday, and by Wednesday be convinced that the worms would take the entire crop. Poisons were used to good effect upon the beets, but the great-

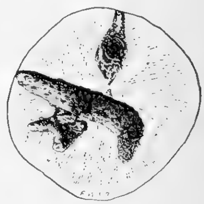

FIG. 5.—Cross-section of radish, showing injury from *Anthomyia* sp. (original).

est benefit was derived from great flocks of blackbirds that congregated in nearly every infested field and ate the worms. The worms that survived burrowed into the dirt and spun silken tubes about 2 inches in length, in which they are spending the winter in the larval condition.

Grasshoppers are always abundant enough in Colorado, but the past summer much of the State has been comparatively free from the introduced species (*Melanoplus bivittatus* Say, *M. differentialis* Thos., and *M. femur-rubrum* DeG.), which are the cause of heaviest losses to farm crops. A native species, *Anabrus simplex* Hald, commonly called "Mormon cricket" or "Idaho cricket," occurred in unprecedented numbers in portions of Routt County. Many of the ranchmen became alarmed and inquiries were sent in to the experiment station to know what could be done. In past years the "crickets" have remained almost entirely upon the native ranges, where they did no damage to cultivated crops. For a series of years the cricket armies have been increasing in numbers and have marched steadily eastward until this year, when they entered cultivated regions along the mountain streams and destroyed crops of grain, potatoes, and hay, as well as everything planted in gardens. The infested region, which is over 80 miles from the nearest railroad, was visited by both Mr. S. A. Johnson and the writer, and much information was gathered in regard to the habits and past history of this interesting migratory grasshopper. The results of our investigations will appear later in an experiment station bulletin.

The potato flea-beetle (*Epitrix cucumeris* Harr.) was unusually abundant in the potato fields of the Greeley district the past summer, where it caused many thousand dollars' worth of loss to potato growers. A prominent potato dealer estimated the loss at fully a half million dollars. The beetles were abundant upon the tops, but did their chief harm by boring into the tubers. From larvæ taken in the tubers in September, pupæ and adults were obtained. Press Bulletin 23 of the Colorado Experiment Station, treating of this insect, was prepared by Mr. S. A. Johnson. I am calling this insect the potato flea-beetle because it is always found congregating upon potatoes and tomatoes, and seldom occurs upon cucumbers or other cucurbitaceous plants, so far as my experience goes.

A beet leaf-miner, probably *Pegomya vicina* Lint., has been abundant enough to attract considerable attention the past summer, particularly in the northern sugar-beet fields of the State. The maggots were noticed in the leaves of young beets the first of June, and they were very abundant in all stages during the last half of August. The white eggs are deposited singly or in groups of two, three, or four upon the under side of the leaves.

DISTRIBUTION AND MIGRATIONS OF THE MORMON CRICKET (ANABRUS SIMPLEX Hald.) IN COLORADO.

By S. Arthur Johnson, *Fort Collins, Colo.*

During the past summer there was a serious outbreak of the Mormon cricket in Colorado. The writer spent about two weeks in the infested part of the State, where he collected many data and made observations on the life history of this insect. It has been thought best, in this account, to give, in the first place, a brief summary of the facts obtained in each locality; second, to attempt to trace the great waves of migration; and, third, to give a summary of this information.

Axiel, a town in Routt County, Colo., just north and east of the Danforth Hills, was the nearest point we reached to what appears to be the established home of *Anabrus simplex*. A lady living on a ranch 7 or 8 miles east of Axiel says that it is necessary to fight the insects almost every year. The armies come in from the west and travel east and up canyons. The migrations appear to begin soon after the eggs have hatched and continue until egg laying begins again, when the insects locate on the dry hills and devote their energies to providing for their offspring. The pest is kept off the crops here by herding or driving and making noises.

At Hamilton, a town perhaps 20 miles east of Axiel, on the Williams Fork of Bear River, the migrations are less frequent, and we were able to obtain definite data regarding them. The first observation was made by Mr. T. H. Hamilton and occurred in 1879. Nothing more was seen of the insects until 1895, when a second migration is recorded. Again, in 1900 and 1902, hordes of the insects passed through. In these visits they took all kinds of garden and field crops. Climbing the trees, they collected on the limbs until these bowed with the weight of insect life. The migration from here in each case was northeast. A glance at the map (fig. 6) will show that the direction of their travel took them immediately into the Williams River Mountains. To accomplish this they were obliged to cross the Williams Fork, which flows with considerable speed at this place. Immense numbers were drowned in the attempt and floated down the stream. In one case they came in contact with an obstruction and formed a temporary dam to the water. According to the observations of Mr. Hamilton, the insects traveled about 30 miles in two years. In each case when a brood has passed through, eggs have been laid in this locality. They hatch early in the spring as soon as the snows melt (March or early April). The young are not injured by the rigors of the season. Frequently they are frozen stiff during the night and thaw out next day to renew operations. Sometimes they are buried in the snow and remain buried without apparent inconvenience until that is melted.

Hayden is situated on the Bear River north of the Williams River Mountains. Two visitations are recorded at this place. A brood came through in 1882, at which time there were but few settlers in the valley. These protected their crops in part by herding. The second invasion was during the present year, and proved to be much more severe than the first. It evidently came from the Williams River Mountains and appeared at the town about the 1st of June. The insects traveled east and stopped at nothing in their course. In the town they climbed over the board fences and houses with the greatest ease. They entered open doors and made themselves at home by the family fireside. On reaching a ditch they leaped in and many were drowned. The dead and the living which did not succeed in reaching the opposite bank floated on the water, and, lodging against a dam, formed a pile a foot deep, 30 feet long, and 4 feet wide. The brood proceeded on its way until it came to the Bear River, where it was deflected to the north, and, following the course of the river, came about and visited the people of Hayden again a few weeks later. After this they retired to the dry hills 3 or 4 miles south of town, where they were to be found at the time of our visit in the latter part of July laying eggs. A diligent search for eggs failed to disclose them in any considerable numbers.

The most remarkable record was made at Lay, a town nearly west of Hayden and 7 miles north of the Bear River. A brood passed through here in 1895. It came from the southwest and went to the north. It was not a very large one and was never heard from afterward. This is the only verified instance of the insect having crossed Bear River. The swarm, before it reached the river, must have been enormous, for even the great numbers at Hayden this year failed to effect a passage.

A glance at the map (fig. 6) will show that the number of migrations recorded and the directions traveled support the testimony given by different individuals that *Anabrus simplex* is permanently located in the Danforth Hills. From this center migrations of insects occur nearly every year. The number of individuals in each band varies greatly and determines, in a large measure, the distance from the home ground that it will ultimately travel before becoming extinct.

The paths of three great migrations are fairly well made out.

A band passed through Hamilton in 1879 and proceeded to the Williams River Mountains, where they became established. Three years later they appeared at Hayden, as before stated, having occupied this time in traversing a distance of about 30 miles.

The second migration is indicated by two records only—one at Hamilton, in 1895, and the other the brood which crossed the Bear River and was observed at Lay the same year. Judging from the locations where these records were made and the unusual circumstances already mentioned, the direction of travel of this brood was more northerly than its predecessor. The records were both made in the same year, and the fate of the brood is uncertain, except that it may have become established in the Williams River Mountains. It was reported to us last summer that the insects have been there for

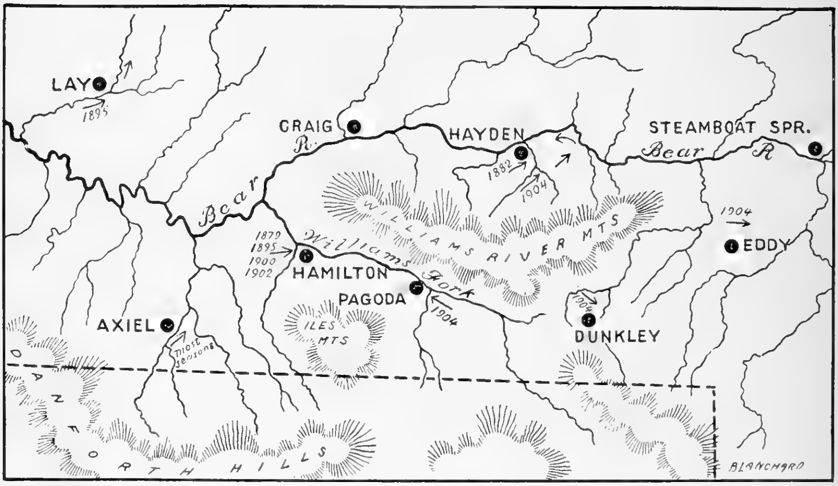

FIG. 6.—Map showing territory infested by *Anabrus simplex* in Colorado (original).

the past ten years, which would agree within one year with the advent of this brood.

In the third great wave we may include the two broods which passed through Hamilton in 1900 and 1902, respectively. They both passed into the Williams River Mountains and were not observed again, so far as we discovered, until the unprecedented migration of the past summer.

Some points with regard to this migration must remain in doubt. Whether it was the result of the accumulation of the three broods which passed through Hamilton in 1895, 1900, and 1902, respectively, or two, or only one of these, is uncertain. It would seem as though the last two, at least, must be contributing factors. In any case the individuals of these previous broods succeeded in giving rise to countless numbers this summer.

All of this year's migrants had their home in the Williams River

Mountains. There were at least three great divisions of the migrants. One band went northeast through Hayden, as already recorded. A second took an easterly direction and proceeded as far as Eddy and Dunkley, a branch going northeasterly to within 5 miles of Steamboat Springs. A third division reached the Williams Fork and followed its course in a westerly direction as far as Pagoda, at which place they were within 12 miles of the point where the former broods crossed the river at Hamilton.

At Pagoda the number of insects was enormous. They were piled several inches deep in the road. The cliffs a mile away were seen, with the aid of the telescope, to be black with them. They fell into the ditches until these were almost choked with the dead. Those that crossed entered the oats and alfalfa. The former they ate to the ground and stripped the latter of leaves and tender shoots, leaving nothing but the bare stems standing for a distance of 30 or 40 feet from the margin. The coming of the insects was announced by telephone from 5 miles up the creek one week before they reached this place, which was about the Fourth of July. It took the brood two weeks to pass a given point.

At the time of our visit, August 9, the insects had retired to the hills, where they were found in great numbers in the act of egg-laying.

CONCLUSIONS.

To recapitulate, the insects are permanently located in the Danforth Hills. From this place immense swarms migrate in different directions at times. The immigration is probably caused by overproduction of the species. The ultimate destination of the swarm is determined in no small measure by the number composing it. If a swarm succeeds in attaining a favorable locality, a brood may be produced which will cause another migration. The Williams River Mountains have more than once served as a temporary breeding ground. Each wave is followed by the enemies of the insect. These, combined with otherwise unfavorable conditions of the new country, would lead to its ultimate destruction.

The insect has been here as far back as our knowledge goes, which is not very far, however. The ranchmen live far apart and the country is altogether new. The advent of civilization has probably had little influence on the destiny of the insect because the percentage of land under cultivation is very small and the localities where there are cultivated fields are only raided during the migratory stage of the insect's life. Its normal home is not in the river bottoms, but on the dry hills. The only change that civilization has caused there is the substitution of the stock of the ranchman for the droves of elk and deer, and the herds of buffalo. This change has not, perhaps, greatly affected the insect's food supply.

Migrations will occur in the future as they have in the past, but we do not anticipate that the insects will become more numerous, and there appears to be little danger that they will become an unbearable pest in the near future.

The migration of last summer was, perhaps, chiefly due to the unusual climatic conditions of the preceding winter.

MISCELLANEOUS NOTES FROM TEXAS.

By A. F. Conradi, *College Station, Tex.*

With the present interest aroused in entomological work in Texas many varied problems confront the entomologist. No attempt will be made here to review the work for the year, as it will be elaborately discussed elsewhere in a short time.

Under date of November 20, *Epicauta pennsylvanica* DeG. was reported to injure onions in southern Texas by eating off the tops near the ground. The injuries this season were not serious, on account of the small numbers of the insect, but they give ground for apprehension in case the pest be numerous another year.

Oncideres cingulata Say has attracted considerable attention, especially during November. Its work is well known, although its life history has not been worked out in Texas. Near Independence it attacked pear and rose, doing serious damage. Experiments with trap lights were made here with apparently good results, for many beetles were thus captured. In this locality it injured apple, peach, and persimmon. Near Manor it injured rosebushes, salt cedar, hackberry, elm, pecan, and cotton. Near Bellville the pear was the chief object of attack. Picking the fallen limbs was a remedy used this season.

The San Jose scale (*Aspidiotus perniciosus* Comst.) is at present definitely known in eight different localities in Texas, representing almost every section of the well-settled portions of the State. With the rapid growth of the State in fruit growing and with no inspection laws, it will be but a short time before this will become one of the most important of its many insect problems.

The sweet-potato weevil (*Cylas formicarius* Fab.) is seriously threatening the sweet-potato industry in several localities. It was first reported in Texas in October, 1890, by T. H. Edwards, Bay View, Harris County. The same year the sweet-potato crops around Buras, La., were reported a failure, owing to this insect. At this writing, it is known in this State from Bee Caves, Hankamer, Pasadena, Cedar

Valley, Bay City, Port Lavaca, Austin, and Hamshire, and it probably occurs at Marlin. No doubt other localities which have not yet come to our notice are infested.

The females lay their eggs on the lower part of the stalk in cavities previously made while feeding. They also oviposit on the tubers in the same manner, in shallow-planted potatoes or where the tubers are easily accessible. The number of eggs that one weevil is capable of laying could not be ascertained the past season, but in the insectary the number was very small, which accounted for the slow increase of the pest. The first mating at College Station was May 2. On May 6 mating pairs were common, but the first eggs were found May 20. The average time to the hatching of these eggs was twelve days. The life cycle from mating to adult is forty-nine days, allowing fourteen days from time of mating to egg-laying, twelve days for eggs to hatch, sixteen days for larvæ to develop, and seven days for the pupæ. The time from emergence to mating varies from a few minutes to several days. Experiments made in breeding the insects on potatoes that had not yet the tubers formed were successful. The young larvæ first bored down in the stem, then upward, in most cases the pupæ being found several inches above the ground in the center of the stalk. On May 20 the first eggs were found in the insectary. On December 7 of the preceding year specimens of tubers sent in from Port Lavaca had all larvæ half grown. As the season of activity is longer at Port Lavaca than at College Station, four to five generations would have ample time to develop. Fumigation in the bin with carbon bisulphid has been thus far the main reliance. At College Station the adults fed voraciously on all parts of the growing plants, giving the plant an appearance something like that given to the tomato by the flea-beetle. These adults were all killed with Paris green and arsenate of lead sprays, the latter insecticide requiring a longer time than the former. Tubers in which all stages of the insect were present in a healthy condition were received at College Station at different times of the year. Infested sweet potatoes can be shipped long distances, and this is an easy way of disseminating the pest. The old practice of allowing the vines and small tubers to remain in the field is unfortunately still in vogue in many localities. Some growers follow the advice given and destroy the remains of the crops after harvesting. They feed the small tubers to cattle, holding that hogs refuse to eat them.

Although the adult insects have wings, their chief mode of migration is on foot. This accounts for the relief obtained by planting carefully selected seed remote from the infested territory. It is important that good seed be thoroughly covered with earth when planted, some successful growers contending that the weevils are more injurious to shallow-planted potatoes on cloddy land than to deep-planted potatoes on sandy land. A note under date of August 1 gives one infested hill among twenty-five, the infested tubers being an early variety and projecting from the seed bed.

During the winter careful observations were made on the mosquitoes infesting College Station and vicinity, especially from a sanitary standpoint. These investigations were stimulated two years ago when yellow fever appeared at San Antonio and seemed to be spreading northward. The country about College Station is low and level, the soil of a loamy nature, underlaid at from 6 to 10 inches with a tough hard clay. The streams are so rapid that they will hold water but a short time after a rain. It is, therefore, the common practice to put dams across the gullies and collect the water during a rainfall. Such tanks will rarely dry out during the summer. It was found that no mosquitoes bred in such waters on account of the number of minnows present in all cases. The main breeding place near the college was at the mouth of the sewer where it empties into the brook. Here mosquito larvæ were so numerous that they formed a solid scum on the water. On account of the annoyance due to mosquitoes during the early spring months, making life on the campus almost unbearable, relief was sought by treating the cisterns and the sewer. Some relief followed, but it was discovered that the mosquito supply came from another source. Each negro hut scattered over the country has a rain barrel or a water tub at one or two corners, and here the mosquitoes bred undisturbed through the greater part of the season, the prevailing south wind carrying them for over a mile.

The only mosquitoes at College Station are species of Culex, no Stegomyia having been found. A few specimens of Anopheles, blown in by a mild east wind from a pond in the valley of Carter Creek, were taken during July. This is the only breeding ground of Anopheles close to College Station, but the supply is blown northward by the prevailing winds. Although mosquitoes breed there all winter and maintain a high percentage of malaria cases in the neighborhood during the summer, they do not affect the college, since nearly all winds from that direction are "northers," which rarely carry mosquitoes. The only other breeding place of Anopheles of any importance is 17 miles southwest across the Brazos River. Although the mosquitoes keep malaria alive in that locality they do not affect the college. The few cases of malaria that appeared at College Station originated in other localities, and such cases were not a menace to the community, as there was no agency for carrying the disease.

INSECTS OF THE YEAR 1904 IN GEORGIA.

By WILMON NEWELL and R. I. SMITH, *Atlanta, Ga.*

Continued experiments with the San Jose scale have demonstrated that a lime-sulphur wash of 21 pounds of lime and 18 pounds of sulphur in 50 gallons of water is fully as effectual as washes containing larger amounts of lime and sulphur, and also that the addition of salt to this wash is unnecessary, so far as the scale is concerned. By first mixing the sulphur with boiling water and then adding the unslaked lime the boiling can be completed in from thirty to fifty minutes in an iron kettle over a fire and in from twenty to thirty minutes where a full head of steam is available for boiling. Washes prepared in this way have given fully as good results as the stronger washes, boiled for a much longer time, which were formerly recommended. The lime-sulphur-caustic-soda wash has also given good results when properly prepared. For successful preparation of this wash we have found that it is necessary to first mix the sulphur with boiling-hot water and then to add slowly the caustic soda until all the sulphur is dissolved and a perfectly clear liquid obtained. By adding the stone lime to this clear liquid and allowing it to slake, a preparation is secured which is in no way distinguishable from the regular lime-sulphur wash. The effects of this wash upon the scale have not thus far been quite as satisfactory as those of the regular boiled wash. Experiments with caustic soda solution alone, which substance was highly indorsed by many agricultural papers during last winter, have demonstrated its utter worthlessness as a remedy for this pest.

The Asiatic ladybird (*Chilocorus similis* Rossi), which in 1903 gave promise of becoming abundant, has proved something of a disappointment. In the majority of the orchards where this species was colonized but few individuals could be found during the past season. In the case of an orchard at Marshallville, where literally thousands of the beetles occurred in the summer and fall of 1903, no specimens were found during 1904. In a near-by plum orchard, however, a few individuals survived the winter, and during early summer and midsummer they fed readily upon *Pulvinaria amygdali* Ckll., which species was fairly abundant in the orchard in question. Their beneficial work in keeping the latter species in check is much more marked than in the case of the San Jose scale, owing to the slower rate of breeding of the Pulvinaria.

The plum curculio (*Conotrachelus nenuphar* Hbst.) has proven very injurious in the peach orchards in southern and middle Georgia, in some cases from 15 to 20 per cent of the crop being rendered unmarketable.

Among the unusual insects attacking the peach during the year may be mentioned *Colaspis favosa* Say, which defoliated peach trees in one locality in northern Georgia. *Hippodamia convergens* Guér. and *Diabrotica 12-punctata* Fab. have both been noticed eating the petals of peach blossoms and also eating into the base of the blooms. Apparently nothing but the relative scarcity of individuals prevented serious damage by these two species. *Ithycerus noveboracensis* Forst. did considerable injury by girdling apple twigs in Gilmer, one of the mountain counties.

Throughout the apple-growing section of northern Georgia, embracing practically all of the State north of the thirty-fourth parallel, *Carpocapsa pomonella* Linn. is universally distributed. The prevalence of this insect is doubtless largely responsible for the lack of interest taken in commercial apple culture, and but few growers have taken the pains to systematically combat it.

Balaninus caryæ Horn. did serious damage to pecan nuts near Thomasville during 1903. While also doing considerable damage during 1904, this species did not appear to be nearly so abundant as in the year previous.

In a number of localities in extreme southern Georgia *Hyphantria textor* Harr. occurred in considerable numbers upon pecan trees. From the summer generation of larvæ adult moths were reared August 31. *Sinoxylon basilare* Say has been found working in the trunks of young pecan trees in southern Georgia; and at Vinings, in northern Georgia, *Chrysochus auratus* Fab. did much damage in a small pecan grove by defoliating the trees.

During the latter part of the summer *Alabama argillacea* Hbn. was generally distributed and abundant over that part of the State south of the thirty-second parallel, and destroyed practically all of the "top crop" of cotton. Upon late cotton the damage from this insect was very pronounced. The Paris green and lime mixture wherever applied effectually checked the pest.

Heliothis obsoleta Fab., while generally distributed, was not as destructive as in 1903. An unusually large amount of injury was done by this species very early in the season, the cotton squares in many fields being liberally punctured during June. Only three or four counties suffered excessively from this insect later in the season.

Chalcodermus æneus Boh. was quite destructive to young cotton plants in Randolph and Terrell counties during May. This beetle makes numerous punctures in the tender buds and leaf-stems before the cotton is large enough to commence squaring, these punctures causing the leaves, and frequently the entire plant, to wilt and die. Upon some small areas fully 50 per cent of the cotton plants were killed and an average damage of 25 per cent occurred in a few fields. The first appearance of the beetle in early spring is, so far as has been observed; always upon land which had been in cowpeas the year previous. A rotation in which cotton does not follow cowpeas effectually disposes of the trouble, but such a rotation is not always practicable. In the laboratory the beetles show a marked preference for cowpeas, when both the latter and young cotton plants are growing side by side. Trap rows of cowpeas, planted between cotton rows when the cotton is planted, would probably serve to direct the attacks away from the cotton almost entirely. However, as many more cotton plants come up than are ultimately utilized, the simplest and cheapest remedy appears to be the delay of the first "chopping" as long as possible, or until the extent of the damage can be approximately forecasted. The first chopping can also be made light, so as to leave plenty of plants, and the damage by the insects will then amount to hardly more than a severe thinning. When the time for the second chopping arrives the period of maximum injury will have passed and a good stand can be secured. Owing to the relative abundance of this species in the localities mentioned, it was mistaken by many for the boll weevil and caused much temporary alarm.

Carpophilus dimidiatus Fab. has several times been found breeding abundantly in cotton bolls which have been destroyed by the cotton anthracnose. *Systena blanda* Mels. developed an unusual appetite for young cotton plants, and during May did severe damage to cotton near Jackson, Ga.

A somewhat detailed inquiry among the wheat growers of the State has revealed that in previous years the damage by *Mayetiola* (*Cecidomyia*) *destructor* Say has been considerable. In the case of Bartow County alone, which normally produces more wheat than any other county of the State, the damage by this insect in 1903 was estimated by many prominent planters as considerably in excess of 20 per cent of the crop. This was equivalent to a money loss of practically $19,000 in that county annually. Examinations in Bartow County revealed the eggs of the spring brood in abundance on April 1. Observations were made from time to time during the summer, and it can now be stated with certainty that in this the southernmost part of its range in the United States the Hessian fly is not more than two-brooded. Plans were made for extensive experiments in sowing wheat in different localities and at different altitudes during the past autumn in order to determine with certainty the dates of egg deposition. Owing to an exceptional and prolonged drought during August, September, and October, early-sown wheat remained in the ground without germinating until about November 5, and did not appear above ground until after the periods for the appearance of the adult flies had passed. The only puparia that can be found at present are in volunteer wheat, and the indications are that during 1905 the attacks of the insect will be much less than formerly. The advisability of further decreasing the numbers of the insect, under these peculiar conditions, by destroying as much of the volunteer wheat as possible, is self-evident. In the laboratory flies emerged between October 18 and 30 from infested stubble collected at Halls, Ga. (approximately 34° 20′ north latitude; elevation 790 feet). In a season of normal rainfall we anticipate that the date of emergence will be several days earlier.

Diatræa saccharalis Fab., after having remained in the background for several years, came prominently to the front near Hawkinsville during early summer, and did considerable damage to corn over a small area. *Ligyrus rugiceps* Lec. appeared as a destructive enemy to corn near Canton, in the northern part of the State.

Cryptocephalus obsoletus Germ., known locally as the "Lincoln bug," has become a rather serious pest to collards in middle Georgia.

Among the interesting cases in which a species rapidly disappears or becomes greatly depleted in numbers we may record the case of *Toumeyella turgida* Ckll., which in 1900 was so abundant upon *Magnolia glauca* and *fuscata* at Thomasville as to thoroughly incrust these trees and kill a considerable number of them. During 1903 and 1904 it has been practically impossible to find even isolated individuals of this scale in that locality. So far as known to the writers no systematic treatment toward eradicating the pest has been undertaken and parasitic insects were not noted in greater numbers than are usually found upon other scale insects.

During July Dr. John B. Smith, who was paying an entomological visit to Georgia, found the larvæ of *Ephestia kuehniella* Zell. feeding in cotton-seed meal.

Dynastes tityus Linn. caused considerable annoyance at Washington, Ga., by its abundance upon ash trees.

During late summer and autumn the larvæ of *Anisota senatoria* S. & A. occurred very generally upon oak throughout the northern part of the State. While the damage, both in cities and in the native forests, was not excessive, still a great many trees were partially or totally defoliated.

Observations made upon the life history of *Melittia satyriniformis* Hübn. show the supposition made by Professor Quaintance in 1899, that this insect is double-brooded in Georgia,[a] to be correct. In central Georgia the second brood of adults emerged between July 1 and 15, 1904, with a few belated individuals coming out after the latter date. Individuals may be found in the pupal stage during a period of from three to four weeks.

Omorgus (*Campoplex*) *frumentarius* Rond. has been reared from

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[a] Ga. Exp. Sta. Bul. No. 45.

the larvæ of *Ephestia kuehniella* Zell., and *Phanerotoma tibialis* Hald. from pecan nuts badly infested with *Balaninus caryæ* Horn.

To Dr. L. O. Howard and his assistants the writers are indebted for the determination of a considerable number of the species above mentioned.

Mr. Slingerland called attention to the fact that prepared arsenate of lead in wooden buckets dried and caked badly. He thought it was much better to purchase in tin.

Various speakers complained of its eating through the tin and consequently they preferred the wood, but the members were evidently divided as to which was better.

Mr. Quaintance asked what the effect of arsenate of lead was on peach and plum.

Mr. Smith said that it could be used two or three times on peach at the rate of 1 pound to 25 gallons without apparent injury.

Mr. Slingerland questioned the advisability of the home-made arsenate of lead, because the materials were often adulterated. Messrs. Burgess and Sanderson both believed that the arsenate of soda was often adulterated and unreliable in strength. Mr. Fernald preferred to make his own, but felt it necessary to be very particular from what source the arsenate of soda was obtained.

The question of the advisability of using trade names in publication was brought up, and a lively discussion, participated in by almost all of the members, indicated that the general feeling was that the exact truth should be told about materials sold under trade names, referring to them by these names in the publications. In some cases, however, this was impossible on account of the official censorship. Some members, however, believed that trade names should not be used in publication.

The question arose as to whether it was desirable to publish the names of people on whose property experiments are made or whose premises are infested with certain insects. Mr. Gillette believed that this should rest in each case with the party concerned. If the owner of the property wished his name mentioned, this should be done, but otherwise not. Mr. Burgess agreed with this view. In Ohio there had been a prejudice against firms who fumigated their trees. A photograph of a fumigating house of one nurseryman was secured, but the owner was consulted as to whether he desired to have his name mentioned before any steps were taken concerning its publication.

Mr. Slingerland asked if entomologists should be expected to test all the nostrums that are put on the market.

Mr. Gillette felt it a duty to test an insecticide whenever he believed that it was liable to do injury to the people of his own State.

Mr. Burgess called attention to the fact that we often knew, before testing, that a remedy would be a failure, and yet, in order to satisfy the people and have them follow our recommendations, it was necessary to make an actual test. For instance, there had been introduced a panacea for pear blight and peach yellows, which was to be used by washing the outside of the trees. Although, of course, this could not possibly be efficient, it was necessary actually to test it.

Mr. Fernald believed that the testing of proprietary insecticides was a matter for cooperation. Each station can not analyze all of them, yet the people of the country have a right to know of the existence of good preparations. He believed that in each of the main divisions of the country one station might assume this testing for a certain period, others taking it up afterwards in rotation. Mr. Phillips felt that this should be done. In Virginia it appeared to be necessary to give this information to the people to protect them from fraud, but it was impossible to test everything. Mr. Quaintance called attention to the fact that the Association of Official Agricultural Chemists has such a system of cooperative tests. Mr. Slingerland believed that even after these tests were made many people would not believe in them. They want to find out by their own experience what the truth is. Mr. Surface dissented from this view to some extent, believing that part of the people at least do accept our reports. Mr. Smith said that he received many advertisements of curculio remedies accompanied by the question, "Do you know anything of this?"

Mr. Fernald moved that a committee of three be appointed to consider the question of cooperation in the testing of insecticides and proprietary preparations, to report at the next annual meeting. The motion was carried, and the chair appointed as such committee Messrs. H. T. Fernald, H. A. Surface, and A. T. Burgess.

The following paper was read:

THE PRESENT STATUS OF THE PREDATORY INSECTS INTRODUCED INTO NEW JERSEY.

By John B. Smith, *New Brunswick, N. J.*

Ever since the introduction of the San Jose or pernicious scale into New Jersey, the question of securing the assistance of predatory insects to exterminate or at least control it has been more or less continuously before the farmers and fruit growers, and of necessity before the entomologist as well. The subject is an old one. It has been before various meetings of farmers, fruit growers, and entomologists, and it has been discussed from all sides. That a measure of success, large or small, has been attained in a number of cases is without doubt. The classic case is of course the effect produced by *Novius* (*Vedalia*) *cardinalis* Muls. against the cottony cushion scale (*Icerya purchasi* Mask.) in California. I have followed in a very general way the records of the successes attained in foreign countries, including under that term, for convenience, Hawaii. There is no doubt that not only a measure of success has been obtained in many instances, but that the measure has been in a few cases a very satisfactory one, amounting in the California instance just cited to the almost complete extermination of the pestiferous insect.

At first blush there seems to be no reason why what has been done in one section of the country can not be equally well done in another; and why, if it has been shown that on the Pacific coast a species of coccinellid is found keeping a scale insect in check, that same species should not do precisely the same work in the State of New Jersey.

With this idea, I made my first visit to California and the Pacific coast in 1896; in the first place to determine whether, as against the San Jose scale, the coccinellids were really effective, and, second, whether it would be possible to acclimate these insects in New Jersey. A few years ago I would have said that what can be done in California can also be done in New Jersey, and that the results of experiments obtained in New Jersey were equally valid in California. The experience of the past few years has modified my opinion on this subject very materially. I am extremely reluctant nowadays to even advise a New York or a Pennsylvania fruit grower to make applications based upon what I have found to be effective in New Jersey. In fact, I have discovered that I can not always duplicate results two years in succession; that when I find an application almost completely effective one summer, I am as likely to find it, under apparently similar conditions, absolutely ineffective the year following. Perhaps it does not often occur that such extreme contradictions are noted; but I think every working economic entomologist has seen cases at least similar to the one just suggested.

I do not encourage too great hopes from importations made from California into New Jersey. You are probably familiar with the report made by me in 1897 as to the results of my investigation; how I found that in the more southern parts of the State the pernicious scale was really kept in check by a coccinellid not the species which had been credited with the work, but by a common native form, *Chilocorus bivulnerus* Muls. I found, too, that the species that was most generally credited with being the check to the scale could scarcely be found at any time, and that instead of *Rhizobius lophantæ* Blaisd., which is an introduced species, *Scymnus marginicollis* Mann. is really the effective form. Nevertheless I succeeded in making arrangements by which I introduced into the State of New Jersey during the season of 1896 a number of colonies both of Rhizobius and Scymnus. In all, several hundred specimens were brought into the State and distributed in the more southern counties, where the climate is mildest and conditions generally more favorable than in the north, and in each instance where there was an abundance of food for them. The colonies were scattered so that anything happening in one section might not affect the entire experiment. The results were absolute failures. Nothing more was seen of either species at any subsequent period.

At the same time I entered into correspondence with Professor Matsumura, of Japan. This resulted in the introduction into New Jersey of a small series of *Chilocorus similis* Rossi, the Asiatic lady beetle of which we have heard so much during the past year or two. Some eighty specimens were contained in the sending and of these nineteen were alive and in apparently good condition. I placed them out myself under favorable circumstances on May 24, in a locality where food was abundant and where conditions might be supposed to be of the best. For a few days afterwards the insects were seen, some of them were noted as feeding, and there is no doubt that they lived for a short period. There is no doubt, either, that they died off, for nothing was seen of them in that same orchard after midsummer, or at any time since. Nothing more was done in this matter until after Mr. Marlatt had succeeded in securing specimens from China and Japan and had actually established them in Washington, D. C.

During the latter part of 1902 I secured, through the courtesy of the Department of Agriculture, sufficient specimens of *Chilocorus similis* to colonize on two infested trees in my own garden, where they were under constant observation. These insects multiplied to some extent during the year, hibernated very fairly, and had only one drawback—they became pretty well parasitized before the season was over. In 1903, while the parasites were very active, I succeeded in getting increase enough to send out 15 colonies, and with what was received from Washington some 400 individuals were distributed in different parts of southern New Jersey. It will be noted that the rate of increase is not especially great. Out of perhaps 30 ladybirds received, only about 360 were actually obtained after a year under the most favorable circumstances.

The winter of 1903–4 was an unusually hard one, not that the temperature was lower than usual, because, as a matter of fact, it did not reach the lowest point of the year before; but the cold was continuous and there were several unusually heavy late frosts. Whether on this account or for some other reason which I have not been able to discover, the colonies in all parts of the State were completely exterminated. I have not seen anywhere even a single example of this species. This report is not based altogether upon statements made by the parties to whom the insects were sent. It is made partly upon the results of my own examination and partly upon those of my assistant, Mr. E. L. Dickerson. Nevertheless I have not given up hopes of securing some better results even yet.

During the summer of 1904 Mr. Wilmon Newell, State entomologist of Georgia, was good enough to give me a week of his time and to guide me through those sections of Georgia where in 1902 this coccinellid had occurred in enormous numbers. As to the status of affairs in Georgia, Mr. Newell is the only one competent to speak; but I may say that after a pretty thorough collecting over the various communities where the beetles had been most abundant I succeeded in getting a sufficient quantity to start a new colony in New Jersey. Mr. Newell was good enough to divide with me in order to give New Jersey an even start with Georgia on the new deal. This time all the specimens that were obtained were placed in one orchard, not far from New Brunswick, and this comes about as near to being an ideal place for insects of this kind as could well be imagined. The orchard consists of apple, peach, pear, and plum trees, several hundred trees in all. Almost every tree is scaly and some trees are dying. Nothing has been done to destroy the scales, and as the estate is in chancery it is very certain that nothing will be done during the current winter. There is plenty of rubbish to serve as hiding places, also plenty of loose bark. Scales occur in abundance, and although *Pentilia misella* Lec. occurs on these trees by the thousands, it has not succeeded in making any impression upon the scales. All the specimens were introduced during the latter part of July. The orchard was visited from time to time and at all times some specimens were seen feeding upon the scales; and in the latter part of the season larvæ and pupæ were found, indicating that the insects had made themselves at home, to some extent at least. A small number that were kept in the laboratory and plentifully supplied with food laid eggs in small numbers. Such larvæ as hatched from these eggs were taken into the orchard to give them normal winter conditions. I can not say that I hope for very much as the result of this last experiment: nevertheless there is a chance that something will be seen of the insects next year, and if they do breed they will have an opportunity to do so under the best possible surroundings.

Some time before 1900 a mantid, *Paratenodera sinensis* Sauss., introduced from China had established itself in the vicinity of Philadelphia and had been doing well, hundreds of egg masses being seen during the winter, while the insects themselves were not at all uncommon during the summer. Mr. Philip Laurent recorded the presence of this insect and figured it in Entomological News.

During the winter of 1900–1901 I secured through Mr. Laurent a small lot of specimens, altogether about 100, which I distributed mostly in southern New Jersey, retaining only a few myself. Adults from these masses were seen during the summer of 1901 at a number of places, and during the following winter I added materially to the supply by further lots of eggs obtained through Mr. Laurent. In addition, Professor Slingerland sent me a number of egg cases of the European species, which had established itself in northern New York, also the result of an accidental importation. There were thus in New Jersey during the early spring of 1902 a large number of eggs of *Paratenodera sinensis* Sauss., some of which had been placed there by insects that might be considered native to the State, since they were born and bred there; and an additional lot of eggs of *Mantis religiosa* Linn., natives of New York State, and which might have been expected to do fairly well in the somewhat milder climate into which they were introduced. Hatching was pretty general from all the egg masses of the Chinese species; but so far as I could make out none of the European egg cases produced young.

During 1902 the adults were seen everywhere that the introduction had been made; but nowhere in any very large numbers. Still they were there, and again, during the early spring of 1903, I added some 350 egg masses, secured from Mr. Laurent, to the previous sendings. The result in 1904 was not in proportion to the work that had been done. Fewer examples were seen in most of the places than ever before. In one locality only was any considerable number of specimens noticed. In one place that had received sendings each year, and which was almost a duplicate of the locality near Philadelphia where they had first established themselves, not a specimen could be found. I sent Mr. Dickerson through one of the places that he had seeded down, and where the location of every egg cluster had been mapped, and, while many of the whole clusters were found, the eggs apparently hatched, the net result seems to have been one new egg mass and nothing else. As the result of introductions continued three years in succession there is no one point where I could go at the present time with any reasonable hope of finding even a single egg mass.

For some reason New Jersey seems to be a veritable paradise for the injurious species that are introduced; but something very much to the contrary for such beneficial insects, or rather predatory forms, as have been introduced to control them. So far as the records go, they offer very little encouragement to those who are inclined to depend upon fighting injurious species with natural enemies.

Mr. Washburn asked whether any coccinellid was found working on Lecanium.

Mr. Smith said no, but that Lecaniums were rare in New Jersey.

Mr. Marlatt said that this work was very interesting to him because of the care with which the experiments had been carried on. His own course had been to try to allay undue enthusiasm regarding the San Jose scale coccinellid. Its introduction was an experiment that seemed at first promising. In many sections the experiment failed, but frequently this was due to the starvation of the coccinellid, because sulphur-lime wash was used at the same time and destroyed most of the scales. Predaceous insects of general feeding habits should be introduced with care. They may destroy beneficial as well as injurious species. Mantis, for instance, seemed to take a special delight in destroying the aphid-eating coccinellid.

The following paper was presented:

REPORT ON THE "NEW ORLEANS" ANT (IRIDOMYRMEX HUMILIS Mayr).

By E. S. G. Titus, *Washington, D. C.*

In July of 1904 the Bureau of Entomology of the Department of Agriculture received a letter from Prof. H. A. Morgan, of Louisiana, inclosing a letter from Mr. E. Baker, superintendent of Audubon Park, New Orleans, La. Mr. Baker's letter gave an account of an ant that occurred in enormous numbers in that city and was causing serious trouble.

Under instructions from the Entomologist, Dr. L. O. Howard, I reached New Orleans from New Iberia, La., October 15, and proceeded to the sugar experiment station in Audubon Park. Mr. R. E. Blouin, vice-director of the station, and Mr. E. Baker gave me such information regarding the presence, distribution, manner of spreading, and ravages of the ant as they had collected during the past few years.

Mr. Baker first noticed the ants in 1896, at which time he moved into Carrollton, near the Southport docks. They then extended over but a small area, reaching approximately from Southport docks to Carrollton avenue and from the river back to Poplar street. At that date the residents in that section had been troubled with them but a short time. I could find no one who could positively remember noticing them before 1895.

In 1899 the ants were first noticed in Audubon Park, and by the next summer had become quite numerous. They are now practically all over the park, the nests more commonly occurring at the bases of trees. On the experiment-station grounds the ants' nests are very common around and beneath buildings, in flower beds and cultivated fields, beneath sidewalks, and even on the lawns. In wet weather, Mr. Baker stated, the ants deserted their ground nests and carried pupæ, larvæ, and eggs into the trees. Here they constructed nests by bringing dirt from the ground. I found several inhabited nests as high as 15 to 20 feet above the ground in the forks of live-oak trees. These nests appeared to be entirely independent of the nests at the foot of the tree.

The ants were noticed aiding in the distribution of the following insects on the grounds of the station and in other parts of the park:

Aphides on fig, citrus trees, sycamore, live-oak, cedar, arbor-vitæ, *Duranta plumieri*, and ornamental plants in greenhouses, and on the grounds.

Ceroplastes floridensis Comst., occurring on fig, persimmon, orange, lemon, and on many plants in the horticultural greenhouses.

FIG. 7.—Persimmon showing protective covering made by *Iridomyrmex humilis* (original).

Pseudococcus citri Risso, occurring on all citrus-fruit trees, fig, persimmon, plum, sycamore, live-oak, willow, and other trees, palms and ornamental shrubbery of almost all kinds, chrysanthemums, dahlias, golden-rod, and various plants in the greenhouses, including ferns, palms, coral-tree, coffee-tree, and a species of Hibiscus.

Scale-lice of several other species are being taken care of by these ants. They occur in such great numbers that they have apparently become care-takers for all kinds of scale and plant-lice present in the regions they infest. Where possible to do so, they build a covering, composed of dead lice, cast skins, dead ant remains, and dirt over the insects for which they are caring. On fruit this is first built near the base of the stem and gradually extended outward as the colony grows. This was especially noticeable on persimmons and oranges. At the stem end, or wherever two specimens of fruit touched, the projecting covering had been extended for a considerable distance.

On twigs of arbor-vitæ the ants were able to build a covering for the plant-lice by extending it outward onto the rough, flat leaves of the plant, and in one instance they had built on both the upper and lower sides of the leaves.

The entrance to these shelters over colonies on fruit was always near the stems, but ants could usually be seen at some place on the outer edge repairing or extending the covering or removing young scales to new territory.

The mealy-bugs infesting citrus trees and other fruits and on the palms appear to be the same species as the one commonly found in the greenhouses in the city—*Pseudococcus citri* Risso.

The mealy-bug affecting the sugar-cane on the sugar experiment station grounds is, so far as I can ascertain, the same species. Careful comparison has been made with mounted specimens of *Pseudococcus calceolariæ* Mask. on sugar-cane from Florida, *P. adonidum* Targ. and *P. citri* Risso.

This sugar-cane mealy-bug has increased very rapidly in the last two years, and this year a large percentage of the cane was affected. The woolly secretions were present in the greatest numbers in the leaf-sheaths, but occurred on the stalks from the base up to from 3 to 6 feet above the ground, and often far out on the leaves, where two or more leaves were touching or rested against a cane stalk. Very few were found in the ground among the roots, but the older specimens could often be seen traveling over the rough dirt from stalk to stalk. The ants were everywhere present among them and were several times seen establishing new colonies on cane.

Ants were found, also, with mealy-bugs on several weeds in the cane fields, on grasses, and rarely on ramie.

I found the ants in boxes of crackers and candies sent directly from New Orleans, and while in that city noticed them being packed up with several kinds of groceries for shipment to outlying towns.

A Louisville and Nashville construction-department cooking car was visited in New Orleans. This car was in daily use and had been for several days located at the point where I saw it. The cook told me the ants worried him nearly to death. "Why, they are so thick that I don't get rid of them till I've been out on the road two or three days."

Their present distribution is probably limited by the distance that wholesale goods are shipped locally from New Orleans. While as yet they do not extend all over the city, it is a matter of only a few years, at the outside, when the entire residence district will be infested.

The ant is now known to occur in the following localities outside of the city of New Orleans: Across the river in Algiers and adjoining small settlements; at West End, Spanish Fort, and Milneburg, summer resorts on Lake Pontchartrain; Bay St. Louis, Miss., a summer resort between New Orleans and Mobile; along the Texas and Pacific Railroad at Donaldsonville, Cheneyville, and Alexandria; along the Southern Pacific at Thibodaux, Schriever, Houma, Berwick, Morgan City, Franklin, New Iberia, and Lafayette; and at Opelousas.

It will be noticed that these points are all, excepting Opelousas and the three first-named summer resorts, on main lines of the railroads leading out of New Orleans. They doubtless occur at many other smaller places along these lines and in localities on other railroads leading into Mississippi, Alabama, and Louisiana. Their distribution to summer resorts occurs through baggage and clothing as well as in supplies sent from New Orleans to these points.

In the lower part of the city one woman told me that the ants appeared in her house late in June, 1904. Her baby was taken sick soon afterwards and they had a great deal of trouble keeping the ants away from him. The ants seemed especially attracted to the child, perhaps from some odor of the sick room, and would cross coal-oil bands on the bed and on chair legs in order to reach the baby. After the child's death they were even more persistent in their efforts to reach him. The coffin was set on a stool the legs of which were placed in dishes of water with a coal-oil film. This would deter the ants for only a short time, when some would get on the oil and, others following, there would soon be a bridge of dead ants.

Several instances were related where ants dropped from the ceiling in order to reach food or other substances they desired. An experiment was tried with some sugar sirups on a table which stood against the wall. The ants came up the wall to reach the table. When it was removed from the wall they came up the legs. Next morning the legs were wrapped with cloths soaked in coal oil and the table removed some distance from the wall. That day the ants were persistent in their efforts to reach the food, constantly climbing up and down the legs, but only a few attempted to cross the oiled bandages and these were not successful. The following morning the table was well covered with ants. They had gone up the wall over the first trail and passed on up to the ceiling, then over that diagonally until they were over the table, when they dropped down onto it. Very few ants were noticed returning from the ceiling, but a constant stream of them was going up. At the point where the table had formerly touched the wall quite a number of ants were clustered, evidently at a loss to know where to go. The ants, in leaving the table, usually went down one of the legs and were crossing the coal-oil bandages with apparently little or no injury to themselves. Some dropped directly from the table top to the floor.

One large colony of ants, on the outskirts of a portion of the infested area on Carrollton avenue, had paths running in several directions; over these paths thousands of ants were hurrying all day long. A willow tree standing alone in a very bare piece of hard ground over 200 feet from the colony was thoroughly infested. The pathway from the colony was about 2 inches wide, going fairly straight through a weed patch, then directly across the barren ground to the tree. The outgoing ants from the colony were usually not laden; a few were noticed carrying ant pupæ, and these were followed to the tree, where they entered a hollow in the trunk. Almost all the returning ants had distended abdomens, evidently being filled with the excretions from the plant lice. A few were seen carrying young lepidopterous larvæ that were dead at the time I found them. To this same nest was traced one large foraging party that was destroying a nest of other ants.

Not only at New Orleans, but at several other towns in the State, I heard complaints of the destruction of flowers by the ants. The calyces and bases of the petals of several kinds of composite ornamental flowers were found to have been so thoroughly destroyed that a slight jar would cause the petals to fall. Lemon blossoms on trees of B. M. Young, at Morgan City, La., were eaten so badly that the trees failed to set fruit. I heard accounts, also, of their establishing colonies of plant lice on the flower buds of shrubs in yards to such an extent that no flowers opened. I found them attending colonies of the "black aphis of chrysanthemum" at Doctor Stubbs's residence, in Audubon Park, and in other yards to such an extent as to dwarf or deform almost half the flowers.

Hard unripened pears left in barrels on a house porch were found several days later to be honeycombed by these ants, almost all the interior being eaten.

Lunch-counter, soda-fountain, candy-store, and fruit-stand proprietors are kept continually on the watch to prevent their stock in trade from being ruined. A grocer in the lower part of the city told me that when the ants first appeared they seemed to come in by thousands in a single day. He stated that he threw away over half a barrel of sugar and several boxes of evaporated fruits.

These ants have driven or killed out all other ants in the regions infested by them. I witnessed two battles between them and other ants on the outskirts of the infested area. The new ant, although much smaller, overcame the other by sheer force of numbers, column after column of them arriving on the scene of battle, while long files were carrying away dead ants, pupæ, and larvæ.

They are extremely active; the residents of New Orleans have christened them "the crazy ant," since when a column is disturbed it breaks up, the ants running aimlessly about in every direction. Professor Wheeler, of the American Museum of Natural History, has very kindly examined specimens of the workers and states that they appear to be identical with *Iridomyrmex humilis* Mayr. This species has been hitherto reported only from tropical regions. The genus is quite closely related to Tapinoma, but this species can be separated by the presence of a distinct, erect, sharp-edged scale and by the fact that the abdomen does not project forward, nor in any way conceal this scale. The workers are from 2 to 2.50 mm. in length, pale brown in color, head and thorax rugose, abdomen shining, but slightly pubescent.

The New Orleans tradesmen early took advantage of the annoyances caused by the ant, and now every grocery and drug store in the infested area has for sale one or more "ant killers," "ant poisons," "ant preventives," etc. These consist of tapes saturated with corrosive sublimate; corrosive sublimate solutions to be painted on walls and legs of tables and chairs; hydrocyanic-acid preparations; coal-oil mixtures; and others having trade names, the compositions of which are kept secret by the manufacturers.

The use of corrosive-sublimate tapes and of cloths saturated with coal oil appears to be the most successful means of keeping the ants away. The use of carbon bisulphid to destroy the nests will be futile unless it can be taken up by the whole community. A nest will be reoccupied in a few days after having been dosed with carbon bisulphid, and cleaning out the ants in any section will be a waste of time and money unless all other surrounding sections are immediately treated.

Mr. Sanderson said that he could corroborate the statements in the paper as to the severity of the attacks. In Morgan City they were at times simply unbearable.

Mr. Surface asked how these ants are disseminated by the methods described, which would presumably apply only to the workers. If the queens were not present they could not become established in the new locality unless the workers reproduce parthenogenetically.

Mr. Titus said that the life history had been little studied and that many of these points were still not clear, but it might be a fact that in this group queens were not always necessary to establish colonies.

In the absence of the author, the following paper was read by Mr. Gillette:

THE COTTONY MAPLE SCALE: AN UNUSUAL OUTBREAK, AND EXPERIMENTS WITH INSECTICIDES.

By S. Arthur Johnson, *Fort Collins, Colo.*

Contrary to general experience the cottony maple scale (*Pulvinaria innumerabilis* Rathv.) has done serious injury in Denver for several years past and gives promise of renewed ravages during the coming summer. The scale is widely distributed over the city on the soft maple (*Acer saccharinum*) shade trees in the parks and streets. In a number of localities the permanent injury has been severe. Two winters ago the time of one man was employed for two weeks cutting out and removing the dead limbs from a park covering one block. In this same park last winter the under surfaces of many limbs on the soft maples and black locusts (*Robinia pseudacacia*) were literally coated with the scale. Here the Colorado Agricultural College, in conjunction with the superintendent of parks, conducted a number of experiments for the purpose of discovering an effective winter treatment. So far as the writer is aware very little thorough work has been done in this line.

The advantages of a winter treatment are indicated both by the condition of the trees and by the life history of the insect. The immense numbers of the pest would make it necessary to spray thoroughly both surfaces of the leaves in summer, which is a practical impossibility with trees of dense foliage which are often 30 or more feet in height. Moreover, it would seem that the life history of the insect would necessitate more than one application of the spray. Doctor Howard,[a] in giving the life history, says:

> The young hatch early in summer, usually in the month of June, but occasionally at least as early as May 22. The hatching period usually extends on into early July, but may last until August. * * * In the course of a month they undergo a molt and begin to secrete a certain amount of wax from the dorsal surface of the body.

It thus appears quite possible that some of the first-hatched insects may molt and become protected with scales before the last of the eggs have hatched. Professor Gillette[b] has expressed the opinion that after the wax is formed sprays of greater strength will be necessary. The leaves of the soft maple appear to be quite sensitive to the greater strengths of contact insecticides.

EXPERIMENTS WITH INSECTICIDES.

Shortly after I came to this station a quantity of badly infested maple twigs were received from Colorado Springs. At that time, under the direction of Professor Gillette, I made a number of experi-

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[a] Bul. 22, n. s., Div. of Ent., U. S. Dept. Agric., pp. 7–16.

[b] Bul. 47, Colo. Exp. Sta., p. 33.

ments for the purpose of determining the effect of insecticides on the insect. The notes I have tabulated below. The results obtained from these experiments indicated the lines of attack which were followed out a year later in Curtis Park, Denver.

Preliminary laboratory experiment in 1903 for determining the effect of different insecticides on the cottony maple scale.

[Treated January 17, 1903; examined January 23, 1903.]

Insecticide.	Strength.	Alive.	Dead.	Per cent dead.	Remarks.
Lime-sulphur-salt (Illinois formula).	Full	69	67	49	
Do	One-half	38	89	70	
Do	Two-thirds	10	24	71	
Do	One-sixth	37	59	61	
Kerosene emulsion	50 per cent kerosene.	10	73	90	Possibly all dead.
Do	25 per cent kerosene.	1	11	92	Those in protected places alive; others dead.
Do	12½ per cent kerosene	44	67	60	
Whale-oil soap (hard)	1 pound to 1 gallon	12	140	92	All dead, except occasional protected ones.
Do	1 pound to 2 gallons	53	23	30	
Do	1 pound to 4 gallons				Little, or no effect.
Do	1 pound to 6 gallons	12	60	83	
Check		62	55	47	

Results of a second experiment in 1903.

[Treated January 31, 1903; examined February 10, 1903.]

Insecticide.	Strength.	Remarks.
Kerosene emulsion	50 per cent kerosene.	Seems to have killed all.
Do	25 per cent kerosene.	Seems to have killed about all.
Whale-oil soap	1 pound to 1 gallon	Seems not to have killed any, but there may be different results later.
Lime-sulphur-salt (Illinois formula).	Full	Seems not to have killed any.

It will be seen by consulting the tables that the mortality of the untreated scale during the winter reaches probably 50 per cent. This is indicated by the counts on the check branches and those on which the treatments were so weak as to have had little or no effect. The numbers counted in the laboratory experiments were too small to have positive values except where the percentage of dead was very high, because the difference in mortality on different twigs is a conspicuous feature on looking over the hibernating insects.

The only effective remedies appeared to be kerosene emulsion, 25 per cent or more in strength, and whale-oil soap at the rate of 1 pound to the gallon. The laboratory experiments indicated that further tests with kerosene emulsion, varying in strength from 10 to 50 per cent, and the stronger solutions of whale-soap should be made to ascertain more accurately the location of the "dead line."

Results of applications of insecticides made in Curtis Park, Denver, for the cottony maple scale.

[Treated November 23, 1903; examined February 27, 1904.]

No. of tree.	Insecticide.	Strength.	Alive.	Dead.	Per cent dead.	Remarks.
2	Kerosene emulsion	50 per cent oil	None.	All.	100	
3	do	20 per cent oil	None.	All.	100	
4	do	12½ per cent oil	1	73	98	
5	do	10 per cent oil	35	273	88	
6	Tobacco stems	1 pound to 1 gallon	217	89	29	
7	do	1 pound to 3 gallons				No benefit.
11	Tree soap	2 pounds to 1 gallon				Scales all dead and shriveled.
13	do	1 pound to 2 gallons			60	About two-thirds dead.
	Check				25	One-fourth dead.

Results of later applications in Curtis Park.

[Treated February 19, 1904; examined March 1, 1904.]

Insecticide.	Strength.	Alive.	Dead.	Per cent dead.	Remarks.
Lime-sulphur-salt (Illinois formula).	Full	87	192	70	
Kerosene emulsion	50 per cent	0	404	100	
Do	33 per cent	0	310	100	
Do	25 per cent	5	274	98	
Do	17 per cent	1	153	99	
Do	12 per cent	14	229	94	
Do	10 per cent	299	688	69	
Whale-oil soap (hard)	1 pound to 1 gallon	3	171	98	
Do	1 pound to 2 gallons	117	563	84	
Do	1 pound to 3 gallons	26	81	76	
Do	1 pound to 4 gallons	128	154	55	
Do	1 pound to 8 gallons	118	154	57	
Check		256	421	62	

PREPARATION OF INSECTICIDES.

The kerosene emulsion was emulsified with whale-oil soap. The tobacco stems were very dry when weighed and were boiled one hour in enough water to cover them, after which the concoction was diluted to the strengths given. The tree soap employed was used in the first series of experiments and hard whale-oil soap, purchased at a drug store, in the second. The lime-sulphur-salt wash was prepared according to the Illinois formula and boiled three hours.

APPLICATION OF THE INSECTICIDES.

Both seneca and vermorel nozzles were used. The latter did good work and is rather to be preferred on account of economy of material. Only the lower branches of the trees were sprayed and in some cases two applications were made on different parts of the same tree. With the lime-sulphur-salt wash two entire trees were treated.

DISCUSSION OF RESULTS.

A glance at the percentage column shows that the effective remedies stand out prominently. They are kerosene emulsion in strengths of over 10 per cent and whale-oil soap at the rate of 1 pound to the gallon. Tobacco-stem decoction and lime-sulphur-salt wash appeared to be ineffective. The lime-sulphur-salt wash was especially disappointing. After several weeks the scales under it appeared bright and healthy, and it almost seemed as if they enjoyed the protection of an extra covering during the cold weather. The insects take little or no nourishment during the winter and might thus be able to withstand for a time an application which deprived them of their food supply.

As a result of these experiments kerosene emulsion in strengths of 1 to 6 or 1 to 8 was recommended. Applications were made by the park authorities on April 16. The trees were examined on May 13 by Professor Gillette, who made the following note:

> Where Mr. Smith applied kerosene emulsion that was one-sixth kerosene the scales appeared to be all dead over the greater portion of the trees. Some limbs have scattering living scales and occasionally limbs were found where the scales were quite abundant. From the fact that the lice are all dead in places where they were very abundant, it seems evident to me that the living lice were those that were not well treated. Mr. Smith was also of the same opinion.

The entire park was not sprayed last winter, and as a result the infested trees have deluged the whole grove with the scale. Treatment is being made at this writing with kerosene emulsion in the strength of one-sixth kerosene. Judging from twigs sent to the laboratory, the application is all that could be desired, the scales all being killed.

Some scales will doubtless be missed by the spray, but these can be trimmed out as soon as the wax becomes conspicuous in the spring and before the eggs have hatched.

In the absence of the author, the following paper was read by the secretary:

SOME EXPERIENCES WITH PULVINARIA.

By Howard Evarts Weed, *Chicago, Ill.*

The entomological literature regarding *Pulvinaria innumerabilis* Rathv. contains so many misleading statements that it is certainly time for attention to be called to them. The two principal misstatements are: (1) That "the insect is rarely injurious in two consecutive years," [a] and (2) that the remedy consists in a "summer spraying with a dilute kerosene-soap emulsion." [b] These, or similar statements, have appeared in every article heretofore written on this subject, and during the past summer I have been shown a score of letters from entomologists making these statements.

Early in June of this year I received a note from the chairman of the North Shore Park Commission stating that a committee of the Rogers Park Improvement Association had been appointed to devise means for the elimination of the cottony maple scale. This committee asked me to investigate the subject and undertake the work of spraying in the territory of Rogers Park—a Chicago suburb, but within the city limits. Upon investigation I found the soft or silver-leafed maple (*Acer dasycarpum*) to be the principal shade tree here, and every tree was covered with the white egg masses of the Pulvinaria. These insects have been present in this territory in large numbers each year since 1886 at least. In 1897 a large number of the trees were severely pruned, the supposition being that this would eliminate the scale, and the beauty of the trees was thus largely spoiled. The insects have been so numerous that they have destroyed the lower and smaller branches and killed hundreds of trees outright. The work of the Pulvinaria, together with the pruning in an effort to get rid of it, has caused the trees to look anything but beautiful. This same condition exists at other places around Chicago, especially at Evanston and Irving Park. No soft maples are now being planted in this territory on account of the ravages of the insect.

During the past summer the eggs were slow in hatching, as the season was very backward. Up to June 25 practically no eggs were hatched. Two quite warm days occurred about July 10, and this served to bring them out. At this time the larger limbs and branches were fairly alive with the young going from the egg masses to the leaves. Persons pruning the trees at this time would get the insects in the hair and upon the person and clothes in the same manner as chicken mites. The insects were scattered to surrounding shrubs and flowers in various ways, especially by the falling of the weakened leaves, so that during August they were to be found on practically every shrub.

The list of plants upon which I have found the Pulvinaria is considerably larger than heretofore given. Of course a distinction should be made as to what constitutes the normal food plants, or those upon which it occurs in both summer and winter forms and the food plants upon which it may have drifted for the summer. My own observation gives the following as the normal food plants of the

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[a] Bul. 22, Div. of Ent., U. S. Dept. Agric., p. 16. [b] Loc. cit.

species, those most affected being mentioned first in the list and those least affected last: Soft or silver-leafed maple (*Acer dasycarpum*), box elder (*Acer negundo*), linden (Tilia), Virginia creeper (*Ampelopsis quinquefolia*), bittersweet (*Celastrus scandens*), sumac (Rhus), grape (Vitis), and willow (Salix). The summer food plants observed have been *Spiræa Van Houtteii*, *S. arguta*, and *S. prunifolia; Philadelphus grandiflorus* and *P. coronarius; Cornus mascula, C. siberica, C. stolonifera*, and *C. paniculata; Ribes aureum* and *R. sanguineum;* Hydrangea; Rudbeckia; *Symphoricarpus racemosus* and *S. vulgaris;* Syringa, several varieties; Viburnum, several varieties. I have not found it upon either the sugar maple (*Acer saccharinum*) or the Norway maple (*A. platanoides*), even where these trees were surrounded by the soft maples, except in such small numbers as to be very inconspicuous.

The work of spraying began the middle of July and continued until September 1. The work was done under my constant supervision by some senior students of the Michigan Agricultural College. Two outfits on wheels with hand pumps were used, these being the most convenient in getting around from tree to tree. Both the vermorel and bordeaux nozzles were used. The trees sprayed were mostly quite large, requiring a 60-foot hose to reach the top. The operators wore fireman's oiled suits and began the spraying at the top by climbing the tree, finishing at the bottom limbs. The work was thoroughly done, so far as possible every leaf being covered.

When I first took hold of this work I had expected to kill the insects readily "with a weak kerosene emulsion." All the entomologists said this was the remedy, and my own fourteen years' experience in practical spraying work told me the same thing. I began with an 8 per cent kerosene emulsion, which was increased within a few days to 10 per cent, then to 12½, and finally to 15 per cent. Practically none of the insects were killed with either the 8 or 10 per cent emulsions. An examination at Professor Forbes's office of leaves sprayed with 12½ per cent, some days after, showed that something over 50 per cent were killed, but the death of some of these was doubtless from natural causes. The 15 per cent emulsion killed the greater portion of the Pulvinaria, but as this strength took practically all the leaves off the box elders, all from the lindens, and fully one-half from the maples, the remedy was at least equal to the disease. A 10 per cent emulsion is all that can with safety be applied to the linden or box elder, while a 12½ per cent is all that can safely be applied to the maple.

In this connection some experience in the making of the emulsion may be of interest. With 2,500 large trees to spray, scattered over a large territory, the matter of making the emulsion was of considerable importance. But, as "necessity is the mother of invention," it so happened that a sample of soft soap containing 50 per cent of naphtha was sent me for trial. A single trial convinced me of its merits, and 500 pounds were ordered. This soap readily dissolves in cold water and takes up the kerosene very readily when pumped through a bucket force pump. I found that the best proportion was 1 pound of the soap to $2\frac{1}{2}$ gallons of kerosene. In the making of a 10 per cent emulsion in this way I first dissolved 1 pound of the soap in $2\frac{1}{2}$ gallons of water. I then added $2\frac{1}{2}$ gallons of oil and pumped the whole through a bucket sprayer and added it to 20 gallons of water.

Toward the end of the spray work Professor Close, of the Delaware station, visited me and told of the experiments which he had just completed with the hydrated-lime emulsion. I obtained some of the hydrated lime at once, intending to give it a trial, but as the season was then rather late and my landscape work took up my entire time, I was unable to conduct the desired experiments. During the coming spring I expect to spray extensively with the hydrated-lime emulsion.

I have endeavored to ascertain the experience of the other entomologists with Pulvinaria so as to compare results, but without exception the reply has come, "I have had no experience with this particular insect." My experience leads me to conclude that the Pulvinaria is as hard to down as the San Jose scale. It also teaches that we can not reason from analogy as to the remedies for insects. If we have had no personal experience with an insect we really know nothing about it, and we should be extremely careful in making statements recommending remedies. The comment of a resident of Rogers Park, after the receipt of a letter reading "remedies are not necessary, as the insects are rarely numerous," was, "He can't make me believe that." I trust that no such letters will hereafter be written.

Mr. Titus said that there had during the past few years been much trouble from Pulvinaria in the Chicago city parks. He had visited there frequently and had found employees using sponges saturated with kerosene. These sponges were rapidly passed along the infested limbs. Apparently the method was very efficient, so far as it reached the scales. Those on the leaves were, of course, missed.

AFTERNOON SESSION, FRIDAY, DECEMBER 30, 1904.

The president called the meeting to order at 2 p. m. The committee on nominations reported as follows:

For president, H. Garman, Lexington, Ky.
For vice-president, E. Dwight Sanderson, Durham, N. H.
For second vice-president, F. L. Washburn, St. Anthony Park, Minn.

For secretary-treasurer, H. E. Summers, Ames, Iowa.

For members of the council, C. L. Marlatt, Washington, D. C.; Herbert Osborn, Columbus, Ohio.

Respectfully submitted.

M. V. SLINGERLAND, *Chairman.*
HERBERT OSBORN.
J. L. PHILLIPS.

On motion, the secretary was instructed to cast the ballot of the association for the officers nominated, and they were duly elected.

The committee on membership recommended the following for membership, and on motion they were declared elected:

For foreign members: H. A. Ballou, Imperial Department of Agriculture, Barbados, West Indies; W. E. Collinge, University, Birmingham, England.

To be changed from associate to active members: F. C. Bishopp, Washington, D. C.; C. T. Brues, Washington, D. C.; A. A. Girault, Washington, D. C.; S. Arthur Johnson, Fort Collins, Colo.; G. W. Martin, Nashville, Tenn.; E. P. Taylor, Urbana, Ill.

For active members: J. C. Crawford, jr., Dallas, Tex.; Edgar L. Dickerson, New Brunswick, N. J.; C. O. Houghton, Newark, Del.; W. J. Phillips, Urbana, Ill.; W. Dwight Pierce, Dallas, Tex.; George I. Reeves, Washington, D. C.; C. E. Sanborn, College Station, Tex.; H. L. Viereck, New Haven, Conn.; B. H. Walden, New Haven, Conn.

For associate members: Gordon M. Bentley, Raleigh, N. C.; F. D. Couden, Washington, D. C.; Harper Dean, jr., Blacksburg, Va.; Enos B. Engle, Harrisburg, Pa.; W. A. Hooker, Amherst, Mass.; John Isaac, Sacramento, Cal.; A. D. MacGillivray, Cornell University, Ithaca, N. Y.; Leslie Martin, Washington, D. C.; A. C. Morgan, Dallas Tex.; E. F. Phillips, Philadelphia, Pa.; H. J. Quayle, Berkeley, Cal.; John M. Rankin, Washington, D. C.; W. A. Riley, Ithaca, N. Y.; J. G. Sanders, Washington, D. C.

JOHN B. SMITH, *Chairman.*
C. E. CHAMBLISS.
E. S. G. TITUS.

The following were reported as having been added to the list of active members during the year by the secretary, in accordance with the constitution:

Frank Benton, Washington, D. C.; Mel T. Cook, Santiago de las Vegas, Cuba; D. L. Van Dine, Honolulu, Hawaii.

The committee on resolutions, Messrs. Felt, Burgess, and Washburn, reported resolutions thanking the Secretary of Agriculture for his courtesy in publishing the proceedings of previous meetings, and asking him to continue that courtesy; and thanking the University of Pennsylvania, the Zoological Society of Philadelphia, the Academy of Natural Sciences of Philadelphia, and the American Entomological Society for favors and courtesies extended.

The secretary called attention to the limitation of size of the proceedings and suggested the appointment of a committee to edit these, with power to require the preparation of abstracts from members where it was deemed necessary. On motion the president appointed as such committee Messrs. Summers, Smith, and Marlatt.

On motion the following amendments to the by-laws, laid on the table at the last meeting, were adopted:

That in the interpretation of the paragraph of the constitution regarding the election of new members it be understood that an "economic entomologist" is a person who has been trained in entomological work and whose known work or published papers show him to be capable of conducting original work in economic entomology.

That the term "practical entomologists," referring to associate members, be held to indicate persons who have done general work in entomology and who have, by published papers or otherwise, given evidence of their attainments in such work.

That associate members be listed separately in the published roll, or the fact that they are associate members be indicated in the list.

The committee on nomenclature made the following recommendations:

That there be published a list of species, giving a single name, the one current for a large part of the world or throughout the range of the species, and that every entomologist be urged to use this name, and this only, for an English name in his publications, and that the Latin name be included but once, and in as inconspicuous a manner as possible.

That copies of this list be furnished to the leading agricultural papers of the country, and that the editors of such papers be requested to use these names, and these only, in all articles referring to such species.

That a second report, to include other names in current use, but which are less firmly established, less definite in application, or limited to less territory, be privately distributed among the members, the name first given to be the preferred name and its use alone urged wherever the entomologist believes it can be done with due regard to his constituency, and a second local or other name used where deemed necessary for the service of his State.

That in choice of scientific names for any species in purely economic papers, care be taken not to change from a long-used and current name to a new or resurrected name until its continual use in scientific papers or adoption in a monograph or catalogue of authority shall furnish evidence that it will remain in use.

LIST OF NAMES RECOMMENDED FOR EXCLUSIVE USE.

American cockroach, *Periplaneta americana* Linn.
Angoumois grain-moth, *Sitotroga cerealella* L.
Apple-leaf skeletonizer, *Canarsia hammondi* Riley.
Apple-aphis, *Aphis pomi* L.
Army-worm, *Heliophila unipuncta* Haw.
Asparagus beetle, *Crioceris asparagi* L.
Bag-worm, *Thyridopteryx ephemeræformis* Haw.
Bean-weevil, *Bruchus obtectus* Say.
Bedbug, *Clinocoris lectularia* L.
Boll-weevil, *Anthonomus grandis* Boh.
Boll-worm, *Heliothis obsoleta* Fab.
Brown-tail moth, *Euproctis chrysorrhœa* L.
Buffalo tree-hopper, *Ceresa bubalus* Fab.
Cabbage aphis, *Aphis brassicæ* L.
Carpet-beetle, *Anthrenus scrophulariæ* L.
Carpet-moth, *Trichophaga tapetzella* Linn.

Cattle-tick, *Boophilus annulatus* Say.
Cecropia-moth, *Samia cecropia* L.
Chinch-bug, *Blissus leucopterus* Say.
Clover-hay worm, *Hypsopygia costalis* Fab.
Codling-moth, *Carpocapsa pomonella* L.
Colorado potato-beetle, *Leptinotarsa decemlineata* Say.
Cotton-stainer, *Dysdercus suturellus* H.-Sch.
Cottony maple-scale, *Pulvinaria innumerabilis* Rathv.
Cottony cushion-scale, *Icerya purchasi* Mask.
Fall canker-worm, *Alsophila pometaria* Harr.
Fall web-worm, *Hyphantria cunea* Drury.
Granary-weevil, *Calandra granaria* L.
Grape-phylloxera, *Phylloxera vastatrix* Planch.
Gypsy-moth, *Porthetria dispar* L.
Harlequin cabbage-bug, *Murgantia histrionica* Hahn.
Hessian-fly, *Mayetiola destructor* Say.
Honey-bee, *Apis mellifera* L.
Hop-aphis, *Phorodon humuli* Schrank.
Horn-fly, *Hæmatobia serrata* R.-D.
Horse bot-fly, *Gastrophilus equi* L.
House-fly, *Musca domestica* L.
Indian-meal moth, *Plodia interpunctella* Hübn.
Larder-beetle, *Dermestes lardarius* L.
Leopard-moth. *Zeuzera pyrina* L.
Mediterranean flour moth, *Ephestia kuehniella* Zell.
Onion thrips, *Thrips tabaci* Lind.
Oyster-shell scale, *Lepidosaphes ulmi* L.
Peach-borer, *Sanninoidea exitiosa* Say.
Peach-scale, *Eulecanium persicæ* Fab.
Pear-slug, *Eriocampoides limacina* Ratz.
Pea-weevil, *Bruchus pisorum* L.
Plum-curculio, *Conotrachelus nenuphar* Hbst.
Plum-gouger, *Anthonomus prunicida* Walsh.
Rice-weevil, *Calandra oryza* L.
Red-legged locust, *Melanoplus femur-rubrum* DeG.
Rose-chafer, *Macrodactylus subspinosus* Fab.
San José scale, *Aspidiotus perniciosus* Comst.
Scurfy scale, *Chionaspis furfura* Fitch.
Silkworm, *Bombyx mori* Linn.
Spring canker-worm, *Paleacrita vernata* Peck.
Squash-bug, *Anasa tristis* DeG.
Striped blister-beetle, *Epicauta vittata* Fab.
Tarnished plant-bug, *Lygus pratensis* L.
Tomato-worm, *Phlegethontius sexta* Joh.

Note.—The list of common names of insects published above differs radically from that in use in the Bureau of Entomology as regards the system of hyphenization, hence it should be understood that it is not authorized by this Bureau.—Ed.

Mr. Sanderson spoke of the possibility and desirability of there being some publication which could be regarded as the semiofficial organ of the Association and in which members could publish economic notes and papers. It was moved and seconded that a committee of four be appointed to consider the feasibility of making an arrangement with Entomological News, similar to that now existing between Science and the American Association for the Advancement of Science.

The motion was carried, and the chair appointed as such committee Messrs. Skinner, Sanderson, Smith, and Titus.

The following paper was presented:

LABORATORY EXPERIMENTS WITH CARBON BISULPHID.

By F. L. Washburn, *St. Anthony Park, Minn.*

[Withdrawn for publication elsewhere.]

The committee on bibliography presented the following resolution relative to the publishing of a bibliography of current economic entomology:

To facilitate the more prompt distribution of information on the literature of economic entomology, the Association of Economic Entomologists respectfully request the Office of Experiment Stations of the United States Department of Agriculture to enlarge its present bibliographical work in this direction, in accordance with the following suggestions:

(1) That the bibliography now being published by the Office of Experiment Stations in the Experiment Station Record be issued also as a separate, and that a copy be mailed to each member of the Association.

(2) That copies of this bibliography be printed on stiff paper in such form that they may be cut apart and used as a card catalogue, a copy of this style of issue to be sent to each member of the Association desiring it.

(3) That the monthly reports be combined at the end of each year, properly classified by subjects, and reissued as a special bulletin with full index. This yearly bulletin to be published by the Office of Experiment Stations or by the Bureau of Entomology, as may be arranged, and to be in effect a continuation and supplement of the Bibliography of Economic Entomology, published hitherto from time to time by the Bureau of Entomology.

C. L. Marlatt,
H. T. Fernald,
E. D. Sanderson,
Committee.

On motion the report of the committee was adopted.

Mr. Sanderson reported for the auditing committee that the report of the treasurer has been examined and found correct. On motion the report of the committee was adopted.

The following paper was read:

SOME NOTES ON THE FUMIGATION OF HOUSEHOLD INSECTS AND THEIR EGGS WITH HYDROCYANIC-ACID GAS.

By J. L. Phillips, *Blacksburg, Va.*

Some buildings used as living apartments near Blacksburg were found in the early summer of 1904 to be plentifully supplied with *Clinocoris lectularia* Linn. in all stages of development. It was finally decided to fumigate one of these buildings with hydrocyanic-acid gas. The building is a four-story brick and contains approximately 150,000 cubic feet of air space distributed in eight sections. The windows were tightly wedged, and then calked with old cloth to prevent as much as possible the escape of the gas. The quantities used were 80 avoirdupois pounds of potassium cyanide, 96 pounds of sulphuric acid, and 240 pounds of water. The water and acid were first put into the jars, of which there were one or more to each section, and the cyanide was weighed out and placed by the jars. Everything being in readiness, the attendants put in the cyanide by beginning on the upper floors and passing rapidly to the lower floors. The doors were then closed, locked, and kept so for two days. Brick walls being porous, and the windows not as tight as desired, much of the gas escaped. Persons walking within 100 feet of the building, on all sides except that from which the wind was blowing, could detect the odor of the gas the entire time. This made it desirable to leave the building closed for a period longer than usual. When the building was opened two days later most of the gas had escaped.

The insects were very abundant and in all stages of growth, and in many cases the eggs almost coated the slats on the beds. Many of the eggs had hatched several weeks earlier, however, and it was necessary to pick them over carefully to find good ones for observation. This was done, and 10 apparently sound eggs were taken to the laboratory and placed in "stender" dishes for examination before the charges were placed. The day after the building was opened 101 eggs that had not hatched were collected, and these also were placed in "stender" dishes for examination. All of the eggs in the first lot (i. e., those taken before fumigating the building) hatched within ten days. The eggs collected after the building was fumigated were examined every few days for two weeks, but not a single one hatched, and they shriveled up and lost their plump appearance after a few weeks.

An examination of the insects the day after the building was opened proved that all were dead and no eggs appeared to hatch afterward, although examinations were made frequently for a period of several weeks. Though this work was done in June, scarcely an insect could be found in the building as late as December 22. This appears to be conclusive evidence that fumigation with hydrocyanic-acid gas will destroy some classes of insect eggs. It is likely to be most effective on those with a large micropyle, like that of the eggs in question, and might not be effective on those with heavy shells suited to stand weather conditions in the field. We are now arranging to study its effect on the eggs of the scurfy scale (*Chionaspis furfura* Fitch).

Rooms used for storing food products have been treated by fumigating with hydrocyanic-acid gas under our directions also. These rooms had become seriously infested with the croton bug (*Blattella germanica* Linn.). Before fumigating these rooms all food products that had been opened, such as butter, lard, etc., in fact, all materials with a moist exterior, were removed from the building. Such materials as boxed oatmeal, coffee, flour, sugar, canned goods, sealed packages of preserves, etc., were left inside.

The charges were placed at night after the workmen had left, but one room above was not fumigated. The next morning, after airing the building for a couple of hours, the insects were brushed up and destroyed. Quite a number of these insects were found on the upper floor where no charge was placed. They appeared to have been stupefied, and staid in that condition till they could be swept up and destroyed.

Mr. Sanderson had found such fumigation for fleas effective, even under circumstances where eggs must have been present.

Mr. Titus reported, however, that he had known instances where even two or three trials had failed to eradicate fleas.

The following papers were then read:

INSECTS COLLECTED FROM THE FLOWERS OF TREE AND BUSH FRUITS.

By W. E. Britton and Henry L. Viereck.

[Withdrawn for publication elsewhere.]

A DESTRUCTIVE PTINID NEW TO NORTH AMERICA.

By James Fletcher, *Ottawa, Canada.*

[Withdrawn for publication elsewhere.]

INJURIOUS INSECTS OF THE YEAR IN CANADA.

By James Fletcher, *Ottawa, Canada.*

[Withdrawn for publication elsewhere.]

The following paper was then presented:

THE AMOUNT OF INJURY FROM THE COTTON BOLL WEEVIL.

By E. Dwight Sanderson, *Durham, N. H.*

[Withdrawn for publication elsewhere.]

THE COFFEE LEAF-MINER (LEUCOPTERA COFFEELLA Stain.).

By Mel. T. Cook, *Santiago de las Vegas, Cuba.*

Probably the greatest enemy of coffee in the West Indies, and especially in Cuba, is a small moth, the coffee leaf-miner (*Leucoptera coffeella* Stain.). According to the Annual Report of the Office of Experiment Stations (1903), United States Department of Agriculture, from 20 to 40 per cent of the leaves on each tree in Porto Rico were affected. The coffee on the farm of the Cuban experiment station consisted entirely of small trees and these were seriously affected. Examination of trees on neighboring farms showed that frequently as much as $56\frac{1}{2}$ per cent of the leaves were affected and that those plants growing in the shade, or very close together, were more seriously affected than those in the open. However, the small trees upon the experiment station farm were suffering more than the large trees upon the neighboring farms.

LIFE HISTORY.

The adult insect is about 2.5 millimeters in length and of a silver-gray color, tipped with black on the posterior end. When not in flight the wings are folded close to the body. The length of life in the adult stage is probably not more than forty-eight hours, and it is improbable that the insect travels to any great distance, unless carried by air currents. Within twenty-four hours after emerging from the pupa the female insect punctures the upper surface of the young leaf and deposits her eggs. In fact the adults usually emerge from the pupa during the night and deposit their eggs during the following night. It is possible with the unaided eye to see the small slits in the leaves, and they are clearly visible with the aid of a small hand lens. Within four or five days small black spots surrounding the punctures make them clearly visible to the unaided eye and indicate that the eggs have hatched and that the larvæ are working within the mesophyll of the leaf. The larva lives within the mesophyll of the leaf for about three weeks, causing large, black, irregular spots, which indicate the area through which the mesophyll has been destroyed. Frequently the punctures are so close together that the galleries become united into one very large area. In some cases every leaf on a plant is affected and many of them are entirely destroyed. Young trees are often entirely defoliated.

After about three weeks within the leaf, the larvæ cut their way out through the upper epidermis and in a very short time seek a protected place on the under surface of the leaf and pupate. The larvæ are 3 to 4 millimeters in length, and in pupating first weave a delicate web in the form of a letter H with a very broad crossbar. Between this web and the surface of the leaf the small pupa is formed. The web and the pupa are very delicate and are so placed on the under surface of the leaf that they are protected from the excessive rains of the rainy season. Within three to seven days the adult moth comes from the pupa, and the life cycle is complete.

TREATMENT.

The location of the larva within the leaf makes any treatment at this stage practically impossible. However, the delicate character of the pupa furnishes a vital point for attack, and experiments were commenced on August 15, using a kerosene emulsion made with 1 part of kerosene, 1 part of whale-oil soap, and 8 parts of water. This was applied to a few plants to note the effect of the emulsion upon the plants. A few applications showed practically no effect, but repeated applications showed the burning of small spots, and also the burning of the tips of the leaves. However, the injury is not sufficient to be of any great importance.

An experiment to demonstrate the effect of the emulsion upon the pupæ was conducted as follows: Two lots of leaves were selected on which were a large number of pupæ. One lot was treated with the emulsion and the other not treated, and both lots put into breeding cages. From the leaves not treated a large number of insects were hatched, while from those treated only two emerged.

Accordingly, on August 18, experiments were commenced upon the coffee on the Experiment Station farm. The coffee field contained 231 plants, ranging from 6 inches to 6 feet in height and well shaded by bananas. All the plants were badly affected at this time. At first the plants were sprayed on Mondays and Thursdays. This was continued until October 3. After that date they were sprayed on October 13, 17, 21, 26, and 31, and on November 5. The trees were numbered, and a careful record was kept of the number of affected leaves on each tree. From time to time the injured leaves were picked from such trees as were entirely free from recent attacks. Care was taken not to pick the leaves from a tree until it was evident that the leaves had been deserted by the larvæ. These leaves were placed in breeding cages and careful records were kept of the number of adults which came from them; thus we know that only a very few insects were removed in this manner.

The picking of these deserted leaves facilitated the work in two ways: (1) The absence of the old leaves made it very much easier to look for newly affected leaves; and (2) trees that were not affected were not sprayed.

For the first six weeks the trees yielded to the treatment very slowly, and September 26 only about one-third of the trees were unaffected. After that date the trees yielded to the treatment more rapidly, and on November 5 they were absolutely free from the insects and were in excellent condition. The small trees responded to the treatment much more rapidly than the large ones.

The writer is reasonably sure that the treatment above described is a good one, but it is impossible at this time to say how effective it will prove, owing to the fact that at this season of the year the insect enters a quiescent period which prevents our continuing the experiments or determining to what extent the reduction was due to natural causes and to what extent to our treatment.

The following paper was presented:

GYPSY MOTH AND BROWN-TAIL MOTH CONDITIONS DURING 1904.

By C. L. Marlatt, *Washington, D. C.*

[Withdrawn for publication elsewhere.[a]]

The following two papers were read by title:

BLACK-FLY STUDIES.

By A. F. Conradi, *College Station, Tex.*

The black-fly (*Simulium venustum* Say) is responsible for much annoyance in many parts of New England, especially about inland summer resorts. For some time it has threatened the business of summer hotels in such localities. This pest becomes troublesome about May 1 in southern New Hampshire and about May 20 in the northern parts of the State, according to data gathered from different hotel managers interested in the extermination of the scourge.

There is no distinct definition of broods; all stages can be found during the entire summer. The life history lasts from five to nine weeks, depending upon the conditions of the breeding places. Shallow, sunlit water rippling over a pebbly bottom forms the ideal breeding ground. The first experiments for the purpose of exterminating this insect that were made in New Hampshire were at Dixville Notch, in the northern part of the State. The results were recorded in the sixteenth annual report of this Association. Since that time experiments have been continued by the writer in several parts of the State, all of which go to show that this species can be reduced to an inconsiderable pest in all localities where it occurs.

The methods of extermination consist: (1) In applying phinotas oil to the breeding grounds; (2) scrubbing with stable brooms where the breeding place covers a small area, and especially when the bottom of the stream is composed of solid rock; (3) damming streams; (4) raking with iron rakes.

The last three methods are to be employed when there is danger of killing the fish in such streams as feed lakes reserved for fish culture.

The first oil experiments were conducted at the Hotel Balsoms, Dixville Notch, N. H., in the waste way of the hotel lake, which is the source of Mohawk Creek. The breeding ground from which the hotel was infested was about 5 feet wide and 20 feet long in the sunlit waters of the waste way. Here the immature stages were present at the rate of 64 to the square inch, making a total of about

[a] Published as Circular No. 58, Bureau of Entomology.

1,000,000 specimens. With one-half gallon of oil this breeding place was destroyed, whereupon almost complete relief at the hotel followed.

In shallow streams several feet wide and half a mile long the bottoms were so densely covered with larvæ as to give them the appearance of a dense covering of moss. Here sufficient black-flies emerged daily to make life unbearable for an entire community. It required only a few minutes to put dams across the streams to check and deepen the water, as a result of which the larvæ and pupæ died.

In Mount Washington brook the problem presents a different aspect. Damming would be out of the question in most places on account of the boulders and the great velocity of the current. Miles of such breeding ground can be swept with a stable broom or raked with iron rakes in one day. When such larvæ are loosened and carried to deep water, they will die, but where shallow, noninfested water is ahead the operations may simply transfer the breeding places. If in such cases a cheese-cloth net is stretched across the stream, nearly all larvæ can be captured. If a stick pointed at one end is fastened to each end of the cloth, it can easily be adjusted to streams of any width by winding.

Through experiments made at Dixville Notch and at Durham, N. H., it was found that 5 gallons of oil poured in at the source of a stream averaging 10 feet wide and containing many shallow breeding places would kill so many of the larvæ as to leave only an inconsiderable number for a distance of 3¼ miles, and the water at the end of a mile would not be too offensive for cattle to drink. Fish apparently escaped down the stream.

As this species will shift its breeding grounds, it is not advisable to make permanent dams, but instead cheap water gates may be constructed which can be opened and closed at will.

THE FUMIGATION OF A FRUIT HOUSE FOR CONTROLLING THE CODLING MOTH.

By A. F. Burgess, *Columbus, Ohio.*

Many larvæ of the second brood of the codling moth (*Carpocapsa pomonella* Linn.) do not emerge from the fruit until after it is picked and placed in storage; hence it is usually possible to find cocoons in the fruit boxes or in crevices in the fruit house during the spring. Last April an examination of the boxes in which apples were stored in a fruit house at Delaware, Ohio, disclosed the fact that many larvæ were present within their cocoons, and, as the building was well constructed, an excellent opportunity was offered for testing the effect of hydrocyanic-acid gas on this insect. After removing the fruit the empty boxes were allowed to remain in the house and the doors and ventilators were kept open for several days, so as to allow it to become as warm as possible, in order to render the larvæ more active.

The maximum temperature from April 25 to May 12, the date when the house was fumigated, was 84° and the minimum 33° F. May 11, the night before the treatment was applied, the thermometer dropped to 33°, but rose rapidly the following day, registering 80° F. in the afternoon.

Before charging the house, my assistant, Mr. Swezey, who was sent to do the work, examined many cocoons, and active larvæ, but no pupæ, were found.

The formula used was 1 ounce of potassium cyanide 98 per cent pure, 1 fluid ounce of sulphuric acid, and 3 fluid ounces of water to each 100 cubic feet of space. As the house measured 32 by 24 by 14 feet, $6\frac{3}{4}$ pounds of cyanide were required; this was divided into three equal parts and placed in separate jars. The ventilators were tightly closed and the house charged at 3 p. m., and the door was opened at the expiration of twenty hours. The odor of gas was then very strong, and, after airing for one hour, Mr. Swezey made an examination of cocoons taken from several boxes. Sixty-nine worms were removed and placed in a jar, and as about one-third of these showed signs of life when they were taken the house was closed and allowed to remain so for over a week.

An examination of the worms in the jar, which was made five hours after they were taken, showed that 39 were alive and 30 were apparently dead. A final examination made June 9 gave the following data: 28 worms and 3 pupæ dead, and 1 larva, 6 pupæ, and 23 moths alive. Eight larvæ had escaped from the jar.

Taking this count as a basis, it is evident that the gas killed less than 45 per cent of the worms. In removing the larvæ from the boxes, it was almost impossible to prevent injuring the cocoons, and in many cases the larvæ placed in the jar left the old cocoons and spun entirely new ones. This would undoubtedly have some influence on the death rate, and under normal conditions, where the cocoons were undisturbed, the treatment would not be as effective as in this instance.

An examination of cocoons in the fruit house May 26 showed that less than 40 per cent of the larvæ were dead, although the house had been tightly closed since the day it was first aired out, and the odor of the gas was still very perceptible. Computing the price of the cyanide at 30 cents and the acid at 5 cents per pound, the cost of this treatment was $2.36. Had it been effective in destroying the larvæ it would have furnished a simple and comparatively cheap method of treating fruit houses and would have been preferable to the use of screens on the doors and ventilators, which are liable through carelessness or accident to be left open and give the moths an opportunity to escape.

Fumigation for a longer period may be satisfactory, but from the above experiment it appears that screens should be used.

The following paper was presented:

THE IMPORTATION AND BREEDING OF HONEY BEES OF VARIOUS TYPES.

By Frank Benton, *Washington, D. C.*

In these later times when the tendency is to specialize more and more in all lines of industry, there are among bee keepers many who devote themselves to one particular line of their pursuit, such as the production of comb honey to the exclusion of extracted honey, or, on the other hand, to the production of extracted (or liquid) honey wholly; others turn the whole strength of their apiaries to the rearing of queen bees of various breeds, which are supplied to those engaged in honey production; others push the multiplication of their colonies at the expense of honey production, in order to have full colonies of bees to sell, either singly, in lots of 100 colonies, or even whole carloads, which are shipped into great honey-producing regions to yield tons upon tons of beautiful nectar for eastern and foreign markets. Then we have the medium-sized and smaller apiaries, many of which are devoted to two or more of these lines of work, some even combining all of them.

It would seem quite natural that if any difference in traits could be discovered between various breeds or varieties of honey bees great care would be taken to propagate those types possessing qualities which fitted them in a more eminent degree than others for any particular purpose desired to be accomplished, and, in truth, exactly this has been done. Bees have been found which are naturally more suited to a given purpose than are other types, which, however, are equally valuable in still different lines. In fact, the differences among bees are exactly comparable to those noted by the raisers of other farm stock. Among horses there are the large cart horses and Percherons for use as draft animals, the fleet Arabian for the turf, the carriage horse, the general-purpose horse for the farm, etc.; among cattle the Jersey, Alderney, and Holstein for producing milk and butter, the shorthorn as a beef animal; the shorthorn and Devon as draft animals; and similarly with sheep and swine; while even a poultry raiser has his egg breeds and meat breeds, fancy fowls, and general-purpose fowls. It is, therefore, small wonder that for more than forty years past great efforts have been made to secure the various types of honey bees found wild, and cultivated to a greater or less extent, in various regions of the earth.

Although about a score of types, more or less distinct in markings, qualities, and habits—some of them no doubt deserving varietal rank, others perhaps to be regarded only as subvarieties or even to be looked upon as mere artificial breeds—have been obtained and tested, there still remain great regions yet to be explored in this respect. The honey bee is believed not to have been a native of the New World, so that in the unexplored portions of South America no varieties nor new species of the genera Apis, Megapis, nor Micrapis are to be looked for. The interior regions of Africa may yet present some new types. It is possible, although hardly probable, that Australia may possess some. The field in the East Indian Islands, however, is far more promising, while the great central regions of Asia have not been touched.

IMPORTATIONS OF VARIOUS BREEDS.

The first importations of bees were doubtless made from England in early colonial times, and perhaps from Holland and Spain. These were the common black or brown bees so generally spread throughout the Eastern States previous to the middle of the last century, but which only reached the Pacific coast in the fifties. They were followed by the introduction, in the early sixties, of the yellow race from Italy, imported by the United States Department of Agriculture. Then followed, in 1880, Cyprian, Syrian, and Palestine bees, brought from their respective native lands by the writer and Mr. D. A. Jones, of Canada. In 1883 the peculiar type known as "Carniolan" bees, from the province of Carniola, in southwestern Austria, was introduced in large numbers by the writer. A few queens of this race had reached this country some years before, but they were not multiplied to any extent, hence the race had gained no hold here previous to my own extensive importations of 1883.

Just as happened in the case of the Carniolans, a small number of Caucasians had reached America a decade or more before their extensive introduction; but, quite in the same manner as occurred with the earlier importations of Carniolans, the efforts attracted no general attention and the cultivation of Caucasians was neglected, resulting, of course, in their complete disappearance. About 1900, however, Rauchfuss Brothers, of Colorado, with the assistance of German shippers, made fresh importations. The writer's importations direct from the Caucasus followed these, and last year the United States Department of Agriculture, at my suggestion, imported still more. As yet, however, the Caucasians exist in America in but limited numbers.

QUALITIES OF THESE TYPES.

Common black or brown bees.—This familiar type possesses some excellent traits, such as hardiness, willingness to enter surplus honey receptacles, and activity during abundant honey flows; but, united with these traits, is a greater disposition to rob during times of dearth, due to easy discouragement when a honey flow slackens. They defend their colonies less energetically than various other types. Spitefulness and a ready disposition to fly at passers-by, as well as to resent greatly any manipulation of the combs, are among their undesirable traits.

Italians.—These are more active, more prolific, much gentler under manipulation, defend their hives better against various bee enemies, and in general are better economic managers.

Cyprian and other Eastern types.—The record for the largest yield of honey ever obtained from a single colony is held by the Cyprians. This is due to a combination of certain excellent traits, such as great prolificness, relatively great wing power, most wonderful energy in honey collecting, rapid breeding in early spring, persistent and continuous field work, even though the return at times be somewhat slow, together with the best possible defense of the hive against enemies which may tend to reduce its effective force. With these traits the Cyprians combine, however, a degree of irascibility which renders their general introduction as a pure type inadvisable. Their disposition to produce laying workers is also great, and operates against them. Another feature, which condemns them for the production of comb honey of the very highest finish, is the tendency which they have of filling the individual cells quite to the brim with honey, so that the wax cap rests flat upon the liquid and presents, therefore, a soaked or watery appearance instead of the clear snow-white surface which certain other races give to their finished combs. The other eastern types possess the same general characteristics, yet the excellent traits here indicated are in the main less pronounced with them.

Carniolans.—These are radically different from the bees just under consideration, both in appearance and characteristics. Large-bodied, gray in color, somewhat droning in flight, they present a great contrast to the slender, yellow, and nimble-winged Cyprians. The Carniolans, having reached their development in an elevated Alpine region, are distinguished for great hardiness, the individual workers being able to stand a considerably lower temperature than those of the next hardiest type—the blacks. The queens are very prolific, and early brood-rearing is the rule, so that the decimation of colonies, so noticeable with blacks and Italians of pure blood, is reduced to a minimum when only pure Carniolans are present. They possess the excellent peculiarity of capping their combs in such a manner as to give them a snowy-white and very attractive appearance. The amount of propolis, or bee glue, gathered by them is small; hence the tendency to daub sections and combs is less than with any other type. Their disposition is most excellent, enabling anyone to handle them easily by the use of a small amount of smoke.

Caucasians.—These bees have hardly been tested sufficiently to enable me to state exactly what their relative value will be as a pure breed. It seems, however, rather evident that as crossing material they will find a certain place, since they have at least proved themselves to be excellent workers and most marvelously gentle. Without smoke or bee veil and with no protection whatever, the hives may be opened at all times and under any circumstances with no danger whatever of stings. Caucasians are particularly well adapted to city bee keeping, to manipulation by ladies and amateur bee keepers, and to the purpose of studying bee life—one of the most fascinating subjects for investigation in the whole realm of animated nature. I believe that the general introduction of these remarkably gentle bees—the Caucasians—would do more to extend and popularize the culture of bees in this country than have all of the importations of other races or all of the bee-keeping inventions since that of the Langstroth frame hive.

SECURING DESIRABLE TRAITS BY CROSS-BREEDING.

Since each one of the above types also possesses, along with its excellent qualities, some faults which thus far have not been entirely eradicated by selection in breeding these types pure, the thought is natural that by some out-cross, or series of out-crosses, followed, perhaps, by continued selection, types might be developed and established which should present the chief among the excellent traits in a pronounced degree without the undesirable qualities or with these greatly minimized. Thus we find that ever since the introduction of the Italian bees there have been efforts along this line, and since the spread of the Italian bee has been so general throughout the country, especially among the professional bee keepers, there are now few apiaries where the original black or brown bee exists in its purity. Special strains of the Italians have also been produced in different parts of the country by continued selection, and queens of supposed pure Italian blood are often sent from this country to various portions of Europe, and occasionally even to Italy itself. The progeny of these queens differ in important colorational features, as well as in qualities, from the original type found generally in northern Italy. The most striking difference in appearance is that in place of the three bands on the first, second, and third anterior segments of the abdomen a yellow color covering the whole of these segments, and often the fourth and fifth segments, is to be seen. This result is strikingly illustrative of what can be done with such plastic material as honey bees by careful and continued selection.

The writer conceived nearly twenty years ago the idea that, notwithstanding the bad traits of the Cyprian race (this being taken as the best of the Eastern types) it would be a very desirable thing to fix in a new type—hardier and gentler than Cyprians—the fundamental and strong characteristics, as regards honey-gathering powers, prolificness, energy, and general activity, which are inherent in this race. Yet, in accomplishing the result just indicated, it was particularly desirable to avoid the extreme irritability of the eastern type. A series of experiments was begun by the writer in the years 1883–84 in Munich, Germany, and continued in subsequent years in Carniola, Austria, looking to the production of a type which should possess the traits just indicated. After many crosses between the queens and drones of each race, starting at times with the Cyprian and again with the Carniolan, it seemed apparent that the temper and constitution were largely derived from the male side, while prolificness and energy in honey production seemed likely to be transmitted from the female side. The proposition was, therefore, laid down that in all crosses the drones must come from a gentle, hardy race, while the mothers were to be selected from a race noted for prolificness, early breeding qualities, and whose worker bees showed the highest energy in honey collecting. As representing, at that time, the two types which had best be utilized in this combination the Cyprians were selected for the blood of the queens and the Carniolans to produce the males; the resulting product, in order to indicate its origin, was named the Cyprio-Carniolan. Since the year 1885 these bees have been bred and tested under most varying conditions, with the result that wherever the principles above mentioned have been followed in their selection and breeding they have given great satisfaction as to the quantity of honey obtained. Indeed, a practical honey producer in southern California stated recently that, while he was obliged to feed his Italian bees during this dry year to keep them from starving, the crosses obtained with the Cyprian race had some 30 to 40 pounds in each of their colonies. In form and coloration the Cyprio-Carniolans approach more nearly the Cyprian type than the Carniolan. Likewise in their manner of flight and many other peculiarities they resemble the Cyprians; but in hardiness and, to a great extent, in temper, particularly in their readiness to yield to smoke, they resemble, to quite a degree, the Carniolan race.

These experiments, which have been carried on in recent years in my private apiaries in and near the city of Washington, have frequently enabled me to secure considerable material illustrating variability in the crossing of different types; and this has been of some service, also, to various workers in zoology who have taken up problems of this nature.

FUTURE WORK.

In view of the results obtained by the use of males of a gentler race, the plan is, during the coming year, to utilize in this respect the newly imported Caucasians, producing thus the Cyprio-Caucasian type and likewise, as a further test of the principle, the Carnio-Caucasian type. We may confidently expect excellent combinations from the crossing of females of either of these prolific races (the Carniolan and Cyprian) with males of the extremely gentle Caucasian race. The mating of the Cyprian with the Caucasian particularly will, it is believed, produce a type even gentler than mating Cyprian with Carniolan; while in mating a Carniolan queen to a Caucasian drone bees will be produced that, while exceedingly gentle, will, I feel confident, be well adapted to the production of comb honey of high grade.

It is proposed, in the future work of the United States Department of Agriculture along this line, to carry forward, in an apiary which the Department has recently acquired, further investigations and breeding of various races of bees now in this country; and also to extend the work so as to include an examination, test, and possible importation of the giant bee of East India (*Megapis dorsata*) and that of the Philippine Islands (*Megapis zonata*), as well as the common East Indian species (*Apis indica*), which is now cultivated to a limited extent. The first and last mentioned of these bees were quite imperfectly investigated by the writer in India in 1881, previous to his connection with the Department of Agriculture. Unfortunately, a severe attack of jungle fever cut short his work at that time and obliged him to leave India at once.

I look forward with great interest to the possibility—I might say the probability—that additional valuable types of honey bees, of which we have as yet only vague accounts, will be found in the great central Asian area eastward and southeastward from Persia, particularly in the elevated valleys of the Himalayan Mountains and in the plateaus to the north and northeast of the main range.

Mr. Washburn asked whether the honey bees were chiefly responsible for the distribution of pear blight.

Mr. Benton answered that he believed not, because other insects did the same work, and if honey bees were not present the blight would be spread quite the same.

On motion, Mr. F. M. Webster was elected to succeed himself as a member of the committee on nomenclature, for three years.

On motion, it was resolved that the next meeting be held in conjunction with the American Association for the Advancement of Science, the exact date to be left to the executive committee.

The meeting was then adjourned.

H. E. Summers, *Secretary*.

LIST OF MEMBERS OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

ACTIVE MEMBERS.

Aldrich, J. M., Agricultural Experiment Station, Moscow, Idaho.
Alwood, William B., Charlottesville, Va.
Ashmead, William H., U. S. National Museum, Washington, D. C.
Baker, C. F., Agricultural Experiment Station, Santiago de las Vegas, Cuba.
Ball, E. D., Agricultural Experiment Station, Logan, Utah.
Banks, C. S., Bacolod, Negros, P. I.
Banks, Nathan, U. S. Department of Agriculture, Washington, D. C.
Bethune, C. J. S., 500 Dufferin avenue, London, Ontario, Canada.
Benton, Frank, U. S. Department of Agriculture, Washington, D. C.
Bishopp, F. C., U. S. Department of Agriculture, Washington, D. C.
Bogue, E. E., Agricultural College, Mich.
Britton, W. E., New Haven, Conn.
Bruner, Lawrence, Agricultural Experiment Station, Lincoln, Nebr.
Brues, C. T., Milwaukee Public Museum, Milwaukee, Wis.
Burgess, Albert F., State Department of Agriculture, Columbus, Ohio.
Busck, August, U. S. Department of Agriculture, Washington, D. C.
Caudell, A. N., U. S. Department of Agriculture, Washington, D. C.
Chambliss, C. E., Clemson College, S. C.
Chittenden, F. H., U. S. Department of Agriculture, Washington, D. C.
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O

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY—BULLETIN No. 53.

L. O. HOWARD, Entomologist.

CATALOGUE

OF THE

EXHIBIT OF ECONOMIC ENTOMOLOGY

AT THE

LEWIS AND CLARK CENTENNIAL EXPOSITION, PORTLAND, OREGON, 1905.

COMPILED UNDER THE DIRECTION OF THE ENTOMOLOGIST

BY

ROLLA P. CURRIE.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1905.

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., April 11, 1905.

SIR: I have the honor to transmit herewith the copy for a catalogue of the exhibit of economic entomology made by the Bureau of Entomology at the Lewis and Clark Centennial Exposition held at Portland, Oreg., during the present year. It has been compiled, under my direction, by Mr. Rolla P. Currie, assistant in the Bureau of Entomology, and I recommend its publication as Bulletin No. 53 of this Bureau.

Respectfully,

L. O. HOWARD,
Entomologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTION.

The following catalogue of the exhibit of economic entomology made by the Bureau of Entomology, U. S. Department of Agriculture, at the Lewis and Clark Centennial Exposition, will, it is believed, increase the usefulness of the exhibit by furnishing the visitor, in a convenient form for future reference, much of the data contained on the labels, and by supplying him with references to published articles from which additional information can be gained.

The catalogue has been compiled from Bulletins Nos. 47[a] and 48[b] of this Bureau and includes all portions of each of these bulletins, revised and corrected, which relate to the exhibits installed at Portland.

Owing to the fact that less space was available for the exhibit by the Bureau of Entomology at Portland than at St. Louis, it has been necessary to reduce the size of the exhibits considerably, and this has in most part been accomplished by leaving out insects which affect strictly eastern or southern crops. In other respects, however, the exhibit is very similar to that made at St. Louis, and includes all those features which proved of especial interest there. Care has been taken to retain such insects as are of especial importance on the Pacific coast and those which affect important Pacific coast industries, such as fruit raising and lumbering.

Persons desiring further information than can be gained from this catalogue, or from conversation with the attendant in charge of the exhibit, are requested to address the writer at the U. S. Department of Agriculture, Washington, D. C.

L. O. Howard,
Entomologist.

[a] Catalogue of the Exhibit of Economic Entomology at the Louisiana Purchase Exposition, St. Louis, Mo., 1904; by E. S. G. Titus and F. C. Pratt.

[b] Catalogue of Exhibits of Insect Enemies of Forests and Forest Products at the Louisiana Purchase Exposition, St. Louis, Mo., 1904; by A. D. Hopkins.

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CATALOGUE OF THE EXHIBIT OF ECONOMIC ENTOMOLOGY AT THE LEWIS AND CLARK CENTENNIAL EXPOSITION.

INSECTS INJURIOUS TO ORANGE AND LEMON.

For general articles relating to insects affecting these fruits see Hubbard, 1885, and Insects Affecting the Orange, U. S. Dept. Agric.; Marlatt, Scale Insects and Mites of Citrus Fruits, Farmers' Bul. 172, 1903.

THE APPLE TWIG-BEETLE.

Stephanoderes hispidulus Lec.

(Formerly *Hypothenemus eruditus* auct.)
Exhibit: Adult and work.

THE OAK AMBROSIA BEETLE.

Xyleborus affinis Eichh.

For general account see Hubbard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 19–20, 1897, under *X. pubescens* Zimm.
Exhibit: Adult, work, and figure.

THE PAN-AMERICAN PLATYPUS.

Platypus compositus Say.

For general article see Hubbard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 14–16, 1897.
Exhibit: Adult, work, and figure.

FULLER'S ROSE BEETLE.

Aramigus fulleri Horn.

For general account of life history see Chittenden, Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., pp. 88–96, 1901.
Exhibit: Adult.

THE COFFEE-BEAN WEEVIL.

Aræcerus fasciculatus DeG.

For partial life history and general account see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., pp. 36–38, 1897.
Exhibit: Adult and work.

THE ORANGE CHRYSOBOTHRIS.

Chrysobothris chrysœla Ill.

Exhibit: Adult.

EPITRAGUS TOMENTOSUS Lec.

Exhibit: Adult.

PACHNÆUS DISTANS Horn.

Exhibit: Adult.

ORANGE LEAF-NOTCHER.

Artipus floridanus Horn.

EXHIBIT: Adult and work.

THE ORANGE SAWYER.

Elaphidion inerme Newm.

For general account see Chittenden, Bul. 18, n. s., Div. Ent., U. S. Dept. Agric., p. 41, 1898.
EXHIBIT: Adult and work.

LEPTOSTYLUS BIUSTUS Lec.

EXHIBIT: Adult and work.

THE ORANGE DOG; HOG CATERPILLAR.

Papilio thoas Linn.

(Formerly *P. cresphontes.*)
For brief account of larva see Lintner, 9th Rpt. State Ent. N. Y., pp. 336–337, 1893.
EXHIBIT: Eggs, larva, chrysalis, adult, and figure.

ORANGE LEAF-ROLLER.

Platynota rosirana Walk.

EXHIBIT: Eggs, pupa, and adult.

THE SADDLE-BACK CATERPILLAR.

Sibine stimulea Clem.

(Formerly *Empretia.*)
For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 98–99, 1899.
EXHIBIT: Pupa, adult, and figure.

THE COMMON BAGWORM.

Thyridopteryx ephemeræformis Steph.

For general account see Packard, 5th Rpt. U. S. Ent. Com., pp. 258–262, 1890.
EXHIBIT: Larva, cocoon, adult, and figure.

THE STINGING CATERPILLAR.

Megalopyge opercularis S. & A.

For short account see Lugger, 4th Rpt. State Ent. Minn., pp. 95–96, 1899.
EXHIBIT: Cocoon and adult.

THE SKIFF CATERPILLAR.

Prolimacodes scapha Harr.

(Larva feeds on leaves.)
EXHIBIT: Adult.

THE ORANGE CASE-BEARER.

Eurycyttarus confederata Grt.

(Larvæ feed upon lichens on tree trunk, occasionally gnawing fruit; formerly *Psyche.*)
EXHIBIT: Cases on twig.

THE TWO-SPOTTED RED SPIDER.

Tetranychus mytilaspidis Riley.

For description and distribution see Banks, Tech. series 8, Div. Ent., U. S. Dept. Agric., pp. 71–72, 1900.
For general account of *T. bimaculatus* Bnks. see Chittenden, Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., pp. 35–42, 1901.
EXHIBIT: Figure.

THE ORANGE WHITE SPOT.

Tetranychoides californica Bks.

For description see Banks, Journ. N. Y. Ent. Soc., Vol. XII, p. 54, pl. II, fig. 1, 1904.
EXHIBIT: Work and figure.

THE ORANGE FRUIT MITE.

Tenuipalpus californicus Bks.

For description see Banks, Journ. N. Y. Ent. Soc., Vol. XII, p. 55, pl. II, fig. 2, 1904.
EXHIBIT: Work and figure.

RUST MITE OF THE ORANGE; THE SILVER MITE OF THE LEMON.

Eriophyes oleivorus Ashm.

(Formerly *Phytoptus.*)
EXHIBIT: Figure.

THE TWO-STRIPED WALKING-STICK.

Anisomorpha buprestoides Stäl.

EXHIBIT: Nymph and adult.

THE ANGULAR-WINGED KATYDID.

Microcentrum retinerve Burm.

EXHIBIT: Eggs, adult, and parasitized eggs.

NORTHERN MOLE CRICKET.

Gryllotalpa borealis Burm.

EXHIBIT: Nymph and adult.

THE LUBBER GRASSHOPPER.

Dictyophorus reticulatus Thunb.

For brief account see Morgan, Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., pp. 28–29, 1901.
EXHIBIT: Nymph and adult.

THE COTTON STAINER.

Dysdercus suturellus H.-Schf.

For short accounts see Howard, Farmers' Bul. 47, U. S. Dept. Agric., pp. 30–31, 1897; Insect Book, p. 308, fig. 201 and pl. 31, fig. 15, 1901.
EXHIBIT: Nymph, adult, and figure.

EUTHOCTHA GALEATOR Fab.

EXHIBIT: Adult.

THE SOUTHERN LEAF-FOOTED PLANT-BUG.

Leptoglossus phyllopus Linn.

For general account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 46–48, 1899.
EXHIBIT: Adult.

EUSCHISTUS SERVUS Say.

EXHIBIT: Adult.

NEZARA HILARIS Say.

EXHIBIT: Adult.

WHITE FLY; MEALY WING.

Aleyrodes citri R. & H.

For general account see Marlatt, Farmers' Bul. 172, U. S. Dept. Agric., pp. 36–38, 1903.
EXHIBIT: Adult, work and figure.

ORANGE APHIS; COTTON APHIS.

Aphis gossypii Glover.

(Curls leaves and stops young growth; usually well controlled by parasites and other enemies.)

For short account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 58–61, 1903.

EXHIBIT: Eggs, adult, work, figure, and the enemies *Baccha clavata* Fab., *Hemerobius* sp., *Chrysopa plorabunda* Fitch, and a hymenopterous parasite.

COTTONY CUSHION SCALE; FLUTED SCALE.

Icerya purchasi Mask.

(Food plants: Acacia, cypress, grasses, lemon, orange, pine, rose.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 25–27, 1903.

EXHIBIT: Infested twig.

THE DESTRUCTIVE MEALY-BUG.

Pseudococcus citri Risso.

(Formerly *Dactylopius destructor.*)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 99–100, 1903.

EXHIBIT: Infested leaves.

THE LONG-SPINED MEALY-BUG.

Pseudococcus longispinus Targ.

(Formerly *Dactylopius* spp.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 104–105, 1903.

EXHIBIT: Infested leaves.

THE FLORIDA WAX-SCALE.

Ceroplastes floridensis Comst.

(Food plants: Citrus, fig, myrtle, oleander.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., p. 157, 1903.

EXHIBIT: Infested leaves.

THE BARNACLE SCALE.

Ceroplastes cirripediformis Comst.

(Food plants: Myrtle, orange, persimmon, quince.)

For bibliography and food plants see Fernald, Cat Coccidæ of World, Bul. 88, Mass. Agr. Coll., p. 150, 1903.

EXHIBIT: Infested leaves.

THE SOFT SCALE.

Coccus hesperidum Linn.

(Food plants: Laurel, lemon, myrtle, oleander, orange, etc.; formerly *Lecanium.*)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 168–170, 1903.

EXHIBIT: Infested twig.

THE HEMISPHERICAL SCALE.

Saissetia hemisphærica Targ.

(Food plants: Oleander, orange, peach, etc.; formerly *Lecanium.*)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 202–203, 1903.

EXHIBIT: Infested twig.

THE BLACK SCALE.

Saissetia oleæ Bern.

(Food plants: Apple, apricot, olive, orange, pear, plum, rose; formerly *Lecanium.*)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 205–206, 1903.
Exhibit: Infested twig.

THE OLEANDER SCALE.

Aspidiotus hederæ Vall.

(Food plants: Currant, box, cherry, olive, oleander, orange, etc.; formerly *A. nerii* Bouché.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 260–264, 1903.
Exhibit: Infested twig.

THE ORANGE CHIONASPIS.

Chionaspis citri Comst.

(Food plants: Euonymus, orange, palms.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bull. 88, Mass. Agr. Coll., pp. 214–215, 1903; Marlatt, Yearbook, U. S. Dept. Agric., 1900, p. 270, 1901.
Exhibit: Infested twig.

THE RED SCALE OF CALIFORNIA.

Chrysomphalus aurantii Mask.

(Food plants: Agave, apple, fig, grape, lemon, orange, pear, plum, quince, willow, etc.; formerly *Aspidiotus.*)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bull. 88, Mass. Agr. Coll., pp. 287–288, 1903; Marlatt, Yearbook, U. S. Dept. Agric., 1900, p. 268, 1901.
Exhibit: Infested twig.

THE CIRCULAR SCALE.

Chrysomphalus ficus Ashm.

(Food plants: Lemon, oleander, orange, palm, rose, etc.; formerly *Aspidiotus.*)
For bibliography and food plants see *Chrysomphalus aonidum*, Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 286–287, 1903; Marlatt, Yearbook, U. S. Dept. Agric., 1900, p. 269, 1901.
Exhibit: Infested twig.

THE PURPLE SCALE.

Lepidosaphes beckii Newm.

(Food plants: Citron, fig, lemon, oak, orange. Formerly *Mytilaspis citricola* Glov.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bull. 88, Mass. Agr. Coll., pp. 305–306, 1903; Marlatt, Yearbook, U. S. Dept. Agric., 1900, p. 261, 1901.
Exhibit: Infested twig.

GLOVER'S SCALE; LONG SCALE.

Lepidosaphes gloveri Pack.

(Food plants: Lime, magnolia, orange, palms; formerly *Mytilaspis.*)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., p. 309, 1903; Marlatt, Yearbook, U. S. Dept. Agric., 1900, p. 265, 1901.
Exhibit: Infested twig.

THE CHAFF SCALE.

Parlatoria pergandei Comst.

(Food plants: Japonica, lemon, orange.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 319–320, 1903; Marlatt, Yearbook, U. S. Dept. Agric., 1900, p. 270, 1901.
EXHIBIT: Infested twigs.

THE SAN JOSE SCALE.

THE SAN JOSE SCALE.

Aspidiotus perniciosus Comst.

(Food plants: Almond, apple, apricot, birch, black walnut, black currant, catalpa, chestnut, crab-apple, crab-grass, cherry, grape, hickory, oak, peach, pear, persimmon, plum, poplar, prune, Rocky Mountain cherry, rose, silver maple, willow, and many other plants.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 271–275, 1903; Howard and Marlatt, Bul. 3, n. s., Div. Ent. U. S. Dept. Agric., 1896, 80 pp.
EXHIBIT: Infested twig, fruit, figures, and enemies: *Pentilia misella* Lec., adult and figure; *Chilocorus similis* Rossi, larva, pupa, adult, and figure; parasite, *Aphelinus diaspidis* How., adult and figure.

INSECTS INJURIOUS TO APPLE.

For special treatises on apple insects see Bruner, Trans. Nebr. St. Hort. Soc. f. 1894, pp. 155–223, 1895; Harvey and Munson, Bul. 56, Maine Agr. Expt. Sta., 1899; Saunders, Insects Injurious to Fruits, 2d ed., pp. 13–139, 1900.

INJURING THE ROOTS.

THE WOOLLY APPLE APHIS.

Schizoneura lanigera Hausm.

For general account see Marlatt, Cir. 20, Div. Ent., U. S. Dept. Agric., 1897.
EXHIBIT: Work, figure, parasite, *Aphelinus mali* Hal., and enemy, *Scymnus cervicalis* Muls.

INJURING THE TRUNK.

FLAT-HEADED APPLE-TREE BORER.

Chrysobothris femorata Fab.

For general account see Chittenden, Cir. 32, Div. Ent., U. S. Dept. Agric., pp. 9–12, 1898.
EXHIBIT: Adult, work, and figure.

ROUND-HEADED APPLE-TREE BORER.

Saperda candida Fab.

For general account see Chittenden, Cir. 32, Div. Ent., U. S. Dept. Agric., pp. 1–8, 1898.
EXHIBIT: Adult, work, and figure.

APPLE-WOOD STAINER; PIN-BORER.

Pterocyclon mali Fitch.

(Formerly *Monarthrum.*)
For general account of this and an allied species, *M. fasciatum* Say, see Hubbard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 26–28, 1897.
EXHIBIT: Adult and figure.

INJURING THE BRANCHES.

THE APPLE-TREE PRUNER.

Elaphidion villosum Fab.

For full account and food plants see Chittenden, Bul. 18, n. s., Div. Ent., U. S. Dept. Agric., pp. 35–40, 1898.
EXHIBIT: Adult, work, and figure.

THE NEW YORK WEEVIL.

Ithycerus noveboracensis Först.

For general account see Lugger, 5th Rpt. St. Ent. Minn., pp. 187–189, 1899.
EXHIBIT: Adult and work.

THE APPLE TWIG-BORER.

Amphicerus bicaudatus Say.

For general account see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., pp. 11–13, fig., 1898.
EXHIBIT: Adult, work, and figur .

THE APPLE TWIG-BEETLE.

Stephanoderes hispidulus Lec.

(Formerly *Hypothenemus.*)
EXHIBIT: Adult and work.

PEAR-BLIGHT BEETLE; SHOT-BORER.

Xyleborus pyri Peck.

(Formerly considered *X. dispar.*)
For general account see Hubbard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 22–23, 1897.
EXHIBIT: Adult and work.

THE COSMOPOLITAN AMBROSIA BEETLE.

Xyleborus saxeseni Ratz.

(Formerly *X. xylographus.*)
For general account see Hubbard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 24–26, 1897.
EXHIBIT: Adult.

FRUIT-TREE BARK BEETLE; THE SHOT-HOLE BORER.

Scolytus rugulosus Ratz.

For general account see Chittenden, Cir. 29, Div. Ent., U. S. Dept. Agric., 1898.
EXHIBIT: Adult and figure.

THE BUFFALO TREE-HOPPER.

Ceresa bubalus Fab.

For general account see Marlatt, Cir. 23, Div. Ent., U. S. Dept. Agric., 1897.
EXHIBIT: Adult, work, and figure.

THE PERIODICAL CICADA.

Tibicen septendecim Linn.

For life history and general article see Marlatt, Bul. 14, n. s., Div. Ent., U. S. Dept. Agric., 1898.
EXHIBIT: Pupa, pupa skins, and adult.

THE SAN JOSE SCALE.

Aspidiotus perniciosus Comst.

(Food plants: Almond, apple, apricot, birch, black walnut, black currant, catalpa, chestnut, crab-apple, crab-grass, cherry, grape, hickory, oak, peach, pear, persimmon, plum, poplar, prune, Rocky Mountain cherry, rose, silver maple, willow, and many other plants.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 271–275, 1903; Howard and Marlatt, Bul. 3, n. s., Div. Ent., U. S. Dept. Agric., 1896. 80 pp.

Exhibit: Infested twig.

PUTNAM'S SCALE; CRANBERRY SCALE.

Aspidiotus ancylus Putn.

(Food plants: Apple, apricot, box elder, cottonwood, cranberry, elm, hemlock, maple, oak, peach, pear, plum, etc.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 252–253, 1903.

Exhibit: Infested twig.

THE CHERRY SCALE; FORBES' SCALE.

Aspidiotus forbesi Johns.

(Food plants: Apple, cherry, currant, honey locust, peach, pear, plum, walnut, etc.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 259–260, 1903.

Exhibit: Infested twig.

THE GREEDY SCALE.

Aspidiotus rapax Comst.

(Food plants: Cottonwood, maple, olive, pear, quince, apple, etc.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 276–278, 1903.

Exhibit: Infested twig.

THE EUROPEAN FRUIT-SCALE.

Aspidiotus ostreæformis Curt.

(Food plants: Apple, cherry, maple, oak, peach, pear, etc.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 268–270, 1903.

Exhibit: Infested twig.

THE SCURFY SCALE.

Chionaspis furfura Fitch.

(Food plants: Apple, cherry, currant, elm, pear, etc.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 217–219, 1903; Howard, Yearbook, U. S. Dept. Agric., 1894, pp. 259–261, figs.; Banks, Bul. 34, Div. Ent., U. S. Dept. Agric., p. 14, 1902.

Exhibit: Infested twig.

OYSTER-SHELL SCALE.

Lepidosaphes ulmi Linn.

(Attacks principally apple, currant, Cornus, cottonwood, lilac, pear, sassafras, etc. Formerly *Mytilaspis pomorum* Bouché.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 314–317, 1903.

Exhibit: Infested twig.

THE BLACK SCALE.

Saissetia oleæ Bern.

(Food plants: Apple, apricot, olive, orange, pear, plum, rose; formerly *Lecanium*.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 205–206, 1903.

Exhibit: Infested twig.

INJURING THE LEAVES.

PISTOL CASE-BEARER.

Coleophora malivorella Riley.

(Feeds on leaves and buds.)
For general account see Slingerland, Bul. 124, Cornell Univ. Agr. Expt. Sta., 1897.
EXHIBIT: Cocoon, adult, work, and figure.

EYE-SPOTTED BUD-MOTH.

Tmetocera ocellana Schiff.

(Feeds on buds and young leaves.)
For general account see Slingerland, Bul. 50, Cornell Univ. Agr. Expt. Sta, 1893.
EXHIBIT: Pupa, adult, and work.

APPLE-TREE BUCCULATRIX.

Bucculatrix pomifoliella Clem.

For general account and partial bibliography see Slingerland and Fletcher, Bul. 214, Cornell Univ. Agr. Expt. Sta., pp. 69–78, figs., 1903.
EXHIBIT: Cocoon, adult, and figure.

THE RESPLENDENT SHIELD-BEARER.

Coptodisca splendoriferella Clem.

For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 263–265, 1899.
EXHIBIT: Cocoon, adult, work, and figure.

CHAPIN'S APPLE-LEAF SEWER.

Ancylis nubeculana Clem.

For brief article see Lugger, 4th Rpt. St. Ent. Minn., pp. 239–240, 1899.
EXHIBIT: Pupa, adult, work, and figure.

THE OBLIQUE-BANDED LEAF-ROLLER.

Archips rosaceana Harr.

(Formerly *Cacœcia.*)
For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 226–227, 1899.
EXHIBIT: Pupa, adult, and work.

THE LESSER APPLE LEAF-FOLDER.

Acleris minuta Rob.

(Formerly *Teras.*)
For general account see J. B. Smith, Farmers' Bul. 178, U. S. Dept. Agric., pp. 12–17, 1903.
EXHIBIT: Pupa and adult.

THE LEAF CRUMPLER.

Mineola indiginella Zell.

For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 211–313, 1899.
EXHIBIT: Cocoon, pupa, adult, and figure.

THE APPLE-LEAF SKELETONIZER.

Canarsia hammondi Riley.

For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 217–218, 1899.
EXHIBIT: Pupa, adult, and work.

APPLE-TREE TENT-CATERPILLAR.

Malacosoma americana Fab.

(Formerly *Clisiocampa.*)
For life history and bibliography see Felt, 14th Rpt. St. Ent., N. Y., pp. 177–190, 1898.
EXHIBIT: Eggs, larva, cocoon, pupa, adult, and work, and the parasites *Pimpla conquisitor* Say, and *Ichneumon lætus* Brullé.

THE LIME-TREE WINTER-MOTH.

Erannis tiliaria Harr.

(Formerly *Hibernia.*)
For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 193–195, 1899.
EXHIBIT: Pupa, adult, and figure.

THE ELM SPANWORM.

Ennomos subsignarius Hbn.

For general account see Packard, 5th Rpt. U. S. Ent. Comm., pp. 232–233, 306–307, 1890.
EXHIBIT: Eggs, larva, pupa, and work.

THE APPLE LEAF-MINER.

Tischeria malifoliella Clem.

For life history and bibliography see Lintner, 11th Rpt. N. Y. St. Ent., pp. 160–162, 1896.
EXHIBIT: Adult and work.

THE SPRING CANKER-WORM.

Paleacrita vernata Peck.

For general account see Coquillett, Cir. 9, Div. Ent., U. S. Dept. Agric., pp. 1–3, 1895.
EXHIBIT: Larva, adult, and figure.

THE FALL CANKER-WORM.

Alsophila pometaria Harr.

(Formerly *Anisopteryx.*)
For general account see Coquillett, Cir. 9, Div. Ent., U. S. Dept. Agric., pp. 3–4, 1895.
EXHIBIT: Eggs, larva, cocoon, adult, and figure.

THE WHITE-MARKED TUSSOCK-CATERPILLAR.

Hemerocampa leucostigma S. & A.

(Larvæ feed extensively upon fruit and shade trees and often damage shrubs and vines; formerly *Orgyia.*)
For general account of this insect and its parasites see Howard, Tech. Ser., 5, Div. Ent., U. S. Dept. Agric., 1897; for life history, etc., Howard, Farmers' Bul. 99, pp. 12–20, 1899.
EXHIBIT: Egg-masses, larva, and adult.

THE FALL WEBWORM.

Hyphantria cunea Dru.

For general account see Howard, Farmers' Bul. 99, U. S. Dept. Agric., pp. 20–25, 1899.
EXHIBIT: Larva, pupa, adult, and work.

THE COMMON BAGWORM.

Thyridopteryx ephemeræformis Steph.

For general account see Packard, 5th Rpt. U. S. Ent. Comm., pp. 258–262, 1890.
EXHIBIT: Cocoons and figure.

IO MOTH.

Automeris io Fab.

For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 126–129, fig. 130, and pl. 16, fig. 129, 1899.
EXHIBIT: Adult.

THE BROWN-TAIL MOTH.

Euproctis chrysorrhœa Linn.

For life history and general article see Fernald and Kirkland, Spec. Bul. Hatch. Expt. Sta., Mass., 15 pp., 1 fig., 3 pls., 1898; Marlatt, Circ. 58, Bur. Ent., U. S. Dept. Agric., 1905.
Exhibit: Larva, adult, and figure.

THE GYPSY MOTH.

Porthetria dispar Linn.

(Formerly *Ocneria.*)
For life history, habits, and general account see Forbush and Fernald, "The Gypsy Moth," 495 pp. + i–c, 1896; Howard, Bul. 11, n. s., Div. Ent., U. S. Dept. Agric., 1897; Marlatt, Circ. 58, Bur. Ent., U. S. Dept. Agric., 1905.
Exhibit: Larva, adult, and figure.

THE CLIMBING CUTWORM.

Euxoa scandens Riley.

(Formerly *Carneades.*)
For general account see Slingerland, Bul. 104, Cornell Univ. Agr. Expt. Sta., pp. 567–569, Pl. I, 1895.
Exhibit: Adult.

THE CECROPIA MOTH.

Samia cecropia Linn.

For general account see Riley, 4th Rpt. Ins. Mo., pp. 103–111, 1872.
Exhibit: Larva, cocoon, and adult.

APPLE APHIS.

Aphis pomi Linn.

For general account as *Aphis mali* see Smith, Bul. 143, N. J. Agr. Expt. Sta., 1900.
For general article treating of several species occurring on apple see Pergande, Bul. 44, Div. Ent., U. S. Dept. Agric., pp. 5–23, 1904.
Exhibit: Work and figure and the following enemies: *Adalia bipunctata* L., *Anatis 15-punctata* Ol., *Coccinella novemnotata* Hbst., *C. sanguinea* L., *Harmonia picta* Rand., *Hippodamia convergens* Guen., and *H. 13-punctata* L.

THE IMBRICATED SNOUT-BEETLE.

Epicærus imbricatus Say.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 28–29, 1903, and Bul. 19, n. s., pp. 62–67, 1899.
Exhibit: Adult.

SYNETA ALBIDA Lec.

For brief notice see Riley and Howard, Insect Life, Vol. IV, p. 396, 1892.
Exhibit: Adult and work.

RED-LEGGED FLEA-BEETLE.

Crepidodera rufipes Linn.

For general article see Insect Life, Vol. V, pp. 334–342, 1893.
Exhibit: Adult.

THE APPLE-LEAF FLEA-WEEVIL.

Orchestes pallicornis Say.

For short account of life history see Forbes, Trans. Ill. St. Hort. Soc. f. 1901, p. 147, 1902.
Exhibit: Adult.

INJURING THE FRUIT.

TEN-SPOTTED XANTHONIA.

Xanthonia decemnotata Say.

EXHIBIT: Adult and work.

THE INDIAN EUPHORIA.

Euphoria inda Linn.

For life history and general account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 67–74, 1899.
EXHIBIT: Adult and work.

JUNE BEETLE; FIG EATER.

Allorhina nitida Linn.

For general account see Howard Bul. 10. n. s., Div. Ent., U. S. Dept. Agric., pp. 20–26, 1898.
EXHIBIT: Adult.

CODLING MOTH; APPLE WORM.

Carpocapsa pomonella Linn.

For full bibliography, life history, and illustrations see Simpson, Bul. 41, Div. Ent. U. S. Dept. Agric., 105 pp., figs., 1903.
EXHIBIT: Full life history (larva, pupa, cocoons, and adult) and parasites: *Pimpla annulipes* Brullé and *P. conquisitor* Say. Enemies: *Chauliognathus pennsylvanicus* DeG. and *Telephorus bilineatus* Say.

THE GREEN FRUIT-WORMS.

The following three species of *Xylina* are commonly known as green fruit-worms. For general account see Slingerland, Bul. 123, Cornell Univ. Agr. Expt. Sta., 1896.

Xylina antennata Walk.

EXHIBIT: Adult and figure.

Xylina grotei Riley.

EXHIBIT: Adult and figure.

Xylina laticinerea Grote.

EXHIBIT: Adult and figure.

ILLUSTRATION SHOWING WORK OF A TORTRICID ON APPLE.

(The larva mines in, and feeds beneath, the skin of the fruit.)

THE PLUM CURCULIO.

Conotrachelus nenuphar Hbst.

For general account and bibliography see Lintner, 7th Rpt. N. Y. St. Ent., pp. 288–296, 1891.
EXHIBIT: Adult and figure.

THE APPLE CURCULIO.

Anthonomus quadrigibbus Say.

For general account see Gillette, Bul. 11, Iowa Agric. Expt. Sta., pp. 492–494, 1890.
EXHIBIT: Adult and figure.

THE APPLE-FRUIT MAGGOT.

Rhagoletis pomonella Walsh.

(Formerly *Trypeta.*)
For life history see Harvey, Rpt. Maine Agr. Expt. Sta., p. 190, 1889; Banks, Bul. 34, Div. Ent., U. S. Dept. Agric., p. 45, 1902.
EXHIBIT: Puparium, adult, and figure.

INSECTS INJURIOUS TO PEACH.

Saunders, Insects Injurious to Fruits, 2d edit., pp. 191–200, 1900.

THE NATIVE PEACH BARK-BEETLE.

Phlœophthorus liminaris Harr.

(Formerly *Phlœotribus.*)
For general account see Lintner, 9th Rpt. N. Y. St. Ent., pp. 365–368, 1893.
EXHIBIT: Adult and work.

THE FRUIT-TREE BARK-BEETLE.

Scolytus rugulosus Ratz.

For general account see Chittenden, Cir. 29, Div. Ent., U. S. Dept. Agric., 1898.
EXHIBIT: Adult, work, figure, and the parasite *Cheiropachys colon* Linn.

THE PEACH BORER.

Sanninoidea exitiosa Say.

(Formerly *Sannina.*)
For general account see Marlatt, Cir. 17, Div. Ent., U. S. Dept. Agric., 1896.
EXHIBIT: Pupa, cocoon, adult, and figure.

THE PERIODICAL CICADA.

Tibicen septendecim Linn.

(Injures, by deposition of eggs in the twigs, almost all fruit, shade, and forest trees.)
For life history and general article see Marlatt, Bul. 14, n. s., Div. Ent., U. S. Dept. Agric., 1898.
EXHIBIT: Pupa, adult, and enemy *Sphecius speciosus* Dru.

THE BLUE-SPANGLED PEACH-MOTH.

Haploa lecontei Boisd.

(Formerly *Callimorpha.*)

For general account see Saunders, Insects Injurious to Fruits, 2d edit., pp. 197–199, 1900.
EXHIBIT: Adult.

THE PEACH-TWIG MOTH.

Anarsia lineatella Zell.

For general article with bibliography see Marlatt, Bul. 10, n. s., Div. Ent., U. S. Dept. Agric., pp. 7–20, 1898.
EXHIBIT: Pupa, adult, work, and figure.

THE INDIAN FRUIT-FLY.

Ceratitis capitata Wied.

For general article see Riley, Rpt. U. S. Dept. Agric., 1890, pp. 255–257.
EXHIBIT: Pupa, adult, and figure.

THE PEACH SCALE.

Eulecanium persicæ Fab.

(Food plants: Peach, plum, quince, etc.; formerly *Lecanium.*)
For bibliography, food plants, and distribution see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 191–193, 1903.
EXHIBIT: Infested twig.

PUTNAM'S SCALE; CRANBERRY SCALE.

Aspidiotus ancylus Putn.

(Food plants: Apple, apricot, box-elder, cottonwood, cranberry, elm, hemlock, maple, oak, peach, pear, plum, etc.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 252–253, 1903.
EXHIBIT: Infested twig.

THE SAN JOSE SCALE.

Aspidiotus perniciosus Comst.

(Food plants: Almond, apple, apricot, birch, black walnut, black currant, catalpa, chestnut, crab-apple, crab-grass, cherry, grape, hickory, oak, peach, pear, persimmon, plum, poplar, prune, Rocky Mountain cherry, rose, silver maple, willow, and many other plants.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 271–275, 1903; Howard and Marlatt, Bul. 3, n. s., Div. Ent., U. S. Dept. Agric., 1896, 80 pp.

Exhibit: Infested twig.

THE CHERRY LEAF-BEETLE.

Galerucella cavicollis Lec.

For general article and distribution see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 90–93, 1899.

Exhibit: Adult.

THE CHERRY-FRUIT MAGGOT.

Rhagoletis cingulata Loew.

For detailed account see Slingerland, Bul. 172, Cornell Univ. Agr. Exp. Sta., 41 pp., 6 figs., 1899; Chittenden, Bul. 44, Div. Ent., U. S. Dept. Agric., pp. 70–75, 1904.

Exhibit: Adult.

INSECTS INJURIOUS TO PEAR.

(Many of the insects injuring the apple will be found attacking the pear.)

THE FRUIT-TREE BARK-BEETLE.

Scolytus rugulosus Ratz.

For general account see Chittenden, Cir. 29, Div. Ent., U. S. Dept. Agric., 1898.

Exhibit: Adult, work, and figure.

PEAR-BLIGHT BEETLE; SHOT-BORER.

Xyleborus pyri Peck.

(Formerly *X. dispar.*)

For general account see Hubbard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 22–23, 1897.

Exhibit: Adult, work, and figure.

THE PEAR BLISTER MITE.

Eriophyes pyri Pagenst.

For detailed account see Slingerland, Bul. 61, Cornell Univ. Agr. Exp. Sta., pp. 317–328, figs., 1893.

Exhibit: Work and figure.

THE PEAR PSYLLA.

Psylla pyri Linn.

(Formerly *P. pyricola.*)

For general accounts see Slingerland, Bul. 44, Cornell Univ. Agr. Sta., 1892; Marlatt, Cir. 7, Div. Ent., U. S. Dept. Agric., 1895.

Exhibit: Adult and figure.

THE PEAR SLUG.

Eriocampoides limacina Retz.

(Formerly *Eriocampa cerasi.*)

For general account see Marlatt, Cir. 28, Div. Ent., U. S. Dept. Agric., 1897.

Exhibit: Adult, work, and figure.

THE SCURFY SCALE.

Chionaspis furfura Fitch.

(Food plants: Apple, cherry, currant, elm, pear, etc.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 217–219, 1903; Howard, Yearbook, U. S. Dept. Agric., 1894, pp. 259–261, figs.; Banks, Bul. 34, Div. Ent., U. S. Dept. Agric., p. 14, 1902.
EXHIBIT: Infested twig.

SINUATE PEAR-BORER.

Agrilus sinuatus Ol.

For general accounts see Smith, Rpt. Entom. N. J. Agr. Exp. Sta. f. 1894, pp. 556–561, 1895; Banks, Bul. 34, Div. Ent., U. S. Dept. Agric., pp. 40–41, 1902.
EXHIBIT: Adult and figure.

INSECTS INJURIOUS TO PLUM.

THE PLUM CURCULIO.

Conotrachelus nenuphar Hbst.

For general account and bibliography see Lintner, 7th Rpt. N. Y. St. Ent., pp. 288–296, 1891.
EXHIBIT: Adult, figure, and enemies, *Aspidoglossa subangulata* Chd., *Chauliognathus pennsylvanicus* DeG., *Harpalus caliginosus* Fab., and parasite *Sigalphus curculionis* Fitch.

THE PLUM GOUGER.

Anthonomus scutellaris Lec.

(Formerly *Coccotorus prunicida* Walsh.)
For general accounts see Riley and Howard, Insect Life, Vol. II, pp. 258–259, 1890; Gillette, Bul. 47, Colo. Agr. Exp. Sta., pp. 20–22, 1898.
EXHIBIT: Adult, work, and figure.

THE HOP APHIS.

Phorodon humuli Schr.

(Attacks hop and plum.)
For full life history see Riley, Cir. 2, Div. Ent., U. S. Dept. Agric., 1891.
EXHIBIT: Adult and work.

FORBES' SCALE; CHERRY SCALE.

Aspidiotus forbesi Johns.

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 259–260, 1903.
EXHIBIT: Infested twig.

INSECTS INJURIOUS TO GRAPE.

For the more important grape insects see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., 1898; Saunders, Insects Injurious to Fruits, 2d edition, pp. 227–302, 1900; Bruner, Nebr. State Hortic. Soc. Rept. f. 1895, pp. 69–162, 1896.

INJURING THE ROOTS.

THE TILE-HORNED PRIONUS.

Prionus imbricornis Linn.

For general account of *Prionus* species see Lugger, 5th Rpt. St. Ent. Minn., pp. 110–111, 1899.
EXHIBIT: Adult.

THE GRAPEVINE ROOT-BORER.

Memythrus polistiformis Harr.

(Formerly *Sciapteron.*)
For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 55–57, 1899.
EXHIBIT: Figures.

INJURING LEAVES AND ROOTS.

GRAPE PHYLLOXERA.

Phylloxera vastatrix Planch.

For general article see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., pp. 4–9, figs., 1898.
Exhibit: Work and figure.

INJURING THE STEMS AND BRANCHES.

COTTONY MAPLE SCALE.

Pulvinaria innumerablis Rathv.

(Foot-plants: Alder, apple, box-elder, elm, grape, linden, maples, pear, willow, etc.)
For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 134–135, 1903; Howard, Bul. 22, n. s., Div. Ent., U. S. Dept. Agric., pp. 8–16, figs. 4, 1900.
Exhibit: Infested twig.

THE GRAPE SCALE.

Aspidiotus uvæ Comst.

(Food-plants: Ampelopsis, grape, hickory.)
For bibliography see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., p. 280, 1903.
Exhibit: Infested twig.

THE APPLE TWIG-BORER.

Amphicerus bicaudatus Say.

For general account see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., pp. 11–13, figure, 1898.
Exhibit: Adult and figure.

RED-SHOULDERED TWIG-BORER.

Sinoxylon basilare Say.

For general account see Lugger, 5th Rpt. St. Ent. Minn., pp. 70–72, 1899.
Exhibit: Adult and figure.

THE SNOWY TREE-CRICKET.

Œcanthus niveus DeG.

For general account see Lugger, 3d Rpt. St. Ent. Minn., pp. 269–271, 1898.
Exhibit: Adult and figure.

ŒCANTHUS LATIPENNIS Riley.

For brief article see Lugger, 3d Rpt. St. Ent. Minn., p. 273, 1898.
Exhibit: Adult.

GRAPE-VINE ROOT-WORM.

Fidia viticida Walsh.

For life history and bibliography see Felt, Bul. 72, N. Y. St. Museum, 1903, 55 pp., with colored plate.
Exhibit: Adult and figure.

GRAPE-VINE FIDIA.

Fidia longipes Mels.

Exhibit: Adult.

INJURING THE LEAVES.

ACHEMON SPHINX.

Pholus achemon Dru.

(Formerly *Philampelus*.)
For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 38–40, 1899.
Exhibit: Larva and adult.

GRAPE-VINE HOG-CATERPILLAR.

Ampelophaga myron Cram.

For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 42–45, 1899.
EXHIBIT: Larva and adult.

ABBOT'S SPHINX.

Sphecodina abbotii Swaine.

(Formerly *Thyreus.*)
For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 32–33, 1899.
EXHIBIT: Larva and adult.

LARGE BEAUTIFUL WOOD NYMPH.

Euthisanotia grata Fab.

(Formerly *Eudryas.*)
For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 69–71, 1899.
EXHIBIT: Larva and adult.

SMALL BEAUTIFUL WOOD NYMPH.

Euthisanotia unio Hübn.

For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 71–72, 1899.
EXHIBIT: Larva and adult.

EIGHT-SPOTTED FORESTER.

Alypia octomaculata Fab.

For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 66–67, 1899.
EXHIBIT: Larva and adult.

SOCIAL GRAPE CATERPILLAR.

Harrisina americana Guer.

(Formerly *Procris.*)
For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 72–74, 1899.
EXHIBIT: Adult and figure.

GRAPE LEAF-FOLDER.

Desmia funeralis Hübn.

For general account see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., pp. 16–17, 1898.
EXHIBIT: Larva, adult, and work.

GRAPE-VINE PLUME-MOTH.

Oxyptilus periscelidactylus Fitch.

For general article see Lugger, 4th Rpt. St. Ent. Minn., pp. 221–222, 1899; for bibliography and article see Lintner, 12th Rpt. St. Ent. N. Y., pp. 218–222, 1897.
EXHIBIT: Larva and adult.

GRAPE-VINE SAW-FLY.

Blennocampa pygmæa Say.

For general articles see Harris, Insects Injurious to Vegetation, pp. 522–525; Beach, Lowe, and Stewart, Bul. 170, N. Y. Agric. Expt. Sta., p. 417, 1899.
EXHIBIT: Adult and figure.

GRAPE-VINE FLEA-BEETLE.

Haltica chalybea Ill.

For general articles see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., pp. 13–14, 1898; Slingerland, Bul. 157, Cornell Univ. Agr. Expt. Sta., N. Y., 1898. For additional food plants see Lugger, 5th Rpt. St. Ent. Minn., pp. 157–159, 1899.
EXHIBIT: Adult and figure.

THE GRAPE-VINE COLASPIS.

Colaspis brunnea Fab.

For general article see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 13–14, 1903.
EXHIBIT: Adult.

THE VARIED ANOMALA.

Anomala varians Burm.

EXHIBIT: Adult.

THE GRAPE-VINE LEAF-HOPPER.

Typhlocyba comes Say.

For general article see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., pp. 18–20, 1898, under *Typhlocyba vitifex*. For full life history and general account see Slingerland, Bul. 215, Cornell Univ. Agr. Expt. Sta., 1904.
EXHIBIT: Adult and figure.

THE WAVED SHARPSHOOTER.

Oncometopia undata Fab.

(Formerly *Proconia*.)
For general article see Lugger, 6th Rpt. St. Ent. Minn., pp. 136–137, 1900.
EXHIBIT: Adult.

INJURING THE FRUIT.

THE GRAPE-SEED WORM.

Evoxysoma vitis Saunders.

(Formerly *Isosoma*.)
For general account see Saunders, Insects Injurious to Fruits, 2d ed., pp. 296–297, 1900.
EXHIBIT: Adult.

THE GRAPE FRUIT-MOTH.

Polychrosis botrana Schiff.

(Formerly *Eudemis*.)
For general article see Marlatt, Farmers' Bul. 70, U. S. Dept. Agric., pp. 20–22, 1898.
EXHIBIT: Adult and figure.

THE GRAPE SEED-WEEVIL.

Craponius inæqualis Say.

For general accounts see Saunders, Insects Injurious to Fruits, 2d ed., pp. 300–301, 1900; Lintner, 9th Rpt. N. Y. St. Ent., pp. 364–365, 1893.
EXHIBIT: Adult and figure.

INSECTS INJURIOUS TO STRAWBERRY.

For general articles treating of these insects see Forbes, 13th Rpt. Ill. St. Ent., pp. 60–180, 1884; Saunders, Insects Injurious to Fruits, 2d ed., pp. 321–335, 1900.

INJURING THE ROOTS AND CROWN.

THE STRAWBERRY CROWN-GIRDLER.

Otiorhynchus ovatus Linn.

For brief bibliography and account see Lintner, 10th Rpt. St. Ent. N. Y., pp. 416–419, 1895.
EXHIBIT: Adult.

THE STRAWBERRY CROWN-BORER.

Tyloderma fragariæ Riley.

For detailed accounts see Forbes, 12th Rpt. Ill. St. Ent., pp. 64–75, 1883; 13th Rpt., p. 142, 1884.
EXHIBIT: Adult, work, and figure.

STRAWBERRY CROWN MOTH.

Ægeria rutilans Hy. Edw.

(Formerly *Sesia*.)
For general account see Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 85–90, 1900.
EXHIBIT: Adult, pupa, and work.

THE SPOTTED STRAWBERRY LEAF-BEETLE.

Typophorus canellus Fab.

For general account see Forbes, 13th Rpt. St. Ent. Ill., pp. 159–163, 1884.
EXHIBIT: Adult.

INJURING THE ROOTS.

WHITE GRUB; JUNE BEETLE.

Lachnosterna arcuata Sm.

For general account see Chittenden, Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., pp. 74–76, 1901.
EXHIBIT: Adult and figure.

THE STRAWBERRY ROOT-BORER.

Graphops nebulosus Lec.

For brief notice see Garman, Bul. 31, Ky. Agric. Exp. Sta., p. 23, 1890.
EXHIBIT: Adult.

INJURING THE LEAVES.

THE STRAWBERRY FALSE-WORM.

Harpiphorus maculatus Nort.

For general account see Harrington, Insect Life, Vol. II, pp. 227–228, 1890.
EXHIBIT: Larva, pupa, adult, work, and figure.

THE STRAWBERRY LEAF-CHAFER.

Diplotaxis frondicola Say.

For brief account see Kridelbaugh, Ann. Rpt. Ia. St. Hort. Soc., 1871, p. 161, 1872
EXHIBIT: Adult and work.

THE STRAWBERRY FLEA-BEETLE.

Haltica ignita Ill.

For general account see Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 70–78, 1900.
EXHIBIT: Adult.

THE ROSE LEAF-BEETLE.

Nodonota puncticollis Say.

For general account see Chittenden, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 60–61, 1897.
EXHIBIT: Adult.

THE DUSKY PLANT-BUG.

Calocoris rapidus Say.

For short account see Lugger, 1st Rpt. St. Ent. Minn., p. 65, 1900.
EXHIBIT: Adult.

RASPBERRY LEAF-ROLLER.

Exartema permundana Clem.

For general account see Packard, 5th Rpt. U. S. Ent. Comm., pp. 312–313, 1890.
EXHIBIT: Adult.

THE STRAWBERRY LEAF-ROLLER.

Ancylis comptana Fröhl.

(Formerly *Phoxopteris.*)
For general account see Smith, Bul. 149, N. J. Agric. Expt. Sta., pp. 3–12, 1901.
EXHIBIT: Larva, pupa, adult, and figure.

THE SMEARED DAGGER.

Apatela oblinita S. & A.

(Formerly *Acronycta.*)
For general account see Packard, 5th Rpt. U. S. Ent. Comm., pp. 567–568, 1890.
EXHIBIT: Larva, adult, and figure.

INJURING THE BUDS AND STEMS.

THE STRAWBERRY WEEVIL.

Anthonomus signatus Say.

(Lays eggs in buds and severs stems.)
For general account see Chittenden, Cir. 21, Div. Ent., U. S. Dept. Agric., 1897.
EXHIBIT: Adult, work, figure, and the parasites *Calyptus tibiator* Cr. and *Catolaccus incertus* Ashm.

INSECTS INJURIOUS TO BLACKBERRY AND RASPBERRY.

For general articles see Webster, Bul. 45, Ohio Agric. Expt. Sta., pp. 151–217, 1893; Saunders, Insects Injurious to Fruits, 2d edit., pp. 303–320, 1900.

INJURING THE ROOTS.

THE RASPBERRY ROOT-BORER.

Bembecia marginata Harr.

For general account see Smith, Spec. Bul. N, N. J. Agric. Expt. Sta., pp. 9–12, 1891.
EXHIBIT: Larva and adult.

INJURING THE STEMS.

BLACKBERRY GALL-MAKER.

Diastrophus turgidus Bass.

(Formerly *D. nebulosus* O. S.)
For brief article see Saunders, Insects Injurious to Fruits, 2d ed., pp. 318–319, 1900.
EXHIBIT: Adult and figure.

RASPBERRY CANE-BORER.

Oberea bimaculata Ol.

For bibliography and general account see Lintner, 5th Rpt. N. Y. St. Ent., pp. 231–233, 1889.
EXHIBIT: Adult and work.

THE SNOWY TREE-CRICKET.

Œcanthus niveus DeG.

For general account see Lugger, 3d Rpt. St. Ent. Minn., pp. 269–271, 1898.
EXHIBIT: Adult, work, and figure.

RED-NECKED CANE-BORER.

Agrilus ruficollis Fab.

For general account see Smith, Spec. Bul. N, N. J. Agric. Expt. Sta., pp. 4–8, 1891.
EXHIBIT: Adult, work, and figure.

INJURING THE LEAVES.

THE RASPBERRY SAWFLY.

Monophadnoides rubi Harris.

(Formerly *Monophadnus.*)
For bibliography and general account see Lowe, Bul. 150, N. Y. Agric. Expt. Sta., pp. 249–262, pls. IV–VI, 1898.
EXHIBIT: Larva, adult, and work.

RASPBERRY LEAF-ROLLER.

Exartema permundana Clem.

For general account see Packard, 5th Rpt. U. S. Ent. Comm., pp. 312–313, 1890.
EXHIBIT: Adult.

THE FALL WEBWORM.

Hyphantria cunea Dru.

(Feeds on leaves of various trees, shrubs, and vines.)
For general account see Howard, Farmers' Bul. 99, U. S. Dept. Agric., pp. 20–25, 1899.
EXHIBIT: Adult and figure.

THE SMEARED DAGGER.

Apatela oblinita S. & A.

(Formerly *Acronycta.*)
For general account see Packard, 5th Rpt. U. S. Ent. Comm., pp. 567–568, 1890.
EXHIBIT: Larva and adult.

STRAWBERRY LEAF-ROLLER.

Ancylis comptana Fröhl.

(Formerly *Phoxopteris.*)
For general account see Smith, Bul. 149, N. J. Agric. Expt. Sta., pp. 3–12, 1901.
EXHIBIT: Pupa and adult.

THE FOUR-MARKED LEAF-BEETLE.

Cryptocephalus quadrimaculatus Say.

EXHIBIT: Adult.

THE HOODED PLANT-BUG.

Euthoctha galeator Fab.

For brief notices see Riley and Howard, Insect Life, Vol. I, p. 54, 1888; p. 366, 1889.
EXHIBIT: Eggs, nymph, and adult.

INJURING THE FRUIT.

RASPBERRY SPAN-WORM.

Synchlora ærata Fab.

(Formerly *S. glaucaria.*)
For bibliography and general account see Lintner, 8th Rpt. St. Ent. N. Y., pp. 129–133, 1893.
EXHIBIT: Pupa, adult, and figure.

THE LITTLE NEGRO BUG.

Corimelæna pulicaria Germ.

For general account see Lintner, 8th Rpt. St. Ent. N. Y., pp. 213–214, 1893.
EXHIBIT: Adult and figure.

INSECTS INJURIOUS TO CURRANT AND GOOSEBERRY.

For general article on insects affecting currant and gooseberry see Piper and Doane, Bul. 36, Washington Agr. Expt. Sta., 1898.

INJURING THE STEMS.

THE TERRAPIN SCALE.

Eulecanium nigrofasciatum Perg.

(Food plants: Apple, birch, linden, maple, peach, plum, sycamore; formerly *Lecanium.*)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., p. 191, 1903; Pergande, Bul. 18, n. s., Div. Ent., U. S. Dept. Agr., pp. 26–29, figs., 1898.

Exhibit: Infested twig.

THE NATIVE CURRANT STEM-BORER.

Psenocerus supernotatus Say.

For general account see Lugger, 5th Rpt. State Entom. of Minnesota, pp. 121–122, 1899.

Exhibit: Adult and work.

CURRANT CLEARWING MOTH; IMPORTED CURRANT-BORER.

Ægeria tipuliformis Clerck.

For general account see Lugger, 4th Rpt. State Entom. Minn., pp. 60–64, 1899.

Exhibit: Adult and work.

PUTNAM'S SCALE; CRANBERRY SCALE.

Aspidiotus ancylus Putn.

(Food plants: Apple, apricot, box-elder, cottonwood, cranberry, elm, hemlock, maple, oak, peach, pear, plum, etc.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 252–253, 1903.

Exhibit: Infested twig.

THE SAN JOSE SCALE.

Aspidiotus perniciosus Comst.

(Food plants: Almond, apple, apricot, birch, black walnut, black currant, catalpa, chestnut, crab-apple, crab-grass, cherry, grape, hickory, oak, peach, pear, persimmon, plum, poplar, prune, Rocky Mountain cherry, rose, silver maple, willow, and many other plants.)

For bibliography and food plants see Fernald, Cat. Coccidæ of World, Bul. 88, Mass. Agr. Coll., pp. 271–275, 1903; Howard and Marlatt, Bul. 3, n. s., Div. Ent., U. S. Dept. Agr., 1896. 80 pp.

Exhibit: Infested twig.

THE BLACK GOOSEBERRY BORER.

Xylocrius agassizii Lec.

For general accounts see Fletcher, Rpt. of Ent. and Bot. for 1898, Can. Dept. Agric., pp. 207-210, 1899; Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 90–92, 1900.

Exhibit: Adult and figure.

INJURING THE LEAVES.

GOOSEBERRY SPANWORM.

Cymatophora ribearia Fitch.

(Formerly *Eufitchia.*)

For short account see Lugger, 4th Rpt. State Ent. Minn., pp. 184–186, 1899.

Exhibit: Eggs, larva, pupa, adult, and figure.

IMPORTED CURRANT WORM.

Pteronus ribesii Scop.

(Formerly *Nematus ventricosus.*)
For bibliography and technical description see Marlatt, Tech. Series 3, Div. Entom., U. S. Dept. Agric., pp. 61–63, 1896.
EXHIBIT: Adult, figure, and an enemy, *Podisus placidus* Uhl.

THE NATIVE CURRANT WORM.

Pristiphora grossulariæ Walsh.

For bibliography see *Gymnonychus appendiculatus* Htg., Marlatt, Tech. Series 3, Div. Entom., U. S. Dept. Agric., p. 124, 1896.
EXHIBIT: Adult and figure.

THE CRANBERRY LOOPER.

Xanthotype crocataria Fab.

For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 178–179, 1899.
EXHIBIT: Larva and adult.

POLYGONIA PROGNE Cram.

(Formerly *Grapta.*)
For general account see Packard, 5th Rpt. U. S. Entom. Comm., pp. 241, 1890.
EXHIBIT: Larva, chrysalis, and adult.

INJURING THE FRUIT.

GOOSEBERRY FRUIT-WORM.

Zophodia grossulariæ Pack.

For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 214–216, 1899.
EXHIBIT: Pupa and adult.

INSECTS INJURIOUS TO GRASSES.

APANTESIS NAIS Dru.

(Formerly *Arctia.*)
For account see Beutenmüller, "Cat. Lep. N. Y.," Ann. Acad. N. Y., p. 206, 1890.
EXHIBIT: Adult.

GRANULATED CUTWORM.

Feltia annexa Fr.

For general account see Riley, Rpt. U. S. Dept. Agric., 1884, pp. 291–292, 1885.
For description and stages see French, Can. Ent., Vol. XIV, pp. 207–210, 1882.
EXHIBIT: Adult and figure.

HOMOPTERA EDUSA Dru.

EXHIBIT: Larva, pupa, and adult.

NORTHERN GRASS WORM.

Drasteria erechtea Cram.

For general account see Slingerland, Insect Life, Vol. V, pp. 87–88, 1892.
EXHIBIT: Larva, pupa, adult, and work.

THE ARMY WORM.

Heliophila unipuncta Harv.

(Formerly *Leucania.*)
For bibliography and life history see Lintner, 12th Rpt., St. Ent. N. Y., pp. 190–214, 1896.
EXHIBIT: Larva, pupa, adult, and figure.

THE SALT-MARSH CATERPILLAR.

Estigmene acræa Dru.

(Formerly *Leucarctia.*)
For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 43–44, 1903.
EXHIBIT: Larva and adult.

FALL ARMY WORM.

Laphygma frugiperda S. & A.

For full bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 40–45, 1901.
EXHIBIT: Larva, pupa, adult, and figure.

THE ISABELLA TIGER MOTH.

Isia isabella S. & A.

(Formerly *Pyrrharctia.*)
For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 44–45, 1903.
EXHIBIT: Larva, cocoon, adult, and figure.

THE VAGABOND CRAMBUS.

Crambus vulgivagellus Clem.

For general accounts see Lintner, 1st Rpt. St. Ent. N. Y., pp. 127–151, 1882; Felt, Bul. 64, Cornell Univ. Agric. Expt. Sta., pp. 69–71, 1894.
EXHIBIT: Eggs, adult, work, figure, and parasite *Lampronotus frigida* Cr.

THE SPOTTED CUTWORM.

Noctua c-nigrum Linn.

For general account and life history see Chittenden, Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., pp. 54–58, 1901.
EXHIBIT: Pupa and adult.

WHITE GRUB; MAY BEETLE.

Lachnosterna fusca Fröh.

For account of white grubs see Forbes, 18th Rpt. St. Ent. Ill., pp. 109–145, 1894.
EXHIBIT: Adult.

WHITE GRUB; JUNE BEETLE.

Lachnosterna arcuata Smith.

For general account see Chittenden, Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., pp. 74–76, 1901.
EXHIBIT: Adult and figure.

THE DISTENDED MAY BEETLE.

Lachnosterna farcta Lec.

For short notices see Comstock, Rpt. U. S. Dept. Agric. 1879, pp. 247–248, Pl. V, fig. 5, 1880, and Howard, Bul. 22, n. s., Div. Ent., U. S. Dept. Agric., p. 107, 1900.
EXHIBIT: Adult.

THE BLUE-GRASS BILL-BUG.

Sphenophorus parvulus Gyll.

For article see Forbes, 16th Rpt. St. Ent. Ill., pp. 63, 65, 1894.
EXHIBIT: Adult.

THE LESSER LOCUST.

Melanoplus atlanis Riley.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 178–183, pl. 12, fig. 7, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 26–27, 1891.
EXHIBIT: Adult.

THE CAROLINA LOCUST.

Dissosteira carolina Linn.

For short account see Forbes and Hart, Bul. 60, Ill. Agric. Expt. Sta., pp. 479–480, 1900.
Exhibit: Nymph and adult.

THE TIMOTHY PLANT-BUG.

Oncognathus binotatus Fab.

For general account see Howard, Insect Life, Vol. V, pp. 90–92, 1892.
Exhibit: Adult.

THE GREATER WHEAT-STEM MAGGOT.

Meromyza americana Fitch.

For general article see Webster, Bul. 42, Div. Ent., U. S. Dept. Agric., pp. 43–51, 1903.
Exhibit: Adult and figure.

LEATHER JACKET; MEADOW WORM.

Tipula bicornis Loew.

For general account see Forbes, 16th Rpt. St. Ent. Ill., pp. 78–83, 1890.
Exhibit: Adult and figure.

INSECTS INJURIOUS TO ALFALFA.

THE VARIEGATED CUTWORM.

Peridroma saucia Hbn.

For general bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp., 46–64, 1901.
Exhibit: Larva and adult.

THE FALL ARMY WORM.

Laphygma frugiperda S. & A.

For full bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 40–45, 1901.
Exhibit: Larva and adult.

THE ALFALFA WEBWORM.

Loxostege commixtalis Walk.

(Formerly *L. cereralis* Zell.)
For account of *Loxostege* sp. attacking alfalfa see Insect Life, Vol. VI, p. 36, 1893.
Exhibit: Adult.

THE TWO-STRIPED LOCUST.

Melanoplus bivittatus Say.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 363–368, pl. 24, fig. 5, 1897.
Exhibit: Adult and figure.

THE DIFFERENTIAL LOCUST.

Melanoplus differentialis Thos.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 349–354, pl. 23, figs. 3 and 4, 1897; also Morgan, Bul. 30, n. s., Div. Ent. U. S. Dept. Agric., pp. 7–26, 1901.
Exhibit: Adult and figure.

THE ROCKY-MOUNTAIN LOCUST.

Melanoplus spretus Thos.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 184–190, pl. 12, fig. 8, 1897.
EXHIBIT: Adult.

THE AMERICAN LOCUST.

Schistocerca americana Dru.

For life history and general account see Howard, Insect Life, Vol. VII, pp. 220–229, 1897; also Morgan, Bul. 30, n. s. Div. Ent., U. S. Dept. Agric., p. 27, 1901.
EXHIBIT: Adult.

THE CLOVER-SEED CHALCIS-FLY.

Bruchophagus funebris How.

For general account see Hopkins, Bul. 6, n. s., Div. Ent. U. S. Dept. Agric., p. 73, 1896, and Bul. 17, n. s., p. 45, 1898; Titus, Bul. 44, pp. 77–80, 1904.
EXHIBIT: Adult and work.

INSECTS INJURIOUS TO CLOVER.

For list of clover insects, and short articles on several important species, see Bruner and Hunter, Rpt. St. Bd. Agr. Nebr., pp. 240–285, 1898.

INJURING THE ROOTS.

THE CLOVER ROOT-BORER.

Hylastinus trifolii Müll.

(Formerly *Hylastes*.)
For general articles see Riley, Rpt. U. S. Dept. Agr., f. 1878, pp. 248–250, 1879.
EXHIBIT: Adult, work, figure, and enemy, *Telephorus bilineatus* Say.

INJURING THE STEM.

THE CLOVER STEM-BORER.

Languria mozardi Latr.

For general account see Weed, Bul. Ohio Agr. Expt. Sta., 2d series, Vol. III, No. 8, p. 235, 1890.
EXHIBIT: Adult.

INJURING THE LEAVES.

THE CLOVER MITE.

Bryobia pratensis Garm.

For general article see Garman, 14th Rpt. St. Ent. Ill., p. 73, 1885; Bruner, Rpt. Nebr. St. Bd. Agric. f. 1898, pp. 280–284, 1899; Marlatt, Cir. 19, Div. Ent., U. S. Dept. Agric., 1897.
EXHIBIT: Figure.

CLOVER ALEYRODES.

Aleyrodes sp.

EXHIBIT: Adult and work.

THE WHEAT THRIPS.

Thrips tritici Fitch.

For citations to literature see Lintner, 11th Rpt. N. Y. St. Ent., pp. 247–250, 1896.
EXHIBIT: Figure.

THE CLOVER-LEAF WEEVIL.

Phytonomus punctatus Fab.

For general account see Lintner, 1st Rpt. St. Ent. N. Y., pp. 247–253, 1883; Sanderson, Insects injurious to staple crops, pp. 177–179, 1902.
EXHIBIT: Larva, cocoon, adult, work, figure, and enemy, *Collops 4-maculatus* Fab.

THE GRAPE-VINE COLASPIS.

Colaspis brunnea Fab.

For general article see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 13–14, 1903.
EXHIBIT: Adult.

THE 12-SPOTTED CUCUMBER BEETLE.

Diabrotica duodecimpunctata Ol.

For general account and remedies see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 12–13, 1903; Quaintance, Bul. 26, n. s., Div. Ent., U. S. Dept. Agric., pp. 35–40, 1900.
EXHIBIT: Adult, figure, and parasite, *Celatoria diabroticæ.*

WESTERN CORN ROOT-WORM.

Diabrotica longicornis Say.

For general account see Forbes, 12th Rpt. St. Ent. Ill., pp. 10–31, figs. 1–5, 1883.
EXHIBIT: Adult.

THE IMBRICATED SNOUT-BEETLE.

Epicærus imbricatus Say.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 28–29, 1903; Bul. 19, n. s., pp. 62–67, 1899.
EXHIBIT: Adult.

THE GIBBOUS JUNE-BEETLE.

Lachnosterna gibbosa Burm.

For general account of white grubs see Forbes, 18th Rpt. St. Ent. Ill., pp. 109–144, 1894.
EXHIBIT: Adult.

THE FLAVESCENT CLOVER WEEVIL.

Sitones flavescens Marsh.

For brief account see Osborn and Gossard, Bul. 14, Ia. Agric. Expt. Sta., pp. 177–178, 1891.
EXHIBIT: Adult.

GRAPHORHINUS VADOSUS Say.

For brief account see Webster, Amer. Nat., Vol. XVI, p. 746, 1882.
EXHIBIT: Adult.

THE ASH-GRAY BLISTER BEETLE.

Macrobasis unicolor Kby.

For general account see Chittenden, Yearbook, U. S. Dept. Agric., 1898, pp. 249–250.
EXHIBIT: Adult.

FOUR-LINED PLANT-BUG.

Pœcilocapsus lineatus Fab.

For general accounts see Lintner, 1st Rpt. St. Ent. N. Y., pp. 271–281, 1883; Slingerland, Bul. 58, Cornell Univ. Agr. Expt. Sta., pp. 207–239, 1893.
EXHIBIT: Adult.

THE TARNISHED PLANT-BUG.

Lygus pratensis Linn.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 312–315, 1885.
EXHIBIT: Adult.

THE CLOVER-LEAF MIDGE.

Dasyneura trifolii Loew.

(Formerly *Cecidomyia.*)
For brief articles see Bruner, Rpt. St. Bd. Agric. Nebr., 1898, pp. 250–251, 1899; Comstock, Rpt. U. S. Dept. Agric., 1879, pp. 197–199, 1880.
EXHIBIT: Cocoon, adult, and work.

THE RED-BANDED LEAF-ROLLER.

Eulia triferana Walk.

(Formerly *Lophoderus.*)
For brief accounts see Lugger, 4th Rpt. State Ent. Minn., p. 231, 1899; Forbes, 14th Rpt. St. Ent. Ill., pp. 20–21, 1885.
EXHIBIT: Pupa and adult.

THE RUSTY-BROWN TORTRIX.

Platynota flavedana Clem.

For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 231–232, 1899.
EXHIBIT: Eggs, pupa, and adult.

THE SULPHUR-COLORED TORTRIX.

Epagoge sulfureana Clem.

(Formerly *Tortrix* and *Dichelia.*)
For brief account see Lugger, 4th Rpt. St. Ent. Minn., pp. 232–233, 1899. For bibliography see Forbes, 14th Rpt. St. Ent. Ill., pp. 17–20, 1885.
EXHIBIT: Pupa, adult, and work.

CŒLOSTATHMA DISCOPUNCTANA Clem.

(Formerly *Amphisa.*)
For brief notice see Comstock, Rpt. U. S. Dept. Agric. f. 1880, p. 258, 1881.
EXHIBIT: Pupa and adult.

THE FALL ARMY WORM.

Laphygma frugiperda S. & A.

For full life history and bibliography see Chittenden, Bul. 29, n. s., Div. Ent. U. S. Dept. Agric., pp. 13–45, 1901.
EXHIBIT: Adult.

ANAPHORA POPEANELLA Clem.

For general account see Riley and Howard, Insect Life, Vol. III, pp. 27–28, 1890.
EXHIBIT: Adult.

THE OBLIQUE-BANDED LEAF-ROLLER.

Archips rosaceana Harr.

(Formerly *Cacœcia.*)
For general account see Lugger, 4th Rpt. St. Ent. Minn., pp. 226–227, 1899.
EXHIBIT: Pupa and adult.

THE GARDEN WEBWORM.

Loxostege similalis Guen.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 39–40, 1903.
EXHIBIT: Adult and work.

ARISTOTELIA ROSEOSUFFUSELLA Clem.

(Formerly *Gelechia.*)
For brief reference to food plant see Murtfeldt, Bul. 23, Div. Ent., U. S. Dept. Agric., p. 54, 1891.
EXHIBIT: Pupa and adult.

ECTROPIS CREPUSCULARIA D. and S.

(Has been placed in genera *Cymatophora*, *Cleora*, and *Boarmia.*)
For brief accounts see Packard, 5th Rpt. U. S. Ent. Comm., p. 371, 1890; Lugger, 4th Rpt. St. Ent. Minn., p. 188, 1899.
EXHIBIT: Adult.

DRASTERIA ERECHTEA Cram.

For general account see Slingerland, Insect Life, Vol. V, pp. 87–88, 1892.
EXHIBIT: Larva, cocoon, pupa, and adult.

THE CHICKWEED GEOMETER.

Hæmatopsis grataria Fab.

For brief notice see Forbes, 14th Rpt. St. Ent. Ill., p. 74, 1885.
EXHIBIT: Adult.

IO MOTH.

Automeris io Fab.

For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 126–129, fig. 130, and pl. 16, fig. 129, 1899.
EXHIBIT: Larva, cocoon, and adult.

CATOPYRRHA DISSIMILARIA Hbn.

(Formerly *Aspilates.*)
EXHIBIT: Adult.

THE GREEN CLOVER WORM.

Plathypena scabra Fab.

(Formerly *Hypena.*)
For accounts see Comstock, Rpt. U. S. Dept. Agric. f. 1879, p. 252, 1880; Chittenden, Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., pp. 44–50, 1901.
EXHIBIT: Larva, pupa, and adult.

THE SMALL WHITE BRISTLY CUTWORM.

Mamestra renigera Steph.

For short account see Forbes, 16th Rpt. St. Ent. Ill., pp. 95–96, 1890.
EXHIBIT: Larva, pupa, and adult.

THE CLOVER CUTWORM.

Mamestra trifolii Rott.

For account see Riley, Rpt. U. S. Dept. Agric. 1883, pp. 123–124, 1883.
EXHIBIT: Larva and adult.

ARMY WORM.

Heliophila unipuncta Harv.

(Formerly *Leucania.*)
For bibliography and life history see Lintner, 12th Rpt. N. Y. St. Ent., pp. 190–214, 1896.
EXHIBIT: Larva, pupa, and adult.

THE VARIEGATED CUTWORM.

Peridroma saucia Hübn.

For general bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 46–64, 1902.
EXHIBIT: Larva, adult, and figure.

THE COMMELINA OWLET MOTH.

Prodenia commelinæ S. & A.

For life history and general account see Chittenden, Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., pp. 59–64, Pl. IV, fig. 1, 1901.
EXHIBIT: Larva, pupa, and adult.

THE DARK-SIDED CUTWORM.

Euxoa messoria Harr.

(Formerly *Carneades.*)
For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 290–291, 1885.
EXHIBIT: Larva and adult.

THE SMEARED DAGGER.

Apatela oblinita S. & A.

(Formerly *Acronycta.*)
For general account see Packard, 5th Rpt. U. S. Ent. Comm., pp. 567–568, 1890.
EXHIBIT: Larva, cocoon, and adult.

THE BRONZED CUTWORM.

Nephelodes minians Guen.

For life history and partial bibliography see Lintner, 1st Rpt. St. Ent. N. Y., pp. 99–110, 1882; Riley, Rpt. U. S. Dept. Agric. f. 1890, pp. 244–246, 1891.
EXHIBIT: Larva and adult.

THE CABBAGE LOOPER.

Autographa brassicæ Riley.

(Formerly *Plusia.*)
For general account and life history see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 60–69, 1902.
EXHIBIT: Larva, adult, and figure.

THE NAIS TIGER-MOTH.

Apantesis nais Dru.

(Formerly *Arctia.*)
For account see Beutenmuller, "Cat. Lepid. N. Y.," Ann. Acad. N. Y., p. 206, 1890.
EXHIBIT: Adult.

ZEBRA CATERPILLAR.

Mamestra picta Harr.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 42–43, 1903.
EXHIBIT: Larva and adult.

THE ISABELLA TIGER-MOTH.

Isia isabella S. & A.

(Formerly *Pyrrharctia.*)
For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 44–45, 1903.
EXHIBIT: Larva and adult.

THE NORTHERN CLOUDY-WING.

Thorybes pylades Scud.

(Formerly *Eudamus.*)
EXHIBIT: Adult.

THE COMYNTAS BUTTERFLY.

Everes comyntas Godt.

(Formerly *Lycæna.*)
For brief account see Lintner, 4th Rpt. N. Y. St. Ent., p. 137, 1888.
EXHIBIT: Adult.

THE AMERICAN COPPER.

Heodes hypophlæas Bd.

(Formerly *Chrysophanus.*)
EXHIBIT: Adult.

LEMONIAS EDITHA Bd.

(Formerly *Melitæa.*)
EXHIBIT: Figure.

SOUTHERN DOG-FACE BUTTERFLY.

Zerene cæsonia Stall.

(Formerly *Colias.*)
For brief notice see Thomas, 10th Rpt. St. Ent. Ill., p. 78, 1881; Howard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., p. 84, 1897.
EXHIBIT: Adult.

THE ORANGE SULPHUR.

Eurymus eurytheme Bd.

(Formerly *Colias.*)
For brief account see French, 7th Rpt. St. Ent. Ill., pp. 147–148, 1878.
EXHIBIT: Larva and adult.

THE YELLOW BUTTERFLY.

Eurymus philodice Godt.

(Formerly *Colias.*)
For brief account see Davis, Bul. 116, Mich. Agr. Expt. Sta., p. 61, 1894.
EXHIBIT: Adult.

THE CLOUDLESS SULPHUR.

Callidryas eubule Linn.

For brief account see French, 7th Rpt. St. Ent. Ill., pp. 147–148, 1878.
EXHIBIT: Larva, pupa, and adult.

THE BLACK-BORDERED YELLOW.

Eurema nicippe Cram.

(Formerly *Terias.*)
For brief account see French, 7th Rpt. St. Ent. Ill., p. 148, 1878.
EXHIBIT: Larva, pupa, and adult.

THE LITTLE SULPHUR.

Eurema euterpe Men.

(Formerly *Terias lisa.*)
For brief account see French, 7th Rpt. St. Ent. Ill., p. 148, 1878.
EXHIBIT: Adult.

OLETHREUTES INSTRUTANA Clem.

EXHIBIT: Adult.

THE CLOVER-HAY WORM.

Hypsopygia costalis Fab.

(Formerly *Asopia* and *Pyralis.*)
For bibliography and general account see Lintner, 11th Rpt. St. Ent. N. Y., pp. 145–151, 1896.
EXHIBIT: Larva and adult.

THE MEAL SNOUT-MOTH.

Pyralis farinalis Linn.

For short account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 10–11, 1897.
EXHIBIT: Larva, pupa, cocoon, and adult.

THE CLOVER APHIS.

Macrosiphum trifolii Perg.

(Attacks dandelion, oats, red clover, strawberry, wheat, etc.)
For general account see Pergande, Bul. 44, Div. Ent., U. S. Dept. Agric., pp. 21–23, 1904.
EXHIBIT: Figure.

THE TWO-STRIPED LOCUST.

Melanoplus bivittatus Say.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 363–368, pl. 24, fig. 5, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 31–32, 1891.
EXHIBIT: Adult and figure.

THE LESSER LOCUST.

Melanoplus atlanis Riley.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 178–183, pl. 12, fig. 7, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 26–27, 1891.
EXHIBIT: Adult.

THE DIFFERENTIAL LOCUST.

Melanoplus differentialis Thos.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 349–354, pl. 23, figs. 3 and 4; Morgan, Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., pp. 7–26, 1901.
Exhibit: Adult.

RED-LEGGED LOCUST.

Melanoplus femur-rubrum DeG.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 278–285; pl. 1, fig. h; pl. 19, figs. 1–4, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 27–28, 1891.
Exhibit: Adult.

THE ROCKY-MOUNTAIN LOCUST.

Melanoplus spretus Thos.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 184–190, pl. 12, fig. 8, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 9–26, 1891.
Exhibit: Adult.

INJURING THE FLOWERS AND SEEDS.

THE CLOVER-FLOWER MIDGE.

Dasyneura leguminicola Lint

(Formerly *Cecidomyia.*)
For general account see Riley, Rpt. U. S. Dept. Agric., 1878, pp. 250–252, 1879.
Exhibit: Cocoon, adult, and figure.

THE CLOVER-SEED CHALCIS-FLY.

Bruchophagus funebris How.

For brief accounts see Hopkins, Bul. 6, n. s., Div. Ent., U. S. Dept. Agric., p. 73, 1896, and Bul. 17, n. s., p. 45, 1898; Titus, Bul. 44, Div. Ent., U. S. Dept. Agric., pp. 77–80, 1904.
Exhibit: Adult and work.

THE CLOVER-SEED WORM.

Enarmonia interstinctana Clem.

(Formerly *Grapholitha.*)
For bibliography and general account see Lintner, 11th Rept. St. Ent. N. Y., pp. 152–157, 1896.
Exhibit: Pupa, adult, and work.

INSECTS INJURIOUS TO SMALL GRAINS.

For general articles see Howard, Tech. Ser. 2, Div. Ent., U. S. Dept. Agric., 24 pp., 1896; Marlatt, Farmers' Bul. 132, U. S. Dept. Agric., 38 pp., 1901; Webster, Bul. 42, Div. Ent., U. S. Dept. Agric., 62 pp., 1903.

THE LESSER LOCUST.

Melanoplus atlanis Riley.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 178–183, pl. 12, fig. 7, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 26–27, 1891.
Exhibit: Nymph and adult.

THE RED-LEGGED LOCUST.

Melanoplus femur-rubrum DeG.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 278–285, pl. 1, fig. h; pl. 19, figs. 1–4. 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 27–28, 1891.
Exhibit: Nymph and adult.

THE ROCKY MOUNTAIN LOCUST.

Melanoplus spretus Thos.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 184–190, pl. 12, fig. 8, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 9–26, 1891.
Exhibit: Nymph, adult, and figure.

THE WESTERN CRICKET.

Anabrus purpurascens Uhl.

For detailed account see Packard, 2d Rpt. U. S. Ent. Comm., pp. 163–178, 1879.
Exhibit: Adult.

THE CLEAR-WINGED LOCUST.

Camnula atrox Scudd.

For account of an allied species (*C. pellucida*) see Simpson, Circ. 53, Div. Ent., U. S. Dept. Agric., 1903.
Exhibit: Adult.

THE ARMY WORM.

Heliophila unipuncta Harv.

(Formerly *Leucania.*)
For bibliography and life history see Lintner, 12th Rept. St. Ent. N. Y., pp. 190–214, 1896.
Exhibit: Larva, pupa, adult, and figure.

FALL ARMY WORM.

Laphygma frugiperda S. & A.

For full bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 40–45, 1901.
Exhibit: Larva, pupa, and adult.

STALK BORER.

Papaipema nitela Guen.

(Bores in stems of various plants.)
For general account see Bird, Can. Ent., Vol. XXX, pp. 127–128, 1898
Exhibit: Larva, pupa, adult, and work.

WHEAT-HEAD ARMY WORM.

Heliophila albilinea Hbn.

For general account see Riley, 9th Rept. St. Ent. Mo., pp. 50–57, 1877.
Exhibit: Pupa, adult, figure, and parasites: *Anomalon apicale* Cress., *Tachina anonyma* Riley.

NUTTALL'S BLISTER BEETLE.

Cantharis nuttalli Say.

For short article see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 27, 1903.
Exhibit: Adult.

THE CLAY-COLORED BILL-BUG.

Sphenophorus æqualis Lec.

(Treated as *S. ochreus* Lec. by authors.)
For articles on bill-bugs see Forbes, 16th Rept. St. Ent. Ill., pp. 58–74, 1890; Webster, Insect Life, Vol. II, pp. 132–134, 1889.
Exhibit: Adult.

THE GERMAN GRAIN-APHIS.

Macrosiphum cerealis Kalt.

(Attacks barley, chess, meadow, orchard, and velvet grass, oats, rye, and wheat, feeding on ears, racemes, and other parts of plant.)

For general account see Pergande, Bul. 44, Div. Ent., U. S. Dept. Agric., pp. 18–21, 1904.

EXHIBIT: Figure.

THE ENGLISH GRAIN-APHIS.

Macrosiphum granaria Buck.

(Formerly *Nectarophora* and *Aphis*. Attacks green foxtail, meadow, and orchard grass, oats, red-clover, red top, rye, wheat, and wild rye.)

For general account see Pergande, Bul. 44, Div. Ent., U. S. Dept. Agric., pp. 13–18, 1904.

EXHIBIT: Figure and work; parasite, *Lysiphlebus testaceipes* Cress. (figure); and enemies, *Anatis 15-punctata* Ol.; *Coccinella sanguinea* Linn.; *Hippodamia parenthesis* Say; *Podabrus tomentosus* Say; *Sphærophoria cylindrica* Say; *Syrphus americanus* Wied.

THE EUROPEAN GRAIN-APHIS.

Siphocoryne avenæ Fab.

(Formerly *Nectarophora* and *Aphis*. Attacks apple, burdock, celery, choke-cherry, dogwood, grasses, oats, rye, wheat, and other plants.)

For general account see Pergande, Bul. 44, Div. Ent., U. S. Dept. Agric., pp. 5–13, 1904.

EXHIBIT: Figure.

THE CHINCH BUG.

Blissus leucopterus Say.

(Injures cane, corn, oats, rye, wheat, etc.)

For bibliography, 1785–1888, see Forbes, App. to 16th Rept. St. Ent. Ill., pp. 1–102, 1894. For general articles see Forbes, 16th Rept. St. Ent. Ill., pp. 1–57, 1894; Webster, Bul. 15, n. s., Div. Ent., U. S. Dept. Agric., 82 pp., 1898.

EXHIBIT: Eggs, nymph, adult, and figure.

THE GRAIN LEAF-HOPPER.

Diedrocephalus flaviceps Riley.

For account of *D. mollipes* see Osborn & Ball, Bul. 34, Iowa Agric. Expt. Sta., p. 614, 1897.

EXHIBIT: Adult.

THE DESTRUCTIVE LEAF-HOPPER.

Cicadula exitiosa Uhl.

For general account see Comstock, Rpt. U. S. Comm. Agric., 1879, pp. 191–193, 1880.

EXHIBIT: Adult.

THE WHEAT SAWFLY.

Dolerus arvensis Say.

For general account see Riley and Marlatt, Insect Life, Vol. IV, pp. 171–172, 1891.

EXHIBIT: Adult and figure.

THE GRASS SAWFLY.

Pachynematus extensicornis Nort.

(Formerly *Nematus marylandicus*.)

For article under *N. marylandicus* see Riley and Marlatt, Insect Life, Vol. IV, pp. 174–177, 1891.

EXHIBIT: Adult and figure.

THE WESTERN GRAIN SAWFLY.

Cephus occidentalis Marl.

For short article see Riley and Howard, Insect Life, Vol. II, p. 286, 1890.

EXHIBIT: Adult, work, and figure.

JOINT-WORMS.

For special articles to four following species see Howard, Tech. Ser. 2, Div. Ent., U. S. Dept. Agric., 24 pp., 1896; also Webster, Bul. 42, Div. Ent., U. S. Dept. Agric., 62 pp., 1903.

GREATER WHEAT-STRAW WORM.

Isosoma grande Riley.

Exhibit: Adult and figure.

BARLEY-STRAW WORM.

Isosoma hordei Harr.

Exhibit: Adult, work, and figure.

THE WHEAT JOINT-WORM.

Isosoma tritici Riley.

Exhibit: Adult, work, and figure.

THE HAIRY-FACED JOINT-WORM.

Isosoma hirtifrons How.

Exhibit: Adult and figure.

THE HESSIAN FLY.

Mayetiola destructor Say.

(Formerly *Cecidomyia*.)

For general article with bibliography see Osborn, Bul. 16, n. s., Div. Ent., U. S. Dept. Agric., 57 pp., 1898; Marlatt, Farmers' Bul. 132, U. S. Dept. Agric., pp. 13–22, 1901.

Exhibit: Puparia, adult, work, figures, and map.

THE GREATER WHEAT-STEM MAGGOT.

Meromyza americana Fitch.

For general article see Webster, Bul. 42, Div. Ent., U. S. Dept. Agric., pp. 43–51, 1903.

Exhibit: Adult, work, and figure.

THE AMERICAN FRIT-FLY.

Oscinis soror Macq.

For general article see Webster, Bul. 42, Div. Ent., U. S. Dept. Agric., pp. 57–62, 1903.

Exhibit: Adult, work, and figure.

THE LESSER WHEAT-STRAW MAGGOT.

Oscinis carbonaria Loew.

For general article see Webster, Bul. 42, Div. Ent., U. S. Dept. Agric., pp. 51–56, 1903.

Exhibit: Adult.

CHLOROPS PROXIMA Say.

For short account see Comstock, Rpt. U. S. Comm. Agric., 1879, pp. 257–258, 1880.

Exhibit: Adult and work.

INSECTS INJURIOUS TO HOPS.

THE HOP APHIS.

Phorodon humuli Schr.

(Attacks hop and plum.)

For full life history see Riley, Cir. 2, Div. Ent., U. S. Dept. Agric., 1891.

Exhibit: Adult, work, and figures, with two enemies: *Chrysopa* sp. and *Adalia bipunctata* Linn.

THE COMMA BUTTERFLY.

Polygonia comma Harr.

(Formerly *Grapta.*)
For general account see Howard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 50–51, 1897.
EXHIBIT: Larva and adult.

THE SEMICOLON BUTTERFLY.

Polygonia interrogationis Fab.

For general account see Howard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 47–49, 1897.
EXHIBIT: Larva and adult.

THE HOP GRUB.

Gortyna immanis Guen.

For general account and life history see Howard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 40–44, 1897.
EXHIBIT: Pupa, adult, and work.

THE HOP SNOUT-MOTH.

Hypena humuli Harr.

For general account see Howard, Bul. 7, n. s., Div. Ent., U. S. Dept. Agric., pp. 44–47, 1897.
EXHIBIT: Larva, pupa, and adult.

THE VARIEGATED CUTWORM.

Peridroma saucia Hbn.

For general bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 46–64, 1901.
EXHIBIT: Larva and adult.

THE MEXICAN COTTON BOLL WEEVIL.

MEXICAN COTTON BOLL WEEVIL.

Anthonomus grandis Boh.

(Breeds in and destroys bolls.)
For full life history and general account see Hunter and Hinds, Bul. 51, Bur. Ent., U. S. Dept. Agric., 1905; also Hunter, Farmers' Bul. 216, U. S. Dept. Agric., 1905.
EXHIBIT: Life history (larvæ, pupæ, adults, injured cotton bolls, with stages present in bolls, and uninjured bolls); illustrations and map showing distribution in United States.

THE COTTON BOLLWORM; CORN-EAR WORM.

COTTON BOLLWORM; CORN-EAR WORM.

Heliothis obsoleta Fab.

(Formerly *H. armiger*. *H. obscura* by error. Larvæ feed on bolls of cotton, ears of corn, tobacco buds, beans, and in tomatoes; also cut off young plants of various garden crops.)
For full life history and general account see Quaintance and Brues, Bul. 50, Bur. Ent., U. S. Dept. Agric., 1905; also Quaintance and Bishopp, Farmers' Bul. 212, U. S. Dept. Agric., 1905.
EXHIBIT: Larva, pupa, adult, work in cotton bolls, and illustrations of different stages, and work on various plants. Parasite exhibited: *Archytas pilirentris* v. d. W.; adult, pupa, and figure. Enemies exhibited: *Calosoma lugubre* Lec., *C. sayi* Dej., *C. scrutator* Fab., *Polistes annularis* Linn., and *P. rubiginosus* Lep.

INSECTS INJURIOUS TO SUGAR BEET.

For general articles see Forbes and Hart, Bul. 60, Ill. Agr. Expt. Sta., 136 pp., 1900; Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., 71 pp., 1903.

RED-LEGGED LOCUST.

Melanoplus femur-rubrum DeG.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 278–285, pl. 1, fig. h. pl. 19, figs. 1–4, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 27–28, 1891.
Exhibit: Adult and figure.

THE DIFFERENTIAL LOCUST.

Melanoplus differentialis Thos.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 349–354, pl. 23, figs. 3 and 4, 1897; also Morgan, Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., pp. 7–26, 1901.
Exhibit: Adult and figure.

THE ROCKY-MOUNTAIN LOCUST.

Melanoplus spretus Thos.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 184–190, pl. 12, fig. 8, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 9–26, 1891.
Exhibit: Adult.

THE TWO STRIPED LOCUST.

Melanoplus bivittatus Say.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 363–368, pl. 24, fig. 5, 1897.
Exhibit: Adult, nymph, and figure.

THE LESSER LOCUST.

Melanoplus atlanis Riley.

For bibliography and general account see Scudder, Proc. U. S. N. M., Vol. XX, pp. 178–183, pl. 12, fig. 7, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 26–27 1891.
Exhibit: Adult.

THE CAROLINA LOCUST.

Dissosteira carolina Linn.

For short account see Forbes and Hart, Bul. 60, Ill. Agr. Expt. Sta., pp. 479–480, 1900.
Exhibit: Nymph, adult, and parasite *Frontina frenchii* Will.

THE BEET LEAF-MINER.

Pegomya vicina, Lint.

Exhibit: Adult and figure.

THE BEET CHLOROPS.

Chlorops assimilis Macq.

Exhibit: Puparium and adult.

THE COMMON ARMY WORM.

Heliophila unipuncta Harr.

(Formerly *Leucania.*)
For bibliography and life history see Lintner, 12th Rept. St. Ent. N. Y., pp. 190–214, 1896.
Exhibit: Larva and adult.

THE VARIEGATED CUTWORM.

Peridroma saucia Hübn.

For general bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 46–64, 1902.
Exhibit: Larva, adult, and figure.

THE PURSLANE CATERPILLAR.

Copidryas gloveri G. & R.

Exhibit: Larva and adult.

FALL ARMY WORM.

Laphygma frugiperda S. & A.

For full bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 40–45, 1901.
Exhibit: Larva, adult, and figure.

THE WHITE-LINED SPHINX.

Deilephila lineata Fab.

Exhibit: Adult and figure.

THE BEET ARMY WORM.

Caradrina exigua Hbn.

For general articles see Gillette, 12th Rpt. Colo. Agr. Expt. Sta., p. 39, 1900; Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 37–46, 1902.
Exhibit: Adult and figure.

THE ZEBRA CATERPILLAR.

Mamestra picta Harr.

For bibliography and general life history see Felt, 14th Rpt. N. Y. St. Ent., pp. 201–207, 1898.
Exhibit: Larva and adult.

GARDEN WEBWORM.

Loxostege similalis Guen.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 39–40, 1903.
Exhibit: Cocoon, adult, and figure.

THE SUGAR-BEET WEBWORM.

Loxostege sticticalis Linn.

For general account see Forbes, Bul. 60, Ill. Agr. Expt. Sta., p. 457–459, 1900.
Exhibit: Cocoon, pupa, adult, and figure.

THE ISABELLA TIGER MOTH.

Isia isabella S. & A.

(Formerly *Pyrrharctia.*)
For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 44–45, 1903.
Exhibit: Larva, adult, and figure.

THE CLOVER CUTWORM.

Mamestra trifolii Rott.

For account see Riley, Rpt. U. S. Dept. Agric., 1883, pp. 123–124, 1883.
Exhibit: Larva, adult, and parasites *Ophion purgatum* Say and *Euphorocera claripennis* Macq.

THE CABBAGE LOOPER.

Autographa brassicæ Riley.

For general account and life history see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 60–69, 1902.
Exhibit: Larva, adult, and parasite *Limneria tibiator* Cr.

THE GARDEN FLEA-HOPPER.

Halticus uhleri Giard.

For general account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 57–62, 1899.
Exhibit: Adult and figure.

THE TARNISHED PLANT-BUG.

Lygus pratensis Linn.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 312–315, 1885.
Exhibit: Adult and figure.

THE SANDY GROUND BUG.

Emblethis arenarius Linn.

Exhibit: Adult.

PURSLANE BUG.

Geocoris bullatus Say.

Exhibit: Adult.

THE MILITARY BUG.

Hadronema militaris Uhl.

Exhibit: Adult.

CLOUDED PIGWEED BUG.

Sphragisticus nebulosus Fall.

Exhibit: Adult.

THE BROWN LEAF-HOPPER.

Agallia sanguinolenta Prov.

Exhibit: Adult.

THE CHINCH-BUG.

Blissus leucopterus Say.

For general article and life history see Webster, Bul. 15, n. s., Div. Ent., U. S. Dept. Agric., 82 pp. 1898.
Exhibit: Eggs, nymph, adult, and figure.

THE FALSE CHINCH-BUG.

Nysius angustatus Uhl.

(Attacks many garden crops.)
Exhibit: Adult and figure.

HOODED PLANT-BUG.

Euthoctha galeator Fab.

Exhibit: Eggs, nymph, and adult.

THE IMBRICATED SNOUT-BEETLE.

Epicærus imbricatus Say.

For detailed account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 62–67, 1899.
Exhibit: Adult and figure.

THE GIBBOUS JUNE BEETLE.

Lachnosterna gibbosa Burm.

For general account of white grubs see Forbes, 18th Rpt. St. Ent. Ill., pp. 109–144, 1894.
EXHIBIT: Adult and figure.

THE 12-SPOTTED CUCUMBER BEETLE.

Diabrotica duodecimpunctata Ol.

For general account and remedies see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 12–13, 1903; Quaintance, Bul. 26, n. s., pp. 35–40, 1900.
EXHIBIT: Adult, figures, and parasite *Celatoria diabroticæ*.

MONOCREPIDIUS VESPERTINUS Fab.

EXHIBIT: Adult and figure.

PENCILED SNOUT-BEETLE.

Centrinus penicellus Hbst.

EXHIBIT: Adult.

THE GREATER SUGAR-BEET LEAF-BEETLE.

Monoxia puncticollis Say.

EXHIBIT: Adult and figure.

THE LESSER SUGAR-BEET LEAF-BEETLE.

Monoxia consputa Lec.

EXHIBIT: Adult and figure.

THE GRAPE-VINE COLASPIS.

Colaspis brunnea Fab.

For general article see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 13–14, 1903.
EXHIBIT: Adult and figure.

WHITE GRUB; MAY BEETLE.

Lachnosterna fusca Fröh.

For account of white grubs injuring corn see Forbes, 18th Rpt. St. Ent. Ill., pp. 109–145, 1894.
EXHIBIT: Adult and figure.

THE CONVEX FLEA-BEETLE.

Psylliodes convexior Lec.

EXHIBIT: Adult.

THE PALE-STRIPED FLEA-BEETLE.

Systena blanda Mels.

For general articles see Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 22–29, 1900; Bul. 43, Div. Ent., p. 16, 1903.
EXHIBIT: Adult and figure.

THE SPINACH FLEA-BEETLE.

Disonycha xanthomelæna Dalm.

EXHIBIT: Adult, figure, and parasite *Hypostena barbata* Coq.

THE WAVY-NECKED FLEA-BEETLE.

Disonycha crenicollis Say.

EXHIBIT: Adult.

THE TRIANGULAR FLEA-BEETLE.

Disonycha triangularis Say.

EXHIBIT: Adult.

THE CUCUMBER FLEA-BEETLE.

Epitrix cucumeris Harr.

For short account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 89–90, 1899.
EXHIBIT: Adult and figure.

THE TOOTHED FLEA-BEETLE.

Chætocnema denticulata Illig.

EXHIBIT: Adult.

THE ASH-GRAY BLISTER BEETLE.

Macrobasis unicolor Kby.

For short article see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 249–250, 1899.
EXHIBIT: Adult.

THE SPOTTED BLISTER BEETLE.

Epicauta maculata Say.

For general account see Saunders, Bul. 57, S. Dak. Agric. Expt. Sta., p. 52, 1898; Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 24–25, 1903.
EXHIBIT: Adult and figure.

THE GRAY BLISTER BEETLE.

Epicauta cinerea Först.

For brief account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 25, 1903.
EXHIBIT: Adult and figure.

BLACK BLISTER BEETLE.

Epicauta pennsylvanica DeG.

For brief account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 25, 1903.
EXHIBIT: Adult and figure.

THE STRIPED BLISTER BEETLE.

Epicauta vittata Fab.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 22–23, 1903.
EXHIBIT: Adult and figure.

NUTTALL'S BLISTER BEETLE.

Cantharis nuttalli Say.

For short article see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 27, 1903.
EXHIBIT: Adult and figure.

INSECTS INJURIOUS TO BEANS AND PEAS.

THE LIMA-BEAN STEM-BORER.

Monoptilota nubilella Hulst.

(Bores in stalks of Lima beans.)
For life history and general account see Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 9–17, 1900.
EXHIBIT: Larva, cocoon, adult, work, and figure.

SMALLER CORN STALK-BORER.

Elasmopalpus lignosellus Zell.

For life history and general account see Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 17–22, 1900.
EXHIBIT: Larva, adult, and figure.

NUTTALL'S BLISTER BEETLE.

Cantharis nuttalli Say.

For short article see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 27, 1903.
EXHIBIT: Adult and figure.

THE ASH-GRAY BLISTER BEETLE.

Macrobasis unicolor Kby.

For short article see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 249–250, 1899.
EXHIBIT: Adult.

THE BEAN LEAF-BEETLE.

Cerotoma trifurcata Först.

(Formerly *C. caminea* Fab.)
For general account see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 253–254, 1899.
EXHIBIT: Adult and figure.

THE BEAN LADYBIRD.

Epilachna corrupta Muls.

For general account see Gillette, Bul. 47, Colorado Agr. Expt. Sta., pp. 41–43, 1898; Chittenden, Yearbook, U. S. Dept. Agric., f. 1898, pp. 251–253, 1899.
EXHIBIT: Adult and figure.

THE 12-SPOTTED CUCUMBER BEETLE.

Diabrotica duodecimpunctata Ol.

For general accounts and remedies see Quaintance, Bul. 26, n. s., Div. Ent., U. S. Dept. Agric., pp. 35–40, 1900; Chittenden, Bul. 43, pp. 12–13, 1903.
EXHIBIT: Adult.

THE IMBRICATED SNOUT-BEETLE.

Epicærus imbricatus Say.

For detailed account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 62–67, 1899; for general account, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 28–29, 1903.
EXHIBIT: Adult.

THE BANDED FLEA-BEETLE.

Systena tæniata Say.

For short account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 17, 1903.
EXHIBIT: Adult.

THE PALE-STRIPED FLEA-BEETLE.

Systena blanda Mels.

For general article see Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 22–29, 1900; Bul. 43, p. 16, 1903.
EXHIBIT: Adult and figure.

THE LEAF-MINING LOCUST BEETLE.

Odontota dorsalis Thunb.

(Lives on locust, but attacks beans and other leguminous plants.)
For full life history, bibliography, and distribution see Chittenden, Bul. 38, Div. Ent., U. S. Dept. Agric., pp. 70–73, 1902.
EXHIBIT: Adult and figure.

THE DISTENDED MAY BEETLE.

Lachnosterna farcta Lec.

For short notices see Comstock, Rpt. U. S. Dept. Agric. f. 1879, pp. 247–248, Pl. V, fig. 5, 1880; Howard, Bul. 22, n. s., Div. Ent., U. S. Dept. Agric., p. 107, 1900.
EXHIBIT: Adult.

THE GARDEN FLEA-HOPPER.

Halticus uhleri Giard.

For general account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 57–62, 1899.
EXHIBIT: Adult and figure.

THE DINGY CUTWORM.

Feltia subgothica Haw.

For brief account see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, p. 257, 1899.
EXHIBIT: Adult.

SALT-MARSH CATERPILLAR.

Estigmene acræa Dru.

(Formerly *Leucarctia.*)
For short account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 43–44, fig. 41, 1903.
EXHIBIT: Adult.

YELLOW-BEAR CATERPILLAR.

Diacrisia virginica Fab.

(Formerly *Spilosoma.*)
For general account see Lugger, 4th Rpt. State Ent. Minn., pp. 79–81, fig. 78, 1899.
EXHIBIT: Adult and figure.

THE BEAN CUTWORM.

Ogdoconta cinereola Guen.

(Feeds on buds and leaves.)
For life history and general account see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 98–100, 1902.
EXHIBIT: Adult and figure.

THE ROLLER WORM.

Eudamus proteus Linn.

(Feeds on buds and leaves.)
For general article and life history see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 92–96, 1902.
EXHIBIT: Larva, chrysalis, adult, and figure.

COMMON BEAN WEEVIL.

Bruchus obtectus Say.

For general account and life history see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 239–242, 1899.
EXHIBIT: Adult, work, and figure.

THE PEA WEEVIL.

Bruchus pisorum Linn.

For general account and life history see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 234–239, 1899.
EXHIBIT: Adult, work, and figure.

THE COWPEA WEEVIL.

Bruchus chinensis Linn.

For general account and life history see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 242–245, 1899.
EXHIBIT: Adult and figure.

FOUR-SPOTTED BEAN-WEEVIL.

Bruchus quadrimaculatus Boh.

For general account and life history see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 245–247, 1899.
EXHIBIT: Adult and figure.

THE LENTIL WEEVIL.

Bruchus lentis Boh.

For brief account see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, p. 248, 1899.
EXHIBIT: Adult.

EUROPEAN BEAN-WEEVIL.

Bruchus rufimanus Boh.

For general account see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 247–248, 1899.
EXHIBIT: Adult.

THE MEXICAN BEAN-WEEVIL.

Spermophagus pectoralis Shp.

For brief account see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, p. 248, 1899.
EXHIBIT: Adult and figure.

THE GRAY HAIR-STREAK.

Uranotes melinus Hbn.

(Works in pods of peas and beans, and in silk corn. Formerly *Thecla.*)
For brief article see Chittenden, Bul. 33. n. s., Div. Ent., U. S. Dept. Agric., pp. 101–102, 1902.
EXHIBIT: Larva, pupa, adult, and figure.

BOLLWORM; CORN-EAR WORM.

Heliothis obsoleta Fab.

(See special case for full life history with illustrations.)
For life history and general account see Quaintance and Brues, Bul. 50, Bur. Ent., U. S. Dept. Agric., 1905; also Quaintance and Bishopp, Farmers' Bul. 212, U. S. Dept. Agric., 1905.
EXHIBIT: Larva, adult, work, and figure.

THE IMPORTED PEA-MOTH.

Semasia nigricana Steph.

For general accounts and life history see Fletcher, Rpt. Ent. and Bot., Can. Dept. Agric., 1900, p. 214, 1901; Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 96–98, 1902.
EXHIBIT: Adult and figure.

INSECTS INJURIOUS TO CRUCIFERS.

IMPORTED CABBAGE-WORM.

Pontia rapæ Sch.

(Formerly *Pieris.*)
For general articles see Riley, Rpt. U. S. Dept. Agric. f. 1883, pp. 108–113, 1884; Lugger, 1st Rpt. St. Ent. Minn., pp. 71–77, Pl. VI, 1896; Chittenden, Cir. 60, Bur Ent., U. S. Dept. Agric., 1905.
EXHIBIT: Larva, chrysalis, and adult.

THE LARGE CABBAGE BUTTERFLY.

Pontia monuste Linn.

(Formerly *Pieris.*)
For general article see Riley, Rpt. U. S. Dept. Agric. f. 1883, pp. 117–118, 1884.
EXHIBIT: Adult.

THE POT-HERB BUTTERFLY.

Pontia oleracea Boisd.

(Formerly *Pieris.*)
For general account see Riley, Rpt. U. S. Dept. Agric. f. 1883, pp. 115–117, 1884.
EXHIBIT: Chrysalis and adult.

THE SOUTHERN CABBAGE WORM.

Pontia protodice Boisd.

(Formerly *Pieris.*)
For general articles see Riley, Rpt. U. S. Dept. Agric. f. 1883, pp. 114–115, 1884 Lugger, 1st Rpt. St. Ent. Minn., pp. 71–77, Pl. VII, 1896.
EXHIBIT: Chrysalis and adult.

GARDEN WEBWORM.

Loxostege similalis Guen.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 39–40, 1903.
EXHIBIT: Adult and figure.

GRANULATED CUTWORM.

Feltia annexa Tr.

For description of eggs and larval stage see French, Can. Ent., Vol. XIV, pp. 207–210, 1882. For general account see Riley, Rpt. U. S. Dept. Agric., 1884, pp. 291–292, 1885.
EXHIBIT: Larva, pupa, adult, and figure.

THE STRIPED CUTWORM.

Feltia subgothica Haw.

For general account see Slingerland, Bul. 104, Cornell Univ. Agric. Expt. Sta., pp. 274–279, 1895.
EXHIBIT: Larva, adult, and figure.

SHAGREENED CUTWORM.

Feltia malefida Guen.

(Larvæ destroy young plants.)
For short account see Riley, Rpt. U. S. Dept. Agric., 1884, pp. 292–293, 1885.
EXHIBIT: Adult and figure.

THE VARIEGATED CUTWORM.

Peridroma saucia Hbn.

For general bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp., 46–64, 1902.
EXHIBIT: Larva, adult, and figure.

THE BLACK CUTWORM.

Agrotis ypsilon Rott.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 294–295, 1885.
EXHIBIT: Larva, adult, and figure.

THE SPECKLED CUTWORM.

Mamestra subjuncta G. & R.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, p. 296, 1885.
EXHIBIT: Larva, pupa, and adult.

THE GLASSY CUTWORM.

Hadena devastatrix Brace.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 296–297, 1885.
EXHIBIT: Adult.

THE W-MARKED CUTWORM.

Noctua clandestina Harr.

For general account see Slingerland, Bul. 104, Cornell Univ. Agr. Expt. Sta., pp. 571–574, 1895.
EXHIBIT: Larva and adult.

FALL ARMY WORM.

Laphygma frugiperda S. & A.

For full bibliography and life history see Chittenden, Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 40–45, 1901.
EXHIBIT: Larva, adult, and figure.

THE CROSS-STRIPED CABBAGE WORM.

Evergestis rimosalis Guen.

(Formerly *Pionea.*)
For general article see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 54–59, 1902.
EXHIBIT: Larva, pupa, cocoon, adult, and figure.

THE SALT-MARSH CATERPILLAR.

Estigmene acræa Dru.

(Formerly *Leucarctia.*)
For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 43–44, 1903.
EXHIBIT: Larva, cocoon, and adult.

THE CABBAGE LOOPER.

Autographa brassicæ Riley.

(Formerly *Plusia.*)
For general account and life history see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 60–69, 1902.
EXHIBIT: Larva, cocoon, pupa, and adult.

THE DIAMOND-BACK MOTH.

Plutella maculipennis Curtis.

(Formerly *P. cruciferarum.*)
For general account see Lugger, 1st Rpt. St. Ent. Minn., p. 79, Pl. VI, 1896.
EXHIBIT: Larva, cocoon, adult, and work.

HARLEQUIN CABBAGE BUG.

Murgantia histrionica Hahn.

(Feeds on cruciferous plants of all kinds.)
For general accounts see Riley, Rept. U. S. Dept. Agric. f. 1884, pp. 309–312, 1885; Smith, Bul. 121, N. J. Agr. Expt. Sta., pp. 3–6, 1897.
EXHIBIT: Eggs, nymph, and adult.

THE TARNISHED PLANT-BUG.

Lygus pratensis Linn.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 312–315, 1885.
EXHIBIT: Adult.

THE EGG-PLANT FLEA-BEETLE.

Epitrix fuscula Cr.

For general account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 87–89, 1899.
EXHIBIT: Adult and figure.

THE RED TURNIP BEETLE.

Entomoscelis adonidis Pallas.

For partial life history, short accounts, and bibliography see Fletcher, Rpt. Ent. and Bot., Can. Dept. Agr., 1892, pp. 152–155, 1893; loc. cit., 1900, pp. 241, 1901; Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 49–53, 1902.
Exhibit: Figure.

WESTERN CABBAGE FLEA-BEETLE.

Phyllotreta albionica Lec.

Exhibit: Adult.

HORSE-RADISH FLEA-BEETLE.

Phyllotreta armoraciæ Koch.

For general accounts see Chittenden, Ins. Life, Vol. VII, pp. 404–406, 1895; Bul. 9, n. s., Div. Ent., U. S. Dept. Agric., pp. 21–22, 1897.
Exhibit: Adult.

THE WESTERN FLEA-BEETLE.

Phyllotreta pusilla Horn.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 18–19, 1903.
Exhibit: Adult and figure.

THE STRIPED FLEA-BEETLE.

Phyllotreta vittata Fab.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 301–304, 1885.
Exhibit: Adult.

WAVY-STRIPED FLEA-BEETLE.

Phyllotreta sinuata Steph.

(Formerly *P. zimmermani.*)
For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 304–308, 1885.
Exhibit: Adult.

THE CAULIFLOWER PYRALID.

Pachyzancla bipunctalis Fab.

(Formerly *Botis repetitalis.*)
For description and brief accounts see Comstock, Rpt. U. S. Dept. Agric. f. 1880, p. 270, 1881; Riley, Rpt. U. S. Dept. Agric. f. 1883, pp. 128–129, 1884.
Exhibit: Pupa and adult.

THE ZEBRA CATERPILLAR.

Mamestra picta Harr.

For bibliography and general life history see Felt, 14th Rpt. N. Y. St. Ent., pp. 201–207, 1898.
Exhibit: Larva, pupa, and adult.

THE CABBAGE MAGGOT.

Pegomya brassicæ Bouché.

(Formerly *Anthomyia.*)
For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 319–321, 1885.
Exhibit: Adult.

THE CABBAGE APHIS.

Aphis brassicæ Linn.

For general account see Riley, Rpt. U. S. Dept. Agric. f. 1884, pp. 317–319, 1885.
Exhibit: Adult and work.

IMPORTED CABBAGE WEBWORM.

Hellula undalis Fab.

For general account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 51–57, 1899.
EXHIBIT: Larva, pupa, adult, and figure.

THE CABBAGE CURCULIO.

Ceutorhynchus rapæ Gyll.

For general account and partial life history see Chittenden, Bul. 23, n. s., Div. Ent., U. S. Dept. Agric., pp. 39–50, 1900.
EXHIBIT: Adult and figure.

THE IMPORTED CABBAGE LEAF-MINER.

Scaptomyza graminum Fall.

(Formerly *Oscinis brassicæ.*)
See Riley, Rpt. U. S. Dept. Agric. f. 1884, p. 322, 1885. For short account see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 76–77, 1902.
EXHIBIT: Adult.

INSECTS INJURIOUS TO POTATO.

THE RINGED MILLIPEDE.

Cambala annulata Say.

EXHIBIT: Figure.

THE SHORT-WINGED MOLE-CRICKET.

Scapteriscus abbreviatus Scudd.

For general account see Chittenden, Bul. 40, Div. Ent., U. S. Dept. Agric., pp. 117–118, 1903. For account of an allied species, *S. didactylus* Latr., see Barrett, Bul. 2, Porto Rico Agric. Expt. Sta., 1902.
EXHIBIT: Adult.

POTATO-TUBER WORM; TOBACCO SPLIT-WORM.

Phthorimæa operculella Zell.

(Formerly *Lita* and *Gelechia solanella.* Works in stems and tubers.)
For general account see Riley and Howard, Insect Life, Vol. IV, pp. 239–242, 1892; Howard, Farmers' Bul. 120, U. S. Dept. Agric., pp. 19–22, 1900.
EXHIBIT: Adult and figure.

THE POTATO-STALK WEEVIL.

Trichobaris trinotata Say.

For life history and general account see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 9–19, 1902.
EXHIBIT: Adult and work.

STALK BORER.

Papaipema nitela Guen.

(Formerly *Gortyna* and *Hydrœcia.* Bores in stems of various plants.)
For general account see Bird, Can. Ent., Vol. XXX, pp. 127–128, 1898.
EXHIBIT: Adult.

THE LITTLE GREEN TORTOISE BEETLE.

Cassida pallidula Boh.

(Formerly *C. texana.*)
For short account see Riley, Amer. Nat., vol. 17, p. 1070, October [17 Sept.], 1883.
EXHIBIT: Adult.

THE GOLDEN TORTOISE BEETLE.

Coptocycla bicolor Fab.

(Formerly *C. aurichalcea.*)
For general account see Sanderson, Bul. 59, Md. Agr. Expt. Sta., pp. 139–140, 1899.
EXHIBIT: Adult.

COLORADO POTATO BEETLE.

Leptinotarsa decemlineata Say.

(Formerly *Doryphora.*)
For general account of life history see Smith, Rpt. N. J. Agric. Expt. Sta. f. 1895, pp. 452–458, 1896.
EXHIBIT: Egg, larva, pupa, adult, figure, and the following enemies: *Brachinus kansanus* Lec., *Chilocorus bivulnerus* Mels., *Coccinella sanguinea* Linn., *Coccinella novemnotata* Hbst., *Harpalus caliginosus* Fab., *Hippodamia convergens* Gúer., *Hippodamia glacialis* Fab., *Lebia atriventris* Say, *Lebia grandis* Htz., *Megilla maculata* DeG., *Nezara hilaris* Say, *Pasimachus elongatus* Lec., *Podisus spinosus* Dall., *Polistes pallipes* Lep., and *Tetracha virginica* Linn.

BOGUS POTATO BEETLE.

Leptinotarsa juncta Germ.

(This species exhibited merely on account of similarity to preceding species. It feeds on wild Solanum [*Solanum* spp.]).
EXHIBIT: Adult.

THREE-LINED POTATO BEETLE.

Lema trilineata Ol.

For general account see Riley, 1st Rpt. St. Ent. Mo., pp. 99–100, 1869.
EXHIBIT: Adult and figure.

THE WHITE BLISTER BEETLE.

Macrobasis albida Say.

For brief account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 26, 1903.
EXHIBIT: Adult.

THE ASH-GRAY BLISTER BEETLE.

Macrobasis unicolor Kby.

For general account see Chittenden, Yearbook, U. S. Dept. Agric. f. 1898, pp. 249–250, 1899.
EXHIBIT: Adult.

THE STRIPED BLISTER BEETLE.

Epicauta vittata Fab.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 22–23, 1903.
EXHIBIT: Adult.

BLACK BLISTER BEETLE.

Epicauta pennsylvanica DeG.

For brief account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric. p. 25, 1903.
EXHIBIT: Adult.

THE CROW BLISTER BEETLE.

Epicauta corvina Lec.

For brief notice see Comstock, Rpt. U. S. Comm. Agric. f. 1879, p. 251, 1880.
EXHIBIT: Adult.

THE GRAY BLISTER BEETLE.

Epicauta cinerea Först.

For brief account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., p. 24, 1903.
EXHIBIT: Adult.

THE SPOTTED BLISTER BEETLE.

Epicauta maculata Say.

For general accounts see Saunders, Bul. 57, S. Dak. Agric. Expt. Sta., p. 52, 1898; Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 24–25, 1903.
EXHIBIT: Adult and figure.

THE EGG-PLANT FLEA-BEETLE.

Epitrix fuscula Cr.

For general account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 87–89, 1899.
EXHIBIT: Adult.

INSECTS INJURIOUS TO SWEET POTATOES.

For general bulletin see Sanderson, Sweet Potato Insects, Bul. 59, Md. Agri Expt. Sta., 1900.

SWEET-POTATO ROOT-BORER.

Cylas formicarius Fab.

EXHIBIT: Adult and work.

SWEET-POTATO HAWK-MOTH.

Phlegethontius convolvuli Linn.

EXHIBIT: Adult.

THE SWEET-POTATO PLUME-MOTH.

Pterophorus monodactylus Linn.

EXHIBIT: Adult.

LARGER SWEET-POTATO SAWFLY.

Schizocerus privatus Nort.

For general account see Marlatt, Insect Life, Vol. V, pp. 24–27, fig. 6, 1892.
EXHIBIT: Adult and figure.

SWEET-POTATO FLEA-BEETLE.

Chætocnema confinis Cr.

EXHIBIT: Adult.

THE CUCUMBER FLEA-BEETLE.

Epitrix cucumeris Harr.

For short account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 89–90, 1899.
EXHIBIT: Adult.

THE MOTTLED TORTOISE BEETLE.

Coptocycla signifera Hbst.

(Formerly *C. guttata.*)
EXHIBIT: Adult.

BLACK-LEGGED TORTOISE BEETLE.

Cassida nigripes Ol.

EXHIBIT: Adult and work.

TWO-STRIPED TORTOISE BEETLE.

Cassida bivittata Say

EXHIBIT: Adult.

THE GREEN TORTOISE BEETLE.

Physonota unipunctata Say.

For brief notices see Hamilton, Can. Ent., Vol. XVI, pp. 134–135, 1884, and Caulfield, l. c., p. 227.
EXHIBIT: Adult.

THE ARGUS TORTOISE BEETLE.

Chelymorpha argus Licht.

(Also called *C. cassidea.*)
EXHIBIT: Adult.

INSECTS INJURIOUS TO TOMATO.

NORTHERN TOBACCO WORM; TOMATO WORM.

Phlegethontius quinquemaculata Haw.

(Formerly *Protoparce celeus.*)
For general account see Howard, Farmers' Bul. 120, U. S. Dept. Agric., pp. 10–14, 1900.
EXHIBIT: Larva and adult.

SOUTHERN TOBACCO WORM; HORNBLOWER.

Phlegethontius sexta Joh.

(Formerly *Protoparce carolina.*)
For general accounts see Howard, Farmers' Bul. 120, U. S. Dept. Agric., pp. 10–14, 1900; Alwood, Bul. 17, n. s., Div. Ent., U. S. Dept. Agric., pp. 72–74, 1898.
EXHIBIT: Larva and adult.

THE STALK BORER.

Papaipema nitela Guen.

For general accounts see Bird, Can. Ent., Vol. XXX, pp. 127–128, 1898; Lugger, 4th Rpt. State Ent. Minn., pp. 167–168, 1899.
EXHIBIT: Pupa and adult.

THE COMMELINA OWLET-MOTH.

Prodenia commelinæ S. & A.

For life history and general account see Chittenden, Bull. 27, n. s., Div. Ent., U. S. Dept. Agric., pp. 59–64, Pl. IV, fig. 1, 1901.
EXHIBIT: Larva and adult.

CORN-EAR WORM; COTTON BOLLWORM.

Heliothis obsoleta Fab.

(Feeds also on tobacco and tomato; formerly *H. armiger* Hbn.)
For life history and general account see Quaintance and Brues, Bul. 50, Bur. Ent., U. S. Dept. Agric., 1905; also Quaintance and Bishopp, Farmers' Bul. 212, 1905.
EXHIBIT: Larva and adult.

INSECTS INJURIOUS TO ASPARAGUS.

For general article on asparagus insects see Chittenden, Bul. 10, n. s., pp. 54–62, 1898.

THE ASPARAGUS MINER.

Agromyza simplex Loew.

For general account see Sirrine, Bul. 189, N. Y. Agric. Exp. Sta., pp. 277–282, 1900.
EXHIBIT: Adult.

LOPIDEA MEDIA Say.

EXHIBIT: Adult.

THE LESSER LOCUST.

Melanoplus atlanis Riley.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 178–183; pl. 12, fig. 7, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 26–27, 1891.
Exhibit: Adult.

THE TWO-STRIPED LOCUST.

Melanoplus bivittatus Say.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 363–368, pl. 24, fig. 5, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 31–32, 1891.
Exhibit: Adult and figure.

RED-LEGGED LOCUST.

Melanoplus femur-rubrum DeG.

For bibliography and general accounts see Scudder, Proc. U. S. N. M., Vol. XX, pp. 278–285, pl. 1, fig. h; pl. 19, figs. 1–4, 1897; Riley, Bul. 25, Div. Ent., U. S. Dept. Agric., pp. 27–28, 1891.
Exhibit: Adult.

MELANOPLUS PROPINQUUS Scudd.

For original description see Scudder, Proc. U. S. N. M., Vol. XX, pp. 285–286, pl. 18, fig. 9, 1897.
Exhibit: Adult.

TWELVE-SPOTTED ASPARAGUS BEETLE.

Crioceris duodecimpunctata Linn.

For detailed account see Chittenden, Yearbook, U. S. Dept. Agric., 1896, pp. 349–352, 1897.
Exhibit: Adult, figure, and adult of enemy, *Podisus spinosus* Dall.

THE ASPARAGUS BEETLE.

Crioceris asparagi Linn.

For detailed account see Chittenden, Yearbook, U. S. Dept. Agric., 1896, pp. 341–349. For bibliography and general account see Lintner, 11th Rpt. St. Ent. N. Y., pp. 177–188, 1896.
Exhibit: Larva, adult, figure, and enemy *Stiretrus anchorago* Fab.

THE TWELVE-SPOTTED CUCUMBER BEETLE.

Diabrotica duodecimpunctata Ol.

For general accounts and remedies see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 12–13, 1903; Quaintance, Bul. 26, n. s., Div. Ent., U. S. Dept. Agric., pp. 35–40, 1900.
Exhibit: Adult and figure.

FALSE BUD-WORM; COTTON BOLLWORM.

Heliothis obsoleta Fab.

(Formerly *H. armiger* Hbn. For full life-history exhibit see under cotton and corn.)
For life history and general account see Quaintance and Brues, Bul. 50, Bur. Ent., U. S. Dept. Agric., 1905; also Quaintance and Bishopp, Farmers' Bul. 212, U. S. Dept. Agric., 1905.
Exhibit: Adult.

ZEBRA CATERPILLAR.

Mamestra picta Harr.

For general account see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 42–43, 1903.
Exhibit: Larva, adult, and figure.

THE PRETTY CUTWORM.

Mamestra legitima Grt.

For brief account see Howard, Farmers' Bul. 120, U. S. Dept. Agric., pp. 24–25, fig. 20, 1900.
EXHIBIT: Larva, adult, and figure.

CRANBERRY SPANWORM.

Cleora pampinaria Guen.

For general account see Smith, Farmers' Bul. 178, pp. 19–21, 1903.
EXHIBIT: Larva, pupa, and adult.

THE RED-BANDED LEAF-ROLLER.

Eulia triferana Walk.

(Formerly *Lophoderus.*)
For brief account see Lugger, 4th Rpt. State Entom. Minn., p. 231, 1899.
EXHIBIT: Larva, pupa, and adult.

THE SULPHUR-COLORED TORTRIX.

Epagoge sulfureana Clem.

(Formerly *Dichelia.*)
For brief account see Lugger, 4th Rpt. State Entom. Minn., pp. 232–233, 1899.
EXHIBIT: Pupa and adult.

INSECTS INJURIOUS TO CUCURBITS.

SQUASH-VINE BORER.

Melittia satyriniformis Hbn.

(Formerly *Ægeria cucurbitæ* and *M. ceto.*)
For life history and general accounts see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 34–40, 1899; Cir. 38, Div. Ent., U. S. Dept. Agric., 1899.
EXHIBIT: Larva, pupa, cocoon, adult, and figure.

PICKLE WORM.

Diaphania nitidalis Cram.

(Formerly *Eudioptis* and *Margaronia.*)
For general accounts and bibliography see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 40–42, 1899; Lintner, 11th Rpt. N. Y. St. Ent., pp. 126–133, 1896.
EXHIBIT: Pupa, cocoon, adult, and figure.

MELON CATERPILLAR.

Diaphania hyalinata Linn.

(Formerly *Eudioptis* and *Margaronia.*)
For general accounts and bibliography see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 42–44, 1899; Lintner, 11th Rpt. N. Y. St. Ent., pp. 134–138, 1896.
EXHIBIT: Larva, pupa, adult, and figure.

NORTHERN LEAF-FOOTED PLANT-BUG.

Leptoglossus oppositus Say.

For life history and general account see Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 18–25, 1902.
EXHIBIT: Nymph, adult, and figure.

STRIPED CUCUMBER BEETLE.

Diabrotica vittata Fab.

For general accounts see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 48–51, 1899; Cir. 31, Div. Ent., U. S. Dept. Agric., 1898.
EHHIBIT: Adult, work, and figure.

TWELVE-SPOTTED CUCUMBER BEETLE.

Diabrotica duodecimpunctata Ol.

For general articles see Chittenden, Bul. 43, Div. Ent., U. S. Dept. Agric., pp. 12–13, 1903; Quaintance, Bul. 26, n. s., pp. 35–40, 1900.
EXHIBIT: Adult.

THE CUCUMBER FLEA-BEETLE.

Epitrix cucumeris Harr.

For short account see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 89–90, 1899.
EXHIBIT: Adult and figure.

THE PUNCTURED FLEA-BEETLE.

Psylliodes punctulata Mels.

For brief account see Forbes and Hart, 21st Rpt. St. Ent. Ill., p. 124, 1900.
EXHIBIT: Adult.

THE HORNED SQUASH-BUG.

Anasa armigera Say.

For general accounts see Chittenden, Can. Ent. Vol. XXX, pp. 239–240, 1898; Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 28–34, 1899.
EXHIBIT: Eggs, nymph, adult, and figure.

THE COMMON SQUASH-BUG.

Anasa tristis DeG.

For general accounts see Chittenden, Cir. 39, Div. Ent., U. S. Dept. Agric., 1899; Bul. 19, n. s., pp. 20–28, 1899.
EXHIBIT: Eggs, nymph, adult, and figure.

THE SQUASH LADYBIRD.

Epilachna borealis Fab.

For bibliography and life history see Chittenden, Bul. 19, n. s., Div. Ent., U. S. Dept. Agric., pp. 11–20, 1899.
EXHIBIT: Larva, pupa, adult, and work.

INSECTS INJURIOUS TO STORED PRODUCTS.

THE WOLF MOTH.

Tinea granella Linn.

For general account see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., pp. 31–34, 1897.
EXHIBIT: Pupa and adult.

MEDITERRANEAN FLOUR-MOTH.

Ephestia kuehniella Zell.

For general account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 8–9, 1897.
EXHIBIT: Larva, pupa, cocoon, adult, and figure.

DRIED-CURRANT MOTH.

Ephestia cautella Wlk.

For short account (under *E. cahiritella*) see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., pp. 7–9, 1897.
EXHIBIT: Larva, adult, and figure.

THE MEAL SNOUT-MOTH.

Pyralis farinalis Linn.

(Formerly *Asopia.*)
For short account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 10–11, 1897.
EXHIBIT: Larva, pupa, cocoon, and adult.

THE INDIAN-MEAL MOTH.

Plodia interpunctella Hbn.

(Formerly *Ephestia.*)
For general account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 9–10 1897.
EXHIBIT: Larva, pupa, adult, work, and figure.

ANGOUMOIS GRAIN MOTH.

Sitotroga cerealella Ol.

(Formerly *Gelechia.*)
For general account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 6–7, 1897.
EXHIBIT: Cocoon, adult, work, and figure.

THE FOREIGN GRAIN-BEETLE.

Cathartus advena Waltl.

For short account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 17–18, 1897.
EXHIBIT: Adult, work, and figure.

RED OR SQUARE-NECKED GRAIN-BEETLE.

Cathartus gemellatus Duv.

For short account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., p. 17, 1897.
EXHIBIT: Adult and figure.

THE SAW-TOOTHED GRAIN-BEETLE.

Silvanus surinamensis Linn.

For short account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 16–17, 1897.
EXHIBIT: Adult and figure.

THE MERCHANT GRAIN-BEETLE.

Silvanus mercator Fauv.

For short account see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., p. 12, 1897.
EXHIBIT: Adult.

PHARAXONOTHA KIRSCHII Reitt.

For short notice see Chittenden, Insect Life, Vol. VII, p. 327, 1895.
EXHIBIT: Adult.

THE FLAT GRAIN-BEETLE.

Læmophlœus pusillus Sch.

For short account see Chittenden, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., p. 129, 1902.
EXHIBIT: Adult.

TYPHŒA FUMATA Linn.

EXHIBIT: Adult and work.

THE BLACK CARPET BEETLE.

Attagenus piceus Ol.

For general account see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., pp. 15–19, 1897.
EXHIBIT: Adult.

TROGODERMA TARSALE Mels.

For general account see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., pp. 19–21, 1897.
EXHIBIT: Adult.

THE CABINET BEETLE.

Anthrenus verbasci Linn.

(Formerly *A. varius.*)
For short account see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., pp 22–23, 1897.
EXHIBIT: Adult and work.

THE MEAL SAP-BEETLE.

Carpophilus dimidiatus Fab.

EXHIBIT: Adult.

THE CORN SAP-BEETLE.

Carpophilus pallipennis Say.

EXHIBIT: Adult.

THE CADELLE.

Tenebroides mauritanicus Linn.

(Formerly *Trogosita.*)
For general account see Chittenden, Farmers' Bul. 45, U. S. Dept. Agric., pp. 18–19, 1897.
EXHIBIT: Larva, adult, work, and figure.

THE DARK MEAL-WORM.

Tenebrio obscurus Fab.

For short account see Chittenden, Farmers' Bul. 45, rev. ed., U. S. Dept. Agric., p. 15, 1897.
EXHIBIT: Larva, pupa, adult, and figure.

THE YELLOW MEAL-WORM.

Tenebrio molitor Linn.

For general account see Chittenden, Farmers' Bul. 45, rev. ed., U. S. Dept. Agric., pp. 14–15, 1897.
EXHIBIT: Larva, pupa, adult, and figure.

THE WHITE-MARKED SPIDER BEETLE.

Ptinus fur Linn.

For general account see Chittenden, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., pp. 127–128, 1902.
EXHIBIT: Adult.

THE BROWN SPIDER BEETLE.

Ptinus brunneus Dufts.

For short account see Chittenden, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., p. 128, 1902.
EXHIBIT: Adult.

THE DRUG-STORE BEETLE.

Sitodrepa panicea Linn.

(Listed as *Anobium* in foreign catalogues.)
For general account see Chittenden, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., pp. 124–126, 1897.
EXHIBIT: Adult, work, and figure.

THE CIGARETTE BEETLE.

Lasioderma testaceum Dufts.

(Formerly *L. serricorne.*)
For general account see Chittenden, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., pp. 126–127, 1897.
EXHIBIT: Adult and figure.

THE LARGER GRAIN-BORER.

Dinoderus truncatus Horn.

For short account see Chittenden, Insect Life, Vol. VII, p. 327, 1895.
EXHIBIT: Adult.

THE RUST-RED FLOUR-BEETLE.

Tribolium ferrugineum Fab.

For general account see Chittenden, Farmers' Bul. 45, rev. ed., U. S. Dept. Agric., pp. 12–13, 1897.
EXHIBIT: Adult.

THE CONFUSED FLOUR-BEETLE.

Tribolium confusum Duv.

For general account see Chittenden, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., pp. 113–115, 1902.
EXHIBIT: Adult and figure.

THE SLENDER-HORNED FLOUR-BEETLE.

Echocerus maxillosus Fab.

For short account see Chittenden, Farmers' Bul. 45, rev. ed., U. S. Dept. Agric., p. 13, 1897.
EXHIBIT: Adult and figure.

THE BROAD-HORNED FLOUR-BEETLE.

Echocerus cornutus Fab.

For short account see Chittenden, Farmers' Bul. 45, rev. ed., U. S. Dept. Agric., p. 13, 1897.
EXHIBIT: Adult and figure.

THE SMALL-EYED FLOUR-BEETLE.

Palorus ratzeburgi Wissm.

For short account see Chittenden, Farmers' Bul. 45, rev. ed., U. S. Dept. Agric., pp. 13–14, 1897.
EXHIBIT: Adult and figure.

THE DEPRESSED FLOUR-BEETLE.

Palorus subdepressus Woll.

EXHIBIT: Adult.

ALPHITOBIUS PICEUS Ol.

EXHIBIT: Adult.

BROAD-NOSED GRAIN WEEVIL.

Caulophilus latinasus Say.

For general account see Chittenden, Bul. 8, n. s., Div. Ent., U. S. Dept. Agric., pp. 13–14, 1897.
EXHIBIT: Adult.

THE GRANARY WEEVIL.

Calandra granaria Linn.

For short account, see Chittenden, Farmers' Bul. 45, rev. ed., U. S. Dept. Agric., pp. 4–5, 1897.
EXHIBIT: Adult, work, and figure.

BRACHYTARSUS ALTERNATUS Say.

For life history, notes, and general accounts, see Quaintance, Ent. News, pp. 1–3, plate, 1897.
EXHIBIT: Adult and figure.

HOUSEHOLD INSECTS.

For general account of household insects see Howard, Marlatt, and Chittenden, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., 1902. Contains articles on all the insects represented in the exhibit.

THE HOUSE CENTIPEDE.

Scutigera forceps Raf.

(While this animal is not an insect, but belongs to the class Myriapoda, it is so regularly associated with the insects that it may appropriately be presented with them. It feeds on flies, moths, roaches, etc.)
For general article see Marlatt, Cir. 48, Div. Ent., U. S. Dept. Agric., 1902.
EXHIBIT: Figure.

THE SILVER FISH.

Lepisma domestica Pack.

For general article see Marlatt, Cir. 49, Div. Ent., U. S. Dept. Agric., 1902.
EXHIBIT: Figure.

THE BOOK-LOUSE.

Troctes divinatoria Müll.

(Formerly *Psocus* and *Atropos.*)
EXHIBIT: Figure.

THE WHITE ANT.

Leucotermes flavipes Koll.

(Formerly *Termes.*)
For general account see Marlatt, Cir. 50, Div. Ent., U. S. Dept. Agric., 1902.
EXHIBIT: Adult and figure.

THE AMERICAN COCKROACH.

Periplaneta americana Linn.

For general article see Marlatt, Cir. 51, Div. Ent., U. S. Dept. Agric, pp. 1–8, 1902.
EXHIBIT: Adult and figure.

THE BLACK "BEETLE."

Blatta orientalis Linn.

For general article see Marlatt, Cir. 51, Div. Ent., U. S. Dept. Agric., pp. 9–10, 1902.
EXHIBIT: Adult and figure.

THE CROTON BUG.

Blattella germanica Linn.

(Formerly *Ectobia.*)
For general article see Marlatt, Cir. 51, Div. Ent., U. S. Dept. Agric., pp. 10–11, 1902.
EXHIBIT: Adult.

THE HOUSE CRICKET.

Gryllus domesticus Linn.

EXHIBIT: Adult.

THE CASE-MAKING CLOTHES MOTH.

Tinea pellionella Linn.

For general article see Marlatt, Cir. 36, Div. Ent., U. S. Dept. Agric., pp. 1–4, 1898.
EXHIBIT: Adult and figure.

THE CARPET MOTH.

Trichophaga tapetzella Linn.

(Formerly *Tinea.*)
For general article see Marlatt, Cir. 36, Div. Ent., U. S. Dept. Agric., p. 5, 1898.
EXHIBIT: Figure.

THE WEBBING CLOTHES MOTH.

Tineola biselliella Hum.

(Formerly *Tinea.*)
For general article see Marlatt, Cir. 36, Div. Ent., U. S. Dept. Agric., pp. 4–5, 1898.
EXHIBIT: Adult and figure.

THE RED-LEGGED HAM BEETLE.

Necrobia rufipes DeG.

(Formerly *Corynetes.*)
EXHIBIT: Adult and figure.

THE LARDER BEETLE.

Dermestes lardarius Linn.

EXHIBIT: Adult and figure.

THE CARPET BEETLE OR "BUFFALO MOTH."

Anthrenus scrophulariæ Linn.

For general article see Howard, Cir. 5, Div. Ent., U. S. Dept. Agric., 1894.
EXHIBIT: Adult and figure.

THE CHEESE OR HAM SKIPPER.

Piophila casei Linn.

EXHIBIT: Adult.

THE FRUIT OR VINEGAR FLY.

Drosophila ampelophila Loew.

For general accounts see Howard, Bul. 4, n. s., Div. Ent., U. S. Dept. Agric., pp. 109–111, 1896; Proc. Wash. Acad. Sci., Vol. II, pp. 589–590, pl. 31, fig. 2, 1900.
EXHIBIT: Adult and figure.

THE LITTLE RED ANT.

Monomorium pharaonis Linn.

For general article see Marlatt, Cir. 34, Div. Ent., U. S. Dept. Agric., pp. 1–2, 1898. For bibliography and general account see Lintner, 11th Rpt. N. Y. St. Entom., pp. 109–114, 1896.
EXHIBIT: Adult and figure.

INSECTS WHICH MAY SPREAD DISEASE.

General articles: Howard, Farmers' Bulletin 155, U. S. Dept. Agric., 1902; also Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., pp. 39–45, 1901.

THE YELLOW-FEVER MOSQUITO.

Stegomyia fasciata Fab.

(Is the intermediate host for the parasite of yellow fever. Formerly *Culex.*)
EXHIBIT: Adult and figure.

THE MALARIA MOSQUITO.

Anopheles maculipennis Meig.

(The most important of the mosquitoes transmitting malaria. Formerly *A. quadrimaculatus.*)
EXHIBIT: Adult and figure.

THE GREEN BOTTLE FLY.

Lucilia cæsar Linn.

For general article see Howard, Cir. 35, Div. Ent., U. S. Dept. Agric., 1898.
EXHIBIT: Adult and figure.

THE STABLE FLY.

Stomoxys calcitrans Linn.

For special article see Howard, Proc. Wash. Acad. Sci., Vol. II, pp. 577–579, fig. 27, 1900.
EXHIBIT: Adult and figure.

THE HIPPELATES FLY.

Hippelates flavipes Loew.

(Facilitates the spread of the disease known as "pink-eye.")
EXHIBIT: Adult and figure.

THE BROWN DUNG FLY.

Scatophaga furcata Say.

EXHIBIT: Adult and figure.

THE SHINING EXCREMENT FLY.

Morellia micans Macq.

EXHIBIT: Adult and figure.

THE LITTLE HOUSE FLY.

Homalomyia brevis Rond.

EXHIBIT: Adult and figure.

THE FRUIT OR VINEGAR FLY.

Drosophila ampelophila Loew.

EXHIBIT: Adult and figure.

THE SCREW-WORM FLY.

Chrysomyia macellaria Fab.

(Formerly *Compsomyia.*)
For special article see Howard, Proc. Wash. Acad. Sci., Vol. II, p. 562, 1900.
EXHIBIT: Adult and figure.

THE CATTLE TICK.

Boophilus annulatus Say.

(Very common on cattle below the Texas fever line, and known to be responsible for transmission of Texas fever among cattle.)
EXHIBIT: Eggs, adult, and figure.

INSECTS WHICH DIRECTLY INJURE OR ANNOY HUMAN BEINGS.

THE HOUSE FLY.

Musca domestica Linn.

For general article see Howard, Cir. 35, Div. Ent., U. S. Dept. Agric., 1898.
EXHIBIT: Adult and figure.

THE SOUTHERN BUFFALO GNAT.

Simulium pecuarum Riley.

For general article and full life history see Osborn, Bul. 5, n. s., Div. Ent., U. S. Dept. Agric., pp. 41–52, 1896.
EXHIBIT: Adult and figure.

THE CAT AND DOG FLEA.

Ctenocephalus canis Curtis.

(Formerly *Pulex serraticeps* Gerv.)
For general account see Howard and Marlatt, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., pp. 24–31, 1902. For full bibliography see Baker, Proc. U. S. N. M., Vol. XXVII, p. 438, 1904.
EXHIBIT: Figure.

THE BLOOD-SUCKING CONE-NOSE.

Conorhinus sanguisuga Lec.

For general article see Howard and Marlatt, Bul. 4, n. s., rev. ed., Div. Ent., U. S. Dept. Agric., pp. 38–42, 1902.
EXHIBIT: Egg, nymph, adult, and figure.

THE HOUSE MOSQUITO.

Culex pipiens Linn.

For general article and life history see Howard, Bul. 25, n. s., Div. Ent., U. S. Dept. Agric., pp. 22–28, 1900. Treated as *C. pungens* Wied.
EXHIBIT: Adult and figure.

THE BEDBUG.

Clinocoris lectularia Linn.

(Formerly *Acanthia*, *Cimex*, and *Klinophilos*.)
For general article see Marlatt, Cir. 47, Div. Ent., U. S. Dept. Agric., 1902.
EXHIBIT: Nymph, adult, and figure.

THE BLACK "BEETLE."

Blatta orientalis Linn.

For general article see Marlatt, Cir. 51, Div. Ent., U. S. Dept. Agric., pp. 9–10, 1902.
EXHIBIT: Adult and figure.

THE RED BUG.

Leptus irritans Riley.

For general article see H. Osborn, Bul. 5, n. s., Div. Ent., U. S. Dept. Agric., pp. 251–253, 1896.
EXHIBIT: Figure.

THE HEAD LOUSE.

Pediculus capitis DeG.

For general article see H. Osborn, Bul. 5, n. s., Div. Ent., U. S. Dept. Agric., pp. 166–167, 1896.
EXHIBIT: Figure.

THE BODY LOUSE.

Pediculus vestimenti Leach.

For general article see H. Osborn, Bul. 5, n. s., Div. Ent., U. S. Dept. Agric., pp. 167–168, 1896.
EXHIBIT: Figure.

THE CRAB LOUSE.

Phthirius inguinalis Leach.

For general article see H. Osborn, Bul. 5, n. s., Div. Ent., U. S. Dept. Agric., pp. 165–166, 1896.
EXHIBIT: Eggs, adult, and figure.

INSECTS INJURIOUS TO DOMESTIC ANIMALS.

For general account with illustrations of many of the insects affecting domestic animals see H. Osborn, Bul. 5, n. s., Div. Ent., U. S. Dept. Agric., pp. 1–302, 1896.

THE SOUTHERN BUFFALO GNAT.

Simulium pecuarum Riley.

Exhibit: Adult and figure.

THE TURKEY GNAT.

Simulium meridionale Riley.

Exhibit: Puparium, adult, and figure.

AMERICAN GADFLY.

Tabanus americanus Forst.

Exhibit: Adult.

THE GRAY-STRIPED GREEN-HEAD.

Tabanus lineola Fab.

Exhibit: Adult and figure.

THE BLACK GADFLY.

Tabanus atratus Linn.

Exhibit: Larva, adult, figure, and figure of parasite *Phanurus tabanivorus* Ashm.

THE GREENHEAD.

Tabanus costalis Wied.

Exhibit: Adult.

TABANUS EXUL O. S.

Exhibit: Adult.

TABANUS PUNCTIFER O. S.

Exhibit: Adult.

TABANUS CINCTUS Fab.

Exhibit: Adult.

MEXICAN GADFLY.

Tabanus mexicanus Linn.

Exhibit: Adult.

THE BLACK-STRIPED GADFLY.

Tabanus nigrovittatus Macq.

Exhibit: Adult.

THE BLACK-STRIPED EAR-FLY.

Chrysops vittatus Wied.

Exhibit: Adult and figure.

CHRYSOPS ATROPOS O. S.

Exhibit: Adult.

CHRYSOPS HILARIS O. S.

Exhibit: Adult.

THE STABLE FLY.

Stomoxys calcitrans Linn.

For special article see Howard, Proc. Wash. Acad. Sci., Vol. II, pp. 577–579, fig. 27, 1900.

Exhibit: Adult and figure.

THE HORSE BOT-FLY.

Gastrophilus equi Fab.

Exhibit: Eggs, larva, puparia, adult, and figure.

THE "CHIN" FLY.

Gastrophilus nasalis Linn.

Exhibit: Adult.

THE WARBLE FLY.

Hypoderma bovis DeG.

(A European species.)
Exhibit: Eggs, adult, and figure.

THE OX BOT; OX WARBLE.

Hypoderma lineata Vill.

Exhibit: Larva, adult, and figure.

THE SHEEP BOT FLY; HEAD MAGGOT.

Œstrus ovis Linn.

Exhibit: Larva, puparia, adult, and figure.

THE HORN FLY.

Hæmatobia serrata R. D.

For special article see Riley and Howard, Insect Life, Vol. II, pp. 93–103.
Exhibit: Puparium, adult, and figure.

THE SHEEP TICK.

Melophagus ovinus Linn.

Exhibit: Adult and figure.

THE SCREW-WORM FLY.

Chrysomyia macellaria Fab.

(Formerly *Compsomyia.*)
For special article see Howard, Proc. Washington Acad. Sci., Vol. II, p. 562, 1900.
Exhibit: Adult and figure.

THE CAT AND DOG FLEA.

Ctenocephalus canis Curtis.

(Formerly *Pulex serraticeps* Gerv.)
For full bibliography see Baker, Proc. U. S. N. M., Vol. XXVII, p. 438, 190
Exhibit: Figure.

THE SUCKING HORSE-LOUSE.

Hæmatopinus asini Linn.

Exhibit: Figure.

THE SHORT-NOSED OX-LOUSE.

Hæmatopinus eurysternus Nitsch.

Exhibit: Figure.

THE LONG-NOSED OX-LOUSE.

Hæmatopinus vituli Linn.

Exhibit: Adult and figure.

THE CATTLE LOUSE.

Trichodectes scalaris Nitsch.

Exhibit: Adult and figure.

THE SHEEP LOUSE.

Trichodectes sphærocephalus Nitsch.

Exhibit: Adult and figure.

FOREST INSECTS.

For treatises and shorter articles see Packard, 5th Rpt. U. S. Ent. Comm., 1886–90; Hopkins, Buls. 21, 28, 32 and 48, Div. Ent., U. S. Dept. Agric., Buls. 16, 17, 31, 32, 35, 36, and 56, W. Va. Agric. Exp. Sta., and Yearbk., U. S. Dept. Agric. f. 1904, pp. 387–404, 1905; Felt, 7th Ann. Rpt. Forest, Fish, and Game Comm., pp. 479–534, 1903.

INSECTS INJURIOUS TO FORESTS IN THE NORTHWESTERN AND NORTHEASTERN UNITED STATES.

NORTHWESTERN STATES.

INJURY BY AMBROSIA BEETLES. ORDER COLEOPTERA, FAMILY SCOLYTIDÆ.

CASE 1.

1. The Western Platypus.

Platypus n. sp.

Excavates long, branching galleries in the sapwood and heartwood of injured, dying, and recently felled Douglas spruce, western hemlock, and giant arborvitæ. California to northern Oregon; also reported from Washington.

EXHIBIT: Adult and work.

2. Western Hemlock Wood-Stainer.

Gnathotrichus sulcatus Lec.

Excavates numerous branching galleries from a central burrow, the broods living in closely joined side chambers; in the sapwood and heartwood of western hemlock, Douglas spruce, giant arborvitæ, and lowland fir. California to northern Washington; common in hemlock.

EXHIBIT: Adult and work.

3. The Western Pine Wood-Stainer.

Gnathotrichus n. sp.

Excavates transverse galleries in the surface of the wood and branching ones deep in the sapwood and heartwood, the broods living in short side chambers; western yellow pine and Douglas spruce. Cascade and Rocky Mountain region, California to northeastern Washington.

EXHIBIT: Adult and work.

4. The Eastern Pine Wood-Stainer.

Gnathotrichus materiarius Fitch.

Excavates several branching galleries from a single-entrance burrow, the broods living in short side chambers in sapwood and heartwood of injured, dying, and recently felled pine and spruce. Eastern United States and Canada. Very common and injurious.

EXHIBIT: Adult and work.

5. The Spruce Timber-Beetle.

Trypodendron bivittatus Kirby.

Excavates several branching galleries from a single entrance burrow, the brood developing in short side chambers in the sapwood of injured, dying, and recently felled spruce, pine, hemlock, cedar, fir, and larch. Eastern, northeastern, and western United States, Canada, and British Columbia to Alaska; very injurious.
Exhibit: Adult and work.

6. The Birch Timber-Beetle.

Trypodendron n. sp.

Excavates branching galleries from an entrance burrow and the broods develop in short side chambers in sapwood and heartwood of paper birch. Kootenai, Idaho, and northwestern Maine; also other birches in Maine.
Exhibit: Adult and work.

7. The Cosmopolitan Timber-Beetle.

Xyleborus saxeseni Ratz.

Excavates branching galleries and broad brood chambers from an entrance burrow in sapwood and heartwood of Douglas spruce in Oregon, red oak in Maine, apple and hemlock in West Virginia, and oak, beech, maple, lime tree, poplar, pine, spruce, and fruit trees in Europe. Widely distributed in different countries of the world, especially in Europe, North America, and Japan.
Exhibit: Adult and work.

INJURY BY BARK-BEETLES. ORDER COLEOPTERA, FAMILY SCOLYTIDÆ.

CASE 2.

8. The Hairy Cryphalus.

Cryphalus n. sp.

Excavates broad, irregular chambers in dying and dead bark of lowland fir. Port Williams, Wash.
Exhibit: Adult and work.

9. The Western Oak Bark-Beetle.

Pityophthorus pubipennis Lec.

Excavates two transverse galleries from a central entrance burrow in the bark of injured, dying, and recently felled California black oak, Pacific post oak, and possibly other oaks. California to Oregon.
Exhibit: Adult and work.

10. The Densely-punctured Bark-Beetle.

Pityophthorus confinis Lec.

Excavates a large central chamber and several radiating primary galleries, with very deep egg cavities, in living bark of injured, dying, and recently felled western yellow pine. Northern California, eastern Washington, and western Idaho.
Exhibit: Adult and work.

11. The Lodgepole Pine Bark-Beetle.

Pityophthorus n. sp.

Excavates radiating curved longitudinal galleries from a medium-sized central chamber in living bark on large branches of dying lodgepole pine. Eastern Washington.
Exhibit: Adult and work.

12. The Knobcone Pine Bark-Beetle.

Pityophthorus n. sp.

Excavates several radiating galleries from a large central chamber in living bark on branches of injured and dying knobcone pine and western yellow pine. Berkeley, Cal., and Albany, Oreg.
Exhibit: Work.

13. The Monterey Pine Twig-Beetle

Pityophthorus puncticollis Lec.

Excavates small, radiating, curved galleries from a large central chamber in twigs and branches of dying and felled Monterey pine, shore pine, western yellow pine, knobcone pine, Sitka spruce, and mountain or silver pine. Middle California to northern Washington.
Exhibit: Adult and work.

14. The Sitka Spruce Twig-Beetle.

Pityophthorus nitidulus Mann.

Excavates three or four radiating galleries from a medium-sized central chamber in bark of Sitka spruce, silver pine, shore pine, and Douglas spruce. California to Alaska, coast and Cascade region. Common.
Exhibit: Adult and work.

15. The Jeffrey Pine Twig-Beetle.

Pityophthorus n. sp.

Excavates small central chambers and long longitudinal galleries in living bark of twigs and branches on living, injured, dying, and recently felled Jeffrey pine and western yellow pine. Mount Shasta, California, to Albany, Oreg., and Moscow Mountains, Idaho.
Exhibit: Adult and work.

16. The Smaller Fir Bark-Beetle.

Pityophthorus n. sp.

Excavates transverse galleries from a central chamber in the bark of dying lowland fir and mountain or silver pine. Kootenai, Idaho.
Exhibit: Adult and work.

CASE 3.

17. The Mountain Pine Wood-Engraver.

Pityogenes n. sp.

Excavates large central chambers and numerous curved primary galleries in the bark and surface of wood of injured, dying, and recently felled mountain or silver pine and lowland fir. Kootenai, Idaho.
Exhibit: Adult and work.

18. The Yellow Pine Wood-Engraver

Pityogenes carinulatus Lec.

Excavates numerous radiating galleries from a large central chamber in living bark and surface of wood of injured, dying, and recently felled western yellow pine and Jeffrey pine. California to eastern Washington, western Idaho, and Colorado.
Exhibit: Adult and work.

19. The Western Fir Bark-Beetle.

Tomicus n. sp.

Excavates several radiating, curved, transverse galleries from a small central chamber in the bark and surface of wood of injured, declining, or dying lowland fir, and white fir. Mount Shasta, California, and Moscow Mountains, Idaho. Common.
Exhibit: Adult and work.

20. The Smaller Sugar Pine Tomicus.

Tomicus latidens Lec.

Excavates two or three longitudinal galleries from a small central chamber in living bark of branches of dying and recently felled sugar pine. Grants Pass, Oregon; also California to Colorado.
Exhibit: Adult and work.

21. The Sitka Spruce Tomicus.

Tomicus concinnus Mann.

Excavates irregular central chambers, and three or four short curved galleries, in partly living bark of injured, dying, and recently felled Monterey pine, shore pine, and Sitka spruce. Coast region, middle California to Alaska.
Exhibit: Adult and work.

22. The Oregon Tomicus.

Tomicus oregoni Eichh.

Excavates two or three longitudinal galleries from a small central chamber in the bark of living, injured, dying, and recently felled western yellow pine, lodgepole pine, silver pine, and probably other pines in the Northwest. Destructive to the western yellow pine in western Idaho.
Exhibit: Adult and work.

23. The Western Five-Spined Tomicus.

Tomicus confusus Lec.

Excavates one to three long longitudinal galleries from a medium-sized central chamber in the living bark of injured, dying, and recently felled western yellow pine. Mount Shasta, California, and Grants Pass, Oregon; also recorded from southern California and Arizona.
Exhibit: Adult and work.

CASE 4.

24. The Silver Pine Tomicus.

Tomicus n. sp.

Excavates very long, straight, longitudinal, and transverse curved galleries from a large central chamber in the bark of living, injured, dying, and recently felled mountain or silver pine and sugar pine. Grants Pass, Oregon, and Kootenai, Idaho. Common and evidently a destructive species.
Exhibit: Adult and work.

25. The Four-Spined Tomicus.

Tomicus integer Eichh.

Excavates several longitudinal primary galleries from a large central chamber in living bark of western yellow pine and lodgepole pine. Eastern Washington; also recorded from California, Washington, and Colorado.
Exhibit: Adult and work.

CASE 5.

26. The Sugar Pine Wood-Engraver.

Carphoborus n. sp.

Excavates several long, curved, longitudinal galleries in the surface of the wood from a deep central chamber in injured or dying sugar pine, western yellow pine, Douglas spruce, and Sitka spruce. Grants Pass, St. Helen, and Ahlers, Oregon; also middle California.
Exhibit: Adult and work.

27. The Western Cedar Bark-Beetle.

Phlœosinus punctatus Lec.

Excavates a single straight longitudinal or curved subtransverse gallery from a basal chamber in the living bark and surface of wood of injured, dying, and recently felled giant arborvitæ, incense cedar, and Port Orford cedar. California to northern and eastern Washington and Rocky Mountain region. Common.
Exhibit: Adult and work.

28. The Sitka Spruce Dolurgus.

Dolurgus pumilis Mann.

Excavates irregular, confused galleries in dying and dead bark of dead and felled Sitka spruce. Southern and central Oregon.
Exhibit: Adult and work.

CASE 6.

29. The Redwood Bark-Beetle.

Phlœosinus sequoiæ Hopk.

Excavates a long, straight, longitudinal gallery from a basal chamber in living bark of injured, declining, and recently felled redwood and giant arborvitæ. California to northern Washington. Very common in redwood.
EXHIBIT: Adult and work.

CASE 7.

30. The Western Pine-Destroyer.

Dendroctonus brevicomis Lec.

Excavates long, winding galleries through the bark of living and injured western yellow pine and sugar pine. Cascade and Rocky Mountain region, New Mexico to British Columbia. Closely allied with the destructive pine bark-beetle of the East and capable of great destruction of the largest and best timber.
EXHIBIT: Adult and work.

CASE 8.

31. The Dark-Red Turpentine-Beetle.

Dendroctonus valens Lec.

The largest North American bark-beetle. Excavates very broad and long primary galleries, the broods developing in broad side chambers in the bark of living, injured, dying, and recently felled western yellow pine, lodgepole pine, and doubtless most of the other western pines. California to British Columbia and eastward to Kansas and northern Michigan. A variety extends into the eastern United States. Common and injurious, but not necessarily destructive to living timber.
EXHIBIT: Adult and work.

32. The Mountain Pine Dendroctonus.

Dendroctonus n. sp.

A medium-sized black bark-beetle, excavating very long, winding galleries in the bark of living, injured or declining, and recently felled mountain or silver pine and sugar pine. Northern California to Washington eastward to Idaho and Montana. Very common and capable of great destruction of the best timber.
EXHIBIT: Adult and work.

CASES 9 AND 10.

33. The Douglas Spruce Dendroctonus.

Dendroctonus n. sp.

(*Dendroctonus similis* in Bul. 21, n. s., Division of Entomology.)
A large, reddish bark-beetle, excavating long longitudinal, slightly curved primary galleries in the bark of living, injured, and recently felled Douglas spruce and western larch. New Mexico to British Columbia, Pacific coast and eastward through the mountain regions. Very common and capable of destroying much valuable timber.
EXHIBIT: Adult and work.

CASE 10.

34. The Western Pine Hylurgops.

Hylurgops subcostulatus Mann.

Excavates short, slightly curved, longitudinal galleries in the living bark of injured, dying, and recently felled sugar pine, silver pine, western yellow pine, lodgepole pine, and probably other pines on the Pacific coast. Cascade and Rocky Mountain region. Common.
EXHIBIT: Adult and work.

35. The Sitka Spruce Hylurgops.

Hylurgops rugipennis Mann.

Excavates a short, curved, longitudinal and subtransverse gallery from an entrance in the living bark of injured, dying, and recently felled Sitka spruce and shore pine. Coast region, California to Washington and Alaska.
EXHIBIT: Adult and work.

CASE 11.

36. The Fir Wood-Engraver.

Hylesinus n. sp.

Excavates a small central chamber at one side of the junction of two short transverse, slightly curved egg galleries, which are deeply grooved in the surface of the wood; the larvæ also groove or engrave the surface of the wood in an ornamental manner. Infests the lowland fir and Douglas spruce. Port Williams and Port Angeles, Wash. Common.

Exhibit: Adult and work.

37. The Larger Fir-Tree Bark-Beetle.

Hylesinus granulatus Lec.

Excavates one or two transverse galleries from a central burrow in the bark and surface of wood near the base of dying lowland fir. Port Williams, Wash.; also recorded from California.

Exhibit: Adult and work.

38. The Grand Fir Bark-Beetle.

Hylesinus n. sp.

Excavates two separate, transverse galleries from a central entrance burrow in the bark and surface of wood of recently felled lowland, or grand, fir. Port Angeles and Port Williams, Wash.

Exhibit: Work.

39. The Shore Pine Hylesinus.

Hylesinus sericeus Mann.

Excavates one short, longitudinal gallery from the entrance burrow and small side cavity in living bark of injured, dying, and recently felled shore pine. Newport and Seaside, Oreg. Common. Also recorded from California and Alaska.

Exhibit: Adult and work.

40. The Ash-Tree Bark-Beetle.

Hylesinus aculeatus Say.

Excavates two long, transverse galleries, from a central entrance burrow and side cavity in the living bark of injured, dying, and recently felled ash. Atlantic to Pacific coast. Common. Specimens from Oregon ash, St. Helen, Oreg.

Exhibit: Adult and work.

41. The White-Alder Bark-Beetle.

Hylesinus aspericollis Lec.

Excavates a moderately long, longitudinal gallery from a basal entrance burrow in the bark of living, injured, dying, and recently felled white alder. Newport, Detroit, and Astoria, Oreg., and Seattle, Wash.; also recorded from California. A destructive enemy, causing the death of large trees.

Exhibit: Adult and work.

42. The Western Hemlock Bark-Beetle.

Hylesinus n. sp.

Excavates one or two transverse galleries from a central burrow in bark and surface of wood of living, injured, and recently felled western hemlock, causing "gum spot" defects in the wood of living trees, and may cause the death of the best timber. Newport, Oreg., and Port Angeles, Wash.

Exhibit: Adult and work.

CASE 12.

43. The Douglas Spruce Hylesinus.

Hylesinus nebulosus Lec.

Excavates two short, straight, longitudinal galleries from a central entrance burrow in the living bark of injured, dying, and recently felled Douglas spruce. California to British Columbia, and eastward to Idaho and Colorado. Very common.

Exhibit: Adult and work.

44. The Single Spine Scolytus.

Scolytus unispinosus Lec.

Excavates two short, straight, longitudinal galleries from an entrance burrow in living bark of injured, dying, and recently felled Douglas spruce and western larch. Pacific coast, Cascade and Rocky Mountain region. Common.
EXHIBIT: Adult and work.

45. The Fir-Branch Scolytus.

Scolytus n. sp.

Excavates two short, longitudinal galleries from a central burrow and side cavity in living bark of the branches of recently felled lowland fir. Cascade Mountains near Grants Pass, Oregon.
EXHIBIT: Work.

46. The Smaller Fir-Tree Scolytus.

Scolytus n. sp.

Excavates two transverse or oblique, slightly curved galleries from a central entrance burrow and side cavity in the bark and surface of wood of injured and dying lowland fir. Kootenai, Idaho.
EXHIBIT: Adult and work.

CASE 13.

47. The California White Fir Scolytus.

Scolytus præceps Lec.

Excavates two nearly straight, transverse galleries from a central entrance burrow and basal cavity in living bark and surface of wood of California white fir. Mount Shasta, California, and lowland fir, Sand Point, Idaho. Closely allied in character and habits to No. 48.
EXHIBIT: Adult and work.

48. The Fir Tree Destroyer.

Scolytus subscaber Lec.

Excavates two long, nearly straight, transverse galleries from a central entrance burrow and central or side cavity in bark of living, injured, and declining lowland fir, white fir, and doubtless other species of fir. California to British Columbia, eastern Washington, and western and northern Idaho. The healed-over wounds in living trees cause serious defects and rapid decay of the heartwood.
EXHIBIT: Adult and work.

BARK AND WOOD-BORING GRUBS. ORDER COLEOPTERA, FAMILIES BUPRESTIDÆ AND CERAMBYCIDÆ.

CASE 14 AND PART OF CASE 15.

49. The Douglas Spruce Bark-Borer.

Asemum nitidum Lec.

A round-headed bark-boring grub, boring transverse and winding galleries in the bark of living, injured, and declining Douglas spruce and western hemlock. Cascade Mountains, near Detroit, Oreg., St. Helen, Oreg., and Port Williams, Wash. A very common and destructive enemy of the Douglas spruce. The healed-over wounds in the wood cause serious defects, and the trees die from successive attacks.
EXHIBIT: Adult and work.

50. The White-Pine Sawyer.

Monohammus scutellatus Say.

A large, whitish, round-headed bark and wood boring grub, excavating burrows through the sapwood and deep into the heartwood of fire-scorched, declining, dying, dead, and recently felled mountain or silver pine. Kootenai, Idaho, and white pine in eastern and northern United States. Common and destructive.
EXHIBIT: Adult and work.

51. The Ponderous Sawyer.

Ergates spiculatus Lec.

An exceedingly large, round-headed, bark and wood boring grub, excavating large and deep burrows in the sapwood and heartwood of dead and felled western yellow pine; destructive to the wood of timber that has been dead or felled one or more years. Southern Oregon.
EXHIBIT: Adult and work.

52. The Western Cedar Bark-Borer.

Hylotrupes amethystinus Lec.

A medium-sized bark and wood boring grub, excavating long, winding burrows in the living bark and surface of the wood and boring into the sapwood of injured, dying, and recently felled giant arborvitæ and incense cedar. Northern California to Washington.
EXHIBIT: Work.

53. The Bronze Birch-Borer.

Agrilus anxius Gory.

A long, flat-headed, slender wood-boring grub, excavating long, winding burrows in the bark and surface of the wood of living and injured birch, aspen, and cottonwood trees in northern Idaho, northern Maine, and mountains of West Virginia; also recorded from northern Michigan, New York, Pennsylvania, Virginia, Quebec, and Ontario. A destructive enemy of the birches, aspen, and cottonwood.
EXHIBIT: Adult and work.

INJURY BY GALL INSECTS. ORDER HYMENOPTERA.

PART OF CASE 15.

54. Bird's-eye Pine.

Chalcidid?

A common condition of the wood of the western yellow pine, evidently caused by a minute four-winged gnat, fragments of which were found in pitch galls in the bark of the main stem of young living pine. The formation of corky wood cells around the accumulation of pitch in the wound produces in the subsequent layers of wood the wavy and so-called bird's-eye effect in the wood of larger trees. Insects found in specimen at Albany, Oreg. Specimen of wood from Grants Pass, Oreg.
EXHIBIT: Work.

55. The Oak-Twig Ormyrus.

Ormyrus sp.

A minute four-winged gnat breeding in small gall-like cavities in the living bark on the branches and twigs of the Pacific post oak in western Oregon, causing the small and large oak trees to present a dying appearance, due to the great number of dying twigs and dead leaves. The healed-over wounds produce deformed branches and defective wood.
EXHIBIT: Work.

INJURY BY BARK AND WOOD-BORING GRUBS. ORDER COLEOPTERA, FAMILY BUPRESTIDÆ.

CASE 16.

56. The Western Hemlock Bark-Borer.

Melanophila drummondi Kirby.

A medium-sized, flat-headed, bark-boring grub, excavating shallow, winding burrows through the inner layers of bark of living, injured, and recently felled western hemlock and Douglas spruce; California to northern and eastern Washington and western Idaho, and in the noble fir near Detroit, Oreg. A very common and destructive enemy, killing the largest and best trees, or causing serious "gum spot" defects in the wood of living ones.
EXHIBIT: Adult and work.

INJURY BY BARK-WEEVILS. ORDER COLEOPTERA, FAMILY CURCULIONIDÆ.

PART OF CASE 17.

57. The Sugar Pine Bark-Weevil.

Pissodes sp.

Adult snout-beetle deposits eggs in the outer bark of young living and injured sugar pine, producing small whitish grubs which mine through the inner bark and change to the adult in oval cavities excavated in the surface of the wood, causing the death or abnormal development of the trees. Grants Pass, Oreg.

Exhibit: Work.

58. The Douglas Spruce Twig-Weevil.

Curculionid.

A small snout-beetle which deposits eggs in cavities in the bark of the small central shoots and terminal twigs of young, living Douglas spruce. The small whitish grubs mine through the inner bark and enter the pith to change to the adult, killing the twigs and causing a deformed development of the tree. St. Helen, Oreg.

Exhibit: Work.

59. The Pine Fungus-Gall Weevil.

Curculionid.

A small snout-beetle breeding in the bark and wood of a common fungus gall on the shore pine and western yellow pine, causing the death of the branches and young trees. Newport, Oreg., and Moscow Mountains, Idaho.

Exhibit: Work.

INJURY TO DEAD WOOD AND BARK BY POWDER-POST BEETLES. ORDER COLEOPTERA, FAMILY PTINIDÆ.

PART OF CASE 17.

60. The Pine Wood Perforator.

Ptinid ?

Small white grubs burrow through the dead wood of western yellow pine logs, causing rapid decay. Grants Pass, Oreg.

Exhibit: Work.

61. The Giant Arborvitæ Ptinid.

Ptinid.

Small white grubs boring in the dead heartwood of living giant arborvitæ, contributing to the rapid decay of the heartwood. Port Angeles, Wash.

Exhibit: Work.

62. The Giant Arborvitæ Dryophilus.

Dryophilus sp.

A small whitish grub and brownish beetle, breeding in the outer bark of the giant arborvitæ. Its work is very common. Detroit, Oreg., and Port Angeles, Wash. "Represents a European family and genus heretofore unrecorded from North America." (Schwarz.)

Exhibit: Work.

INJURY TO TWIGS BY BARK MAGGOTS. ORDER DIPTERA, FAMILY CECIDOMYIIDÆ.

PART OF CASE 17.

63. The Pine Twig-Maggot.

Cecidomyiid.

Minute reddish maggot, living in the bark of terminal twigs of the western yellow pine, causing the leaves to turn yellow and die. Moscow Mountains, Idaho. Common.

Exhibit: Work.

INJURY BY GALL INSECTS. ORDER HEMIPTERA, FAMILY APHIDIDÆ.

CASE 18.

64. The Sitka Spruce Gall-Aphis.

Chermes sibiricus ?

A minute insect forming cone-like galls on the terminal twigs of the Sitka spruce at Newport, Oreg. Very common and injurious to young trees.
Exhibit: Work.

65. The Engelmann Spruce Gall-Aphis.

Chermes sibiricus ? var.

Same habit as 64, but probably a variety or different species. Common on Engelmann spruce at Sand Point, Idaho.
Exhibit: Work.

INJURY BY CICADA. ORDER HEMIPTERA, FAMILY CICADIDÆ.

CASE 18.

66. Small Western Cicada.

Cicada sp.

Injuring twigs of Douglas spruce, St. Helen, Oreg.
Exhibit: Adult and work.

INJURY BY TWIG-MINER. ORDER LEPIDOPTERA, FAMILY TORTRICIDÆ.

CASE 18.

67. The Pine Twig-Miner.

Tortricid.

A caterpillar of a moth with similar habits to that of the pine moth of Nantucket, excavating burrows through the pith of the terminal twigs and shoots of young western yellow pine. Moscow Mountains, Idaho, where it was common and quite injurious.
Exhibit: Work.

NORTHEASTERN STATES.

INJURY BY BARK AND TWIG-BEETLES. ORDER COLEOPTERA, FAMILY SCOLYTIDÆ.

CASE 19.

68. The Balsam Fir Cryphalus.

Cryphalus n. sp.

Excavates irregular, broad, elongate egg chambers to one side of the entrance burrow in the bark and surface of wood, the larval galleries radiating in all directions and deeply grooved in the surface of the wood of the branches of dying and dead balsam fir. Shores and islands of Parmacheene Lake and Rump Mountain, Maine.
Exhibit: Work.

69. The Spruce Cryphalus.

Cryphalus n. sp.

Excavates broad transverse egg chambers in the bark and surface of wood; the larval galleries but slightly grooved in the surface of the wood of dying and dead red spruce and balsam fir. Islands and shores of Parmacheene Lake and near Portland, Me. Common in bark of small dying and dead red spruce.
Exhibit: Adult and work.

70. The Minute Oak Bark-Beetle.

Pityophthorus minutissimus Zimm.

Excavates two straight transverse galleries from a central entrance burrow and elongate longitudinal chamber in the bark and surface of wood of branches on living, dying, and felled trees, rarely in the thicker bark on the main trunk, of red oak, southern Maine, and other oaks in the eastern United States.
Exhibit: Adult and work.

71. The Minute Birch Bark-Beetle.

Pityophthorus n. sp.

Excavates galleries like that of the minute oak bark-beetle (70) in the living and dying bark of branches of the paper birch. Southern Massachusetts.
Exhibit: Adult and work.

72. The White Pine Twig-Beetle.

Pityophthorus n. sp.

Excavates several long winding galleries from a central chamber in the bark; deeply grooved in the surface of the wood of small dying and broken branches of white pine. Camp Caribou, Maine.
Exhibit: Adult and work.

73. The Minute Spruce-Twig Wood-Engraver.

Pityophthorus n. sp.

Excavates a large central chamber and several curved galleries in the bark and deeply grooved in the surface of the wood of small branches of felled red spruce. Shores of Barkers Lake, Maine, and West Virginia.
Exhibit: Work.

74. The Spruce Wood-Engraver.

Pityophthorus cariniceps Lec.

Excavates many short, radiating, curved galleries from a large central chamber in the bark and surface of the wood of twigs and branches of dying trees and main stem of young dying red spruce. Western Maine to Morgantown, W. Va., and Detroit, Mich.
Exhibit: Adult and work.

75. The Black Spruce Wood-Engraver.

Pityophthorus n. sp.

Excavates short longitudinal galleries from the entrance burrow in the bark and surface of wood of small dying black spruce. Shores of Parmacheene Lake, northwestern Maine; Peakes Island, in Casco Bay, Maine, and Adirondacks, New York.
Exhibit: Adult and work.

76. The White Pine Wood-Engraver.

Pityogenes n. sp.

Excavates numerous short, radiating, curved egg galleries from a large central chamber in the bark and surface of wood of large and small branches and small dying white pine. Northern Maine to West Virginia. Common. Heretofore recognized as *Pityophthorus sparsus* Lec.
Exhibit: Adult and work.

CASE 20.

77. The Small Red Spruce Bark-Beetle.

Dryocœtes n. sp.

Excavates three or four short, curved galleries from a small central cavity in the bark and surface of the wood of injured, dying, and recently felled red, white, and black spruce, Maine to northern New York, and the red spruce in the mountains of West Virginia. Common.
Exhibit: Adult and work.

78. The American Spruce Bark-Beetle.

Dryocœtes n. sp.

Excavates short, irregular galleries in the living bark of injured, dying, and recently felled red, white, and black spruce in Maine, spruce and pine in West Virginia; also in spruce and pine in Europe. Widely distributed in Europe and eastern North America.
Exhibit: Adult and work.

79. The Birch Bark-Beetle.

Dryocœtes n. sp.

Excavates irregular galleries in the bark of living, injured, and dying birch. Northwestern Maine and mountains of West Virginia. Common. Under favorable conditions causes the death of large trees.
Exhibit: Adult and work.

80. The Balsam Fir Bark-Beetle.

Tomicus balsameus Lec.

Excavates several radiating, curved, transverse galleries from a small central chamber in the living and dying bark of injured and dying balsam fir and red and black spruce. Western Maine; also recorded from northern Michigan and New York.
Exhibit: Adult and work.

81. The White Spruce Bark-Beetle.

Tomicus n. sp.

Excavates several long, radiating, longitudinal egg galleries from a large central chamber in the living bark of recently felled white spruce. Near Camp Caribou, northwestern Maine.
Exhibit: Adult and work.

82. The Hudson Bay Tomicus.

Tomicus n. sp.

Excavates one or two longitudinal primary galleries from a central burrow and small central chambers in the living bark of recently felled white and red spruce. Northwestern Maine; also recorded from Canada and British Columbia.
Exhibit: Adult and work.

CASE 21.

83. The Spruce Bark-Beetle.

Polygraphus rufipennis Kirby.

Excavates three or four short, curved egg galleries from a large central chamber in the surface of the inner bark, through the bark and slightly grooving the surface of the wood of injured, declining, dying, and recently felled black, red, and white spruce, and rare in balsam fir. Very common throughout the northern and Appalachian spruce regions.
Exhibit: Adult and work.

84. The Cedar Bark-Beetle.

Phlœosinus dentatus Lec.

Excavates a single short longitudinal egg gallery from the entrance burrow and basal chambers in the bark and surface of wood of injured and dying red juniper and arborvitæ. Eastern and northwestern United States and Canada. Common.
Exhibit: Adult and work.

86. The Parmacheene Bark-Beetle.

Xylochinus n. sp.

Excavates short, irregular egg galleries in the dead bark of small red spruce and balsam fir. Islands of Parmacheene Lake, Maine.
Exhibit: Work.

87. The Red Spruce Scolytus.

Scolytus n. sp.

Excavates two longitudinal egg galleries from a central entrance burrow and small lateral cavity in the living bark of branches of dying and recently felled red spruce. Northwestern Maine and Peak's Island, near Portland, Me.

EXHIBIT: Adult and work.

CASE 22.

88. The Minute Spruce Bark-Beetle.

Crypturgus atomus Lec.

Enters the galleries of other bark-beetles, from which it excavates numerous very small, irregular galleries through the inner bark of dying and dead black and red spruce and white pine. Northwestern Maine.

EXHIBIT: Adult and work.

89. The Spruce-Destroying Beetle.

Dendroctonus piceaperda Hopk.

Excavates long, longitudinal egg galleries from a basal entrance burrow in the bark, and grooving the wood of living and injured red and white spruce trees. Very destructive to the largest and best timber. Northern Maine to New York and New Brunswick. This is the great enemy of the red and white spruce of the northeastern spruce region, having caused the death and loss of a vast amount of timber. For methods of preventing losses, see Bulletin 28, n. s., Division of Entomology, U. S. Department of Agriculture.

EXHIBIT: Adult and work.

ENEMIES OF BARK-BEETLES. BIRDS AND INSECTS.

PART OF CASE 23.

90. Work of woodpeckers in spruce bark, when infested with the spruce-destroying beetle.

These birds are exceedingly beneficial in destroying the greatest enemy of the spruce.

EXHIBIT: Work.

91. The Cloudy Bark-Beetle Destroyer.

Thanasimus nubilus Kl.

The adults feed on the adults of the spruce-destroying and other bark-beetles, and its young or larvæ prey upon their developing broods. Very beneficial. The specimen of bark shows the pupa case of the Clerid in an egg gallery of the spruce-destroying beetle.

EXHIBIT: Adult and work.

92. Polyporus volvatus Peck.

A fungus growing from entrance and exit burrows of the spruce-destroying beetle in the bark and the spruce-timber beetle in the wood, and from those of other bark and wood boring insects in dying and recently dead spruce trees killed by the spruce-destroying beetle in the Northeast and the fir-destroying Scolytus in the Northwest. The presence of this fungus usually indicates the destructive work of insects.

EXHIBIT: Work.

93. Parasitic Enemy of the Spruce-Destroying Beetle.

Bracon simplex Cress.

The adult deposits eggs in the bark with the developing brood of the bark-beetle; the young maggot-like larvæ feed upon and kill the young. Very common and beneficial. Maine to West Virginia. Also attacks numerous other bark-infesting insects. The bark specimen shows the cocoon in which the matured larva develops to the adult.

EXHIBIT: Adult and work.

INJURY BY BARK AND WOOD BORING GRUBS. ORDER COLEOPTERA, FAMILIES BUPRESTIDÆ, CERAMBYCIDÆ, AND MELANDRYIDÆ.

CASE 24.

94. Buprestid.

Work of flat-headed bark and wood miner in wood of dying balsam fir.
EXHIBIT: Work.

95. The Destructive Spruce-Wood Borer.

Tetropium cinnamopterum Kirby.

A slender, round-headed bark and wood boring grub which excavates winding burrows through the inner bark and surface of the wood, then enters the sapwood and changes to the adult. Infests slightly injured, declining, and recently felled red, black, and white spruce. Maine to West Virginia. Common, and very destructive to the wood of dying trees, and may also cause the death of slightly injured ones.
EXHIBIT: Adult and work.

96. The Cedar Tree Borer.

Hylotrupes ligneus Fab.

A slender, whitish, bark and wood boring grub, excavating winding burrows in the bark and surface of the wood of living arborvitæ, causing the death of the trees and serious defects in the wood of living ones. Common in northwestern Maine.
EXHIBIT: Adult and work.

97. The Blazed-Tree Borer.

Serropalpus barbatus Schall.

A slender, whitish, wood-boring grub, which enters at wounds on living trees and bores deep into the sapwood and heartwood, causing a rapid decay of the infested parts. Common in "blazed" wounds on balsam fir and spruce trees along the trails in northwestern Maine.
EXHIBIT: Work.

98. The Mountain Ash Borer.

Saperda sp.

A destructive enemy of the mountain ash, boring in the healthy wood of the main stem. Northwestern Maine.
EXHIBIT: Work.

INSECT ENEMIES OF FORESTS IN GENERAL.

INJURING THE FOLIAGE.

CATERPILLARS OF BUTTERFLIES AND MOTHS. ORDER LEPIDOPTERA.

CASE 25.

99. The Violet-Tip Butterfly.

Polygonia interrogationis Fab.

Larvæ on elm.
EXHIBIT: Adults, larva.

100. The Mourning-Cloak Butterfly.

Euvanessa antiopa Linn.

Larvæ on foliage of elm, willow, and poplar, sometimes defoliating trees.
EXHIBIT: Adults, larvæ and pupa.

101. The Viceroy Butterfly.

Basilarchia archippus Cram.

Larvæ on willow and poplar.
EXHIBIT: Adult.

102. The Buff-Tipped Butterfly.

Limenitis bredowii Hbn.

Larvæ on oak in California.
EXHIBIT: Adult.

103. The Common Hackberry Butterfly.

Chlorippe celtis Bd. & Lec.

Larvæ on hackberry.
EXHIBIT: Adult, pupa.

104. The Pine Butterfly.

Neophasia menapia Feld.

Larvæ defoliate pine in the Pacific States.
EXHIBIT: Adults.

105. The Locust Leaf Folder.

Epargyreus (*Eudamus*) *tityrus* Fab.

Larvæ on locust.
EXHIBIT: Adults, larva, pupa, cocoon.

106. The Walnut Sphinx.

Cressonia juglandis S. & A.

Larvæ on hickory and walnut.
EXHIBIT: Adults.

107. The Pine Sphinx.

Lapara coniferarum S. & A.

Larvæ on pine in the Eastern States.
EXHIBIT: Adults, larva.

108. The Catalpa Sphinx.

Ceratomia catalpæ Bd.

The larvæ feed upon and frequently defoliate catalpa wherever this tree is native.
EXHIBIT: Adult, larva.

109. The Wavy Ash Sphinx.

Ceratomia undulosa Walk.

Larvæ on ash.
EXHIBIT: Adult, larva.

110. The Ash Sphinx.

Sphinx (*Hyloicus*) *kalmiæ* S. & A.

Larvæ on ash in the Eastern States.
EXHIBIT: Adult.

CASE 26.

111. The Four-Horned Sphinx.

Ceratomia amyntor Hbn.

Larvæ on elm.
EXHIBIT: Adults, larva.

112. The Western Cottonwood Sphinx.

Pachysphinx modesta var. *occidentalis* Hy. Edw.

Larvæ on cottonwood in the Western States.
EXHIBIT: Adult.

113. The Polyphemus Moth.

Telea polyphemus Cram.

The large green larvæ occur on maple, oak, birch, and a variety of other forest trees.
EXHIBIT: Adult.

114. The Hickory Horned Devil.

Citheronia regalis Hbn.

Larvæ on hickory and walnut.
EXHIBIT: Adults, larva.

115. The Imperial Moth.

Basilona imperialis Dru.

The larvæ feed upon pine and many other species of coniferous and deciduous trees.
EXHIBIT: Adults, larva, pupa.

116. The Orange-Striped Oak Worm.

Anisota senatoria Hübn.

The larvæ defoliate oak in the Eastern States.
EXHIBIT: Adults, larvæ, pupæ.

CASE 27.

117. The Spiny Oak Worm

Anisota stigma Hbn.

Larvæ in large colonies on oak, sometimes defoliating trees. Eastern States.
EXHIBIT: Adults, larvæ, pupæ.

118. The Green-Striped Maple Worm.

Anisota rubicunda Fab.

Larvæ in colonies on maple, sometimes defoliating trees. Eastern States.
EXHIBIT: Adults, eggs, larvæ, pupæ.

119. The Buck Moth.

Hemileuca maia Dru.

The black spiny larvæ feed in colonies on oak. Eastern States.
EXHIBIT: Adults.

120. The Pale Tussock Caterpillar.

Halisidota tessellaris Harr.

The pale-yellow, black tufted larvæ feed on elm, sycamore, maple, walnut, oak, etc.
EXHIBIT: Adults.

121. The Pine Tussock Caterpillar.

Euschausia argentata Pack.

The larvæ feed in colonies on pine, cedar, Douglas spruce, etc. Northwestern States.
EXHIBIT: Adults, pupæ, cocoon, work.

122. The Hickory Tussock Caterpillar.

Halisidota caryæ Harr.

The white wooly caterpillars, tufted with black, feed in large colonies on hickory, walnut, elm, and other forest trees, sometimes becoming very destructive. Eastern States.
EXHIBIT: Adults, cocoons.

123. The Oak Tussock Caterpillar.

Halisidota maculata Harr.

The orange and black tufted larvæ on oak, elm, alder, etc. Northern States.
EXHIBIT: Adults.

124. The Fall Webworm.

Hyphantria textor Harr.

Larvæ construct large tents on most species of deciduous forest trees. At times very destructive.
EXHIBIT: Adults, larvæ, pupa.

125. The American Dagger-Moth.

Apatela americana Harr.

The larvæ occur on maple, elm, and a variety of other forest trees.
EXHIBIT: Adults, larva.

126. The Smeared Dagger-Moth.

Apatela oblinita S. & A.

Larvæ occur on nearly all varieties of deciduous trees.
EXHIBIT: Adults, larvæ.

CASE 28.

127. The Underwing Moths.

Genus *Catocala*.

The large gray larvæ of these moths, of which there are many species in the United States, are nocturnal in habit, and conceal themselves during the day in the crevices of the bark on tree trunks and limbs. They devour the foliage of oak, hickory, walnut, poplar, birch, and other species of forest trees.
EXHIBIT: Adults of the following species: *Catocala retecta* Grote, *Catocala vidua* S. & A., *Catocala obscura* Strk., *Catocala cerogama* Guen., *Catocala unijuga* Walk., *Catocala concumbens* Walk., *Catocala cara* Guen.

128. The Semi-Looping Maple Worm.

Homoptera lunata Dru.

The slender green larvæ occur on maple, willow, etc.
EXHIBIT: Adults, larva, pupa.

129. The California Phryganidia.

Phryganidia californica Pack.

Larvæ on oak, sometimes defoliating trees in California.
EXHIBIT: Adults, larvæ.

130. The Poplar Tent-Maker.

Melalopha inclusa Hübn.

Larvæ construct small tents on aspen, cottonwood, and willow. Eastern States.
EXHIBIT: Adults, larva.

131. The Black Hickory Caterpillar.

Datana integerrima G. & R.

Larvæ in colonies on hickory and walnut, sometimes defoliating the trees. Eastern States.
EXHIBIT: Adult, larva, pupæ.

132. The Yellow-Necked Apple-Tree Caterpillar.

Datana ministra Dru.

Larvæ in colonies on birch, oak, and other forest trees, as well as on apple. Eastern States.
EXHIBIT: Adults, eggs, larvæ, pupa.

133. The Striped Hickory Caterpillar.

Datana angusii G. & R.

Larvæ in colonies on hickory and oak. Eastern States.
EXHIBIT: Adults.

134. The Green Oak Caterpillar.

Nadata gibbosa S. & A.

Larvæ on oak, maple, and other forest trees.
EXHIBIT: Adult, larvæ.

135. The Rosy Hyparpax.

Hyparpax aurora S. & A.

Larvæ on oak in Eastern States.
EXHIBIT: Adults.

CASE 29.

136. The Red-Humped Oak Caterpillar.

Symmerista albifrons S. & A.

Larvæ on oak, sometimes defoliating trees in the Eastern States.
EXHIBIT: Adults, larva, pupa.

137. The Rusty Tussock-Moth.

Notolophus antiqua Linn.

Larvæ on most species of deciduous forest trees in America and Europe.
EXHIBIT: Adults.

138. The California Tussock-Moth.

Hemerocampa vetusta Bd.

Larvæ on various species of deciduous forest trees in California.
EXHIBIT: Adults, larva.

139. The White-Marked Tussock-Moth.

Hemerocampa leucostigma S. & A.

Larvæ sometimes defoliate elm, maple, and other deciduous forest trees in the Eastern States.
EXHIBIT: Adults, egg-mass, larva, cocoon.

140. The Dark Tussock-Moth.

Olene achatina S. & A.

Larvæ on various deciduous forest trees in the Eastern States.
EXHIBIT: Adult.

141. The Brown-Tail Moth.

Euproctis chrysorrhœa Linn.

Introduced from Europe and destructive to deciduous forest trees in Massachusetts and New Hampshire.
EXHIBIT: Adults.

142. The Gypsy Moth.

Porthetria dispar Linn.

Introduced from Europe and very destructive to nearly all deciduous and a few coniferous forest trees in Massachusetts. It has recently become established in portions of the city of Providence, Rhode Island.
EXHIBIT: Adults, larvæ.

143. The Forest Tent-Caterpillar.

Malacosoma (Clisiocampa) disstria Hbn.

Larvæ at times very destructive to maple, oak, aspen, cottonwood, gum, and nearly all other deciduous forest trees throughout the United States.
EXHIBIT: Adults, eggs, larvæ, pupa, cocoons.

144. The Tufted Tent-Caterpillar.

Malacosoma (*Clisiocampa*) *constricta* Stretch.

Larvæ on oak in California.
Exhibit: Adults, eggs, larvæ.

145. The American Tent-Caterpillar.

Malacosoma (*Clisiocampa*) *americana* Fab.

Larvæ principally destructive to fruit trees, but also to wild cherry and a few other forest trees in the Eastern States.
Exhibit: Adults, eggs.

146. The Rocky Mountain Tent-Caterpillar.

Malacosoma (*Clisiocampa*) *fragilis* Stretch.

Larvæ feed on deciduous forest trees generally, and are at times very destructive. Rocky Mountain States.
Exhibit: Adults, eggs, larvæ.

147. The Northwestern Tent-Caterpillar.

Malacosoma (*Clisiocampa*) *pluvialis* Dyar.

Larvæ on most species of deciduous forest trees in the Northwestern States.
Exhibit: Adults, larva, cocoon.

148. The Californian Tent-Caterpillar.

Malacosoma (*Clisiocampa*) *californica* Pack.

Larvæ on oak in California.
Exhibit: Adults, larva.

149. The Spring Canker-Worm.

Paleacrita vernata Harr.

The larvæ feed upon the surface of the leaves of various forest and shade trees, especially upon elm in the Eastern States.
Exhibit: Adults, pupa.

CASE 30.

150. The Cherry-Leaf Webworm.

Calocalpe undulata Linn.

The larvæ live in webs on the terminal shoots of black cherry.
Exhibit: Adults, work.

151. The Western Oak Span-Worm.

Therina somniaria Hulst.

The larvæ occur on oak in the Northwestern States, sometimes defoliating trees.
Exhibit: Adults, pupæ.

152. The Large Forest Span-Worm.

Sabulodes transversata Dru.

Larvæ occur on maple, poplar, oak, etc.
Exhibit: Adults, larva.

153. The Crinkly Flannel Moth.

Lagoa crispata Pack.

The larvæ, which somewhat resemble the slug caterpillars, feed upon oak, poplar, and a variety of other deciduous trees.
Exhibit: Adults.

154. The Oak Webworm.

Archips (Cacœcia) fervidana Clem.

Larvæ live in colonies on oak, sheltered by a web inclosing leaves and a mass of excrement.
EXHIBIT: Adults.

155. The Slug Caterpillars.

Family *Cochlidiidæ.*

These bright-colored slug-like larvæ feed very generally on foliage of most deciduous trees.
EXHIBIT: the following species: *Sibine stimulea* Clem., adults, larva, cocoon; *Euclea delphinii* Bd., adult; *Euclea indetermina* Bd., adult.

THE FALSE CATERPILLARS OR SAWFLIES. FAMILY TENTHREDINIDÆ.

PART OF CASE 30.

156. Abbot's White-Pine Sawfly.

Lophyrus abbotii Leach.

This species, together with several closely allied forms, is at times very destructive to pine.
EXHIBIT: Adults, larvæ, cocoons.

157. The Larch Sawfly.

Nematus erichsonii Hartig.

One of the most destructive forest insects; the larvæ at various times past entirely defoliated the larch throughout the Northeastern States and caused the death of a large proportion of the trees.
EXHIBIT: Adults.

158. The Large American Sawfly.

Cimbex americana Leach.

Larvæ destroy foliage of elm, willow, poplar, and linden.
EXHIBIT: Adult.

MISCELLANEOUS FOLIAGE INSECTS.

PART OF CASE 30.

159. The Common Walking Stick.

Diapheromera femorata Say.

Young and adults devour foliage of deciduous forest trees.
EXHIBIT: Adult.

160. Katydid.

Microcentrum laurifolium Linn.

Young and adults feed on foliage of trees.
EXHIBIT: Adult, eggs.

LEAF-BEETLES. FAMILY SCARABÆIDÆ.

PART OF CASE 31.

161. The Rhinoceros Beetle.

Dynastes tityus Linn.

Larvæ mine in decaying stumps; adults destroy foliage of ash.
EXHIBIT: Adults.

162. The Goldsmith Beetle.

Cotalpa lanigera Linn.

Adults on oak, poplar, and other deciduous trees, sometimes defoliating them.
EXHIBIT: Adults.

THE LEAF-BEETLES. FAMILY CHRYSOMELIDÆ.

PART OF CASE 31.

163. The Imported Elm Leaf-Beetle.

Galerucella luteola Müll.

A very serious enemy to the elm in the Eastern States.
EXHIBIT: Adults, work.

164. The Larger Elm Leaf-Beetle.

Monocesta coryli Say.

Adults and larvæ destroy foliage of elm in sections of the Middle West.
EXHIBIT: Adults, work.

165. The Striped Willow Leaf-Beetle.

Melasoma scripta Fab.

Both larvæ and adults feed on foliage of poplar and willow, and are at times very destructive to these trees. An especial enemy of the osier willow industry.
EXHIBIT: Adults, pupæ.

166. The Spotted Willow Leaf-Beetle.

Melasoma lapponica Linn.

Habits similar to the above, but less abundant and injurious.
EXHIBIT: Adults.

INJURING THE FRUIT.

THE WEEVILS. FAMILY CURCULIONIDÆ.

PART OF CASE 31.

167. The Nut Weevils.

Genus *Balaninus*.

There are numerous species, the larvæ of which live within acorns and nuts of various sorts.
EXHIBIT: Adults of the following species: *Balaninus nasicus* Say, *Balaninus caryæ* Horn, *Balaninus quercus* Horn.

168. The Walnut Fruit Weevil.

Conotrachelus juglandis Lec.

The larvæ live in green fruit of walnut.
EXHIBITS: Adults.

CONE AND NUT WORMS. ORDER LEPIDOPTERA.

PART OF CASE 31.

169. The Hickory Husk-Worm.

Grapholitha caryana Fitch.

The larvæ live within the immature nuts and husks of the hickory and pecan.
EXHIBIT: Adults, work.

170. The Spruce Cone-Worm.

Dioryctia reniculella Grt.

Larvæ attack cones of spruce.
EXHIBIT: Adult, work.

171. The Southern Pine Cone-Worm.

An insect closely allied to the spruce cone-worm which attacks the cone of the Southern longleaf pine.
EXHIBIT: Work.

INJURING THE TWIGS AND SMALLER BRANCHES.

THE CICADAS. FAMILY CICADIDÆ.

PART OF CASE 31.

172. The Seventeen-Year Cicada.

Tibicen septendecim Linn.

A most destructive species, but owing to the long period required by the young to reach maturity only injurious during certain years.

Exhibit: Adults, pupa, work.

THE SCALE INSECTS. FAMILY COCCIDÆ.

PART OF CASE 31.

173. The Cottony Maple Scale.

Pulvinaria innumerabilis Rathv.

Becomes at times very abundant on twigs of maple.

Exhibit: Adult scales on twigs.

174. The Gloomy Maple Scale.

Aspidiotus tenebricosus Comst.

At times very abundant on maple. Principally injurious to shade trees in the neighborhood of towns.

Exhibit: Adult scales on bark.

175. The Hickory Soft Scale.

Lecanium sp.

At times abundant on hickory and pecan in the Southern States.

Exhibit: Adult scales on twigs.

THE TWIG WEEVILS. FAMILY CURCULIONIDÆ.

PART OF CASE 32.

176. The Western Spruce Weevil.

Pissodes sp.

Attacks and kills the terminal shoots of Sitka spruce, causing deformed trees. Northwestern States.

Exhibit: Adults, larvæ, work.

177. The White-Pine Weevil.

Pissodes strobi Peck.

Attacks and kills the terminal shoots of white pine, spruce, and deodar, causing serious deformity to the tree; also breeds in the bark of the lower portions of the trunk of pine and spruce, hastening the death of injured trees. Eastern States.

Exhibit: Adults, work. Sections of young white pine showing nature of injury to terminal shoots. (Large case.)

ROUND-HEADED BORERS. FAMILY CERAMBYCIDÆ.

PART OF CASE 32.

178. The Oak Pruner.

Elaphidion villosum Fab.

The larvæ bore in twigs of living oak, hickory, etc., causing them to break and fall.

Exhibit: Adults, work.

179. The Hickory Twig Girdler.

Oncideres cingulata Say.

The adult girdles the twigs of oak, hickory, persimmon, and other trees, sometimes so extensively as to cause serious injury.
EXHIBIT: Adults, work, figure.

INJURING THE INNER BARK AND SAPWOOD.

THE BARK WEEVILS. FAMILY CURCULIONIDÆ.

CASE 33.

180. The Cypress Weevil.

Eudocimus mannerheimii Boh.

The adults feed on the bark of bald cypress twigs, causing their death, and the larvæ mine the inner bark of injured and recently felled trees. Southern States.
EXHIBIT: Adult, larva, work.

181. The Pales Weevil.

Hylobius pales Hbst.

The larvæ bore into the inner bark of stumps and roots of recently felled, dying, and injured pine. Eastern States.
EXHIBIT: Adults.

182. The Pitch-Eating Weevil.

Pachylobius picivorus Germ.

Has habits similar to the pales weevil. Eastern States.
EXHIBIT: Adults.

183. The Walnut Weevil.

Cryptorhynchus parochus Hbst.

The larvæ mine the inner bark and sapwood of weakened and recently dead walnut.
EXHIBIT: Adults, work.

184. The Fir Weevil.

Pissodes dubius Rand.

The larvæ mine the inner bark of balsam fir, hastening the death of injured trees. Northeastern States.
EXHIBIT: Adults, larvæ, work.

THE ROUND-HEADED BORERS. FAMILY CERAMBYCIDÆ.

CASE 34.

185. The White-Pine Sawyer.

Monohammus scutellatus Say.

Larvæ mine the inner bark and bore deep into the sapwood of white and silver pine, hastening the death of dying trees and injuring saw logs.
EXHIBIT: Adults, work.

186. The Common Pine Sawyer.

Monohammus confusor Kirby.

The larvæ mine the inner bark and bore large holes into the sapwood of dying trees and saw logs of pine and spruce.
EXHIBIT: Adults, larva.

187. The Ponderous Pine-Borer.

Ergates spiculatus Lec.

Larvæ bore in dead pine logs, injuring them for timber. Northwestern States.
EXHIBIT: Adults, larva, work.

188. The Knob-Horned Pine-Borer.

Acanthocinus nodosus Fab.

The larvæ mine the inner bark of pine stumps and large logs.
EXHIBIT: Adults.

189. The Obsolete Pine-Borer.

Acanthocinus obsoletus Ol.

The larvæ mine the inner bark of freshly killed pine.
EXHIBIT: Adults.

190. The Small Pine Bark-Borer.

Ceratographis pusillus Kirby.

Larvæ mine the inner bark of dead and dying pine.
EXHIBIT: Adults.

191. The Lesser Pine-Borer.

Asemum mæstum Hald.

Larvæ bore into sapwood of dead pine and spruce logs and stumps. Eastern States.
EXHIBIT: Adults.

CASE 35.

192. The Poplar Borer.

Saperda calcarata Say.

Larvæ bore in trunks of living aspen, cottonwood, and willow, causing great destruction to these trees.
EXHIBIT: Adults, work.

193. The Common Elm-Tree Borer.

Saperda tridentata Ol.

The larvæ mine the bark and sapwood of dead, dying, and healthy elm, often causing great destruction.
EXHIBIT: Adults, work.

194. The Poplar Girdler.

Saperda concolor Lec.

Larvæ mine in green bark of aspen and cottonwood saplings, girdling the trunks and causing large swellings; also attack willow.
EXHIBIT: Adults, work.

195. The Sugar-Maple Borer.

Plagionotus speciosus Say.

Larvæ mine the inner bark and sapwood of recently dead, dying, and living maple, often causing the death of weakened trees.
EXHIBIT: Adults.

196. The Locust Borer.

Cyllene robiniæ Forst.

Larvæ mine the wood and bark of living locust, causing great damage and destruction.
EXHIBIT: Adults, work.

197. The Linden Borer.

Saperda vestita Say.

Larvæ mine the inner bark and bore into the trunk of linden, causing much injury.
EXHIBIT: Adults, work.

198. The Chestnut Callidium.

Callidium æreum Newm.

Larvæ mine inner bark of chestnut, hastening, and perhaps causing, death of aged or injured trees.
Exhibit: Adults, larvæ, pupa.

199. The Belted Chion.

Chion cinctus Dru.

The larvæ mine the inner bark and bore into the wood of trunk and branches of dying and recently dead hickory, chestnut, oak, etc.
Exhibit: Adults, larva, work.

200. The Dusty Oak Borer.

Romaleum atomarium Dru.

Larvæ in stumps and logs of recently dead oak.
Exhibit: Adults.

CASE 36.

201. The Beautiful Hickory Borer.

Goes pulchra Hald.

Larvæ bore in hickory.
Exhibit: Adults.

202. The Tiger Hickory Borer.

Goes tigrina DeG.

Larvæ mine the inner bark and sapwood of living hickory and oak.
Exhibit: Adults.

203. The White-Lined Cypress Borer.

Physocnemum andreæ Hald.

Larvæ mine the inner bark and outer sapwood of bald cypress logs. Southern States.
Exhibit: Adults, larva, work.

204. The Common Hickory Borer.

Saperda discoidea Fab.

Larvæ mine the inner bark of injured, dying, and recently dead hickory.
Exhibit: Adults.

205. The Blue-Winged Walnut Borer.

Gaurotes cyanipennis Say.

Larvæ infest walnut.
Exhibit: Adults.

206. The Lichen-like Beetle.

Leptostylus aculiferus Say.

Larvæ mine the inner bark of dying and dead tulip-tree (*Liriodendron*).
Exhibit: Adults.

207. The Ash-Colored Mulberry Borer.

Hetœmis cinerea Ol.

Adults feed on the foliage and larvæ mine the green bark and sapwood of dying and injured mulberry.
Exhibit: Adults.

208. The Painted Hickory Borer.

Cyllene picta Dru.

Larvæ bore in the trunks of dead, dying, and sometimes healthy hickory trees.
Exhibit: Adults.

CASE 37.

209. The Curious Cypress Borer.

Curius dentatus Newm.

Larvæ mine the smaller branches of young bald cypress.
EXHIBIT: Adults, work.

210. The Banded Ash Borer.

Neoclytus capræa Say.

Larvæ very injurious to dying trees and saw logs of black ash, boring numerous holes through the wood.
EXHIBIT: Adults, work.

211. The Rigid Cypress Borer.

Œme rigida Say.

Larvæ mine inner bark of girdled bald cypress and dying white cedar.
EXHIBIT: Adult, larva, work.

212. The Southern Oak Borer.

Mallodon dasystomus Say.

Larvæ bore in healthy live oak, hackberry, and hickory trees, greatly injuring them. Southern States.
EXHIBIT: Adults.

213. The Live-Oak Root-Borer.

Mallodon melanopus Linn.

Larvæ bore into the roots of young oaks, causing dwarfed and worthless trees. Southern States.
EXHIBIT: Adult.

214. The Variable Oak Borer.

Phymatodes variabilis Fab.

Larvæ mine inner bark of dying and recently dead oak; are also injurious to tan-bark.
EXHIBIT: Adult, work.

215. The Thunderbolt Beetle.

Arhopalus fulminans Fab.

Larvæ mine the inner bark and sapwood of chestnut and oak.
EXHIBIT: Adults.

216. The Lesser Prionus.

Orthosoma brunneum Forst.

Larva in decaying logs and stumps of nearly all forest trees.
EXHIBIT: Adults.

217. The Cottonwood Root-Borer.

Plectrodera scalator Fab.

Larvæ in roots of aspen and cottonwood.
EXHIBIT: Adults.

218. The Broad-Necked Prionus.

Prionus laticollis Dru.

Larvæ in roots of oak, aspen, and cottonwood. Sometimes destructive. Also in stumps of pine.
EXHIBIT: Adults.

CASE 38.

219. The Destructive Spruce Wood-Borer.

Tetropium cinnamopterum Kirby.

Larvæ mine green bark and wood of injured and dying spruce, hastening death and promoting decay.
EXHIBIT: Adults, larvæ, work.

220. The Wavy Spruce Borer.

Xylotrechus undulatus Say.

Larvæ mine the inner bark and sapwood of Douglas spruce, fir, and hemlock.
EXHIBIT: Adults.

221. The Canadian Leptura.

Leptura canadensis Fab.

Larvæ mine sapwood of dead spruce and hemlock, inducing rapid decay.
EXHIBIT: Adults.

222. The Red-Headed Clytus.

Neoclytus erythrocephalus Fab.

Larvæ mine in dead and dying bark and sapwood of a great variety of forest trees, maple, ash, hickory, sweet gum, bald cypress, etc.
EXHIBIT: Adults.

223. The Ribbed Pine Borer.

Rhagium lineatum Ol.

Larvæ mine the inner bark of dying and dead pine, spruce, and some other conifers.
EXHIBIT: Adults, larvæ, pupa, work.

224. The Black-Horned Pine Borer.

Callidium antennatum Newm.

Larvæ mine inner bark and wood of dying and dead pine, cedar, etc.
EXHIBIT: Adults, work.

225. The Four-Marked Ash Borer.

Eburia quadrigeminata Say.

Larvæ infest ash and hickory.
EXHIBIT: Adults.

226. The Cedar Borer.

Hylotrupes ligneus Fab.

Larvæ mine inner bark and sapwood of white cedar, causing the death of the trees.
EXHIBIT: Adults, larvæ, pupa, work.

227. The Banded Urographis.

Urographis fasciatus Horn.

The larvæ mine the inner bark of dead oak, maple, chestnut, sweet gum, hickory, walnut, sourwood, dogwood, and probably nearly all deciduous trees. Eastern States.
EXHIBIT: Adults.

228. The Rustic Borer.

Xylotrechus colonus Fab.

Larvæ mine the inner bark and sapwood of recently cut or dying oak, chestnut, hickory, maple, and other hard woods.
EXHIBIT: Adults.

THE FLAT-HEADED BORERS. FAMILY BUPRESTIDÆ.

CASE 39.

229. The Bronze Birch Borer.

Agrilus anxius Gory.

The larvæ mine the inner bark of living and injured birch, aspen, and cottonwood. Very destructive in the Northern States.
EXHIBIT: Adults, work.

230. The Two-Lined Chestnut Borer.

Agrilus bilineatus Web.

The slender larvæ mine the inner bark of recently dead, injured, and healthy chestnut and oak. One of the principal causes for the wholesale destruction of chestnut in the Southern States.
EXHIBIT: Adults, work.

231. The Eastern Hemlock Bark-Borer.

Melanophila fulvoguttata Harr.

Larvæ mine the inner bark of recently dead and injured hemlock in the Eastern States.
EXHIBIT: Adults, work.

232. The Flat-Headed Apple-Tree Borer.

Chrysobothris femorata Fab.

The larvæ mine the inner bark of recently dead and injured oak, chestnut, hickory, maple, and some other deciduous forest trees. Eastern States.
EXHIBIT: Adults, larvæ, pupæ, work.

CASE 40.

233. The Flat-Headed Pine Bark-Borer.

Chrysobothris dentipes Germ.

Larvæ mine the inner bark of recently dead and dying pine.
EXHIBIT: Adults.

234. The Flat-Headed Hickory Borer.

Dicerca obscura Fab.

Larvæ bore into the trunk and limbs of hickory, maple, and some other deciduous trees.
EXHIBIT: Adults.

235. The Western Hemlock Bark-Borer.

Melanophila drummondi Kirby.

The larvæ mine the inner bark of dead and healthy western hemlock and Douglas spruce, causing defects in the lumber and killing trees. Northwestern States.
EXHIBIT: Adults, larva, pupa, work.

INJURING THE WOOD.

THE FLAT-HEADED BORERS. FAMILY BUPRESTIDÆ.

PART OF CASE 40.

236. The Turpentine Borer.

Buprestis apricans Hbst.

The larvæ bore into the solid resinous heartwood of longleaf pine after "boxing" by turpentine workers, so weakening the trunk as to cause it to break and spoiling portions of it for lumber.
EXHIBIT: Adult, work.

237. The Golden Buprestis.

Buprestis aurulenta Linn.

Larvæ bore into trunks of dead pines, spruce, fir, and other conifers.
EXHIBIT: Adults.

238. The Heart-wood Pine Borer.

Chalcophora virginiensis Dru.

Larvæ bore into trunks of dead pine and spruce and into heartwood of living trees.
EXHIBIT: Adults, work.

THE TIMBER BEETLES. FAMILY SCOLYTIDÆ.

PART OF CASE 41.

240. The Hickory Timber-Beetle.

Xyleborus celsus Eich.

The adults excavate long branching galleries in dying trees and logs of hickory.
EXHIBIT: Adults, work.

THE POWDER-POST BEETLES. FAMILY PTINIDÆ.

PART OF CASE 41.

242. The Red-Shouldered Ptinid Borer.

Sinoxylon basilare Say.

Adult bores short curved galleries in branches of dead hickory, persimmon, and most other deciduous trees; the larvæ bore the solid wood.
EXHIBIT: Adults, work.

243. Powder-Post Beetles.

Genus *Lyctus.*

EXHIBIT: Work, sections of seasoned ash and hickory showing characteristic injury by the beetles and larvæ.

THE TIMBER WORMS. FAMILIES BRENTHIDÆ AND LYMEXYLIDÆ.

PART OF CASE 41.

244. The Northern Brenthis.

Eupsalis minuta Dru.

The larvæ excavate extensive galleries in solid wood of recently dead and dying oak, chestnut, beech, elm, bald cypress, and most other species of deciduous forest trees.
EXHIBIT: Adults, work.

245. The Chestnut Timber Worm.

Lymexylon sericeum Harr.

The larvæ excavate extensive galleries in the heartwood and sapwood of living and dead chestnut and oak.
EXHIBIT: Adult, work.

THE CARPENTER WORMS. ORDER LEPIDOPTERA, FAMILY COSSIDÆ.

CASE 42.

246. The Leopard Moth.

Zeuzera pyrina Fab.

An introduced species very injurious to forest, shade, and orchard trees in the vicinity of New York City.
EXHIBIT: Adults, larvæ, pupa, work.

247. The Oak Carpenter Worm.

Prionoxystus robiniæ Peck.

The larvæ mine in living oak and locust, and are sometimes very destructive, especially to aged trees.
EXHIBIT: Adults, work.

248. The Poplar Carpenter Worm.

Cossus centerensis Lint.

The larvæ mine in trunks of cottonwood.
EXHIBIT: Adults.

THE HORNTAILS OR WOOD WASPS. FAMILY UROCERIDÆ.

CASE 43.

249. The Pigeon Tremex.

Tremex columba Linn.

Larvæ mine the sapwood of hickory, oak, poplar, maple, and other deciduous forest trees, hastening the death of those weakened by other causes.
EXHIBIT: Adults, work.

250. The Pale Tremex.

Tremex sericeus Say.

Habits like the pigeon tremex.
EXHIBIT: Adults.

251. The White-Horned Horntail.

Urocerus albicornis Fab.

Attacks spruce, hemlock, and fir.
EXHIBIT: Adults, larva, pupa, work.

252. The Blue Horntail.

Paururus cyaneus Fab.

Attacks spruce and fir.
EXHIBIT: Adult.

253. The Banded Horntail.

Urocerus abdominalis Harr.

Attacks spruce.
EXHIBIT: Adults.

254. The Yellow-Winged Horntail.

Urocerus flavipennis Kirby.

Attacks spruce.
EXHIBIT: Adults.

255. The Small-Pine Horntail.

Paururus pinicola Ashm.

Larvæ in pine.
EXHIBIT: Adults.

256. The Black-Pine Horntail.

Paururus hopkinsi Ashm.

Larvæ in pine.
EXHIBIT: Adults.

PARASITIC ENEMIES. FAMILY ICHNEUMONIDÆ.

PART OF CASE 43.

257. The Lunated Long-Sting.

Thalessa lunator Fab.

There are several quite similar species of these insects, which, by means of the long, thread-like appendage to the body, deposit their eggs within the galleries of the horntail larvæ, upon which their own larvæ are parasitic.
EXHIBITS: Adults.

INJURING INNER BARK.

THE BARK-BEETLES. FAMILY SCOLYTIDÆ.

CASE 44.

258. The Pine-Destroying Beetle of the Black Hills.

Dendroctonus ponderosæ Hopk.

Attacks healthy pine and spruce in the Black Hills of South Dakota and Rocky Mountain region. The adult beetles excavate characteristic galleries in the inner bark of dead, dying, and healthy trees. Their eggs are deposited along the sides of these galleries, and the larvæ developing from them mine the inner bark. It is estimated that it has been the primary cause of the destruction of 1,000,000,000 feet of western yellow pine (*Pinus ponderosa*) in the Black Hills.
EXHIBIT: Adults, work. Sections of trunks of western yellow pine attacked by beetles showing pitch tubes on surface and marks of galleries in inner bark.

CASE 45.

259. The Destructive Pine Bark-Beetle.

Dendroctonus frontalis Zimm.

Attacks healthy pine and spruce in the Southern States. It is capable of enormous destruction and, though usually held in check by natural causes, has at various times past so increased as to seriously menace the entire stand of pine and spruce in portions of the Southeastern States, notably in West Virginia in 1891–92.
EXHIBIT: Adults, work. Markings on surface of wood of beetle-killed tree; appearance of outer bark of beetle-killed trees; outer bark of tree scaled off by woodpeckers in search of beetles and their larvæ.

260. The Oregon Tomicus.

Tomicus oregoni Eich.

A secondary enemy of pine, attacking and hastening the death of trees primarily attacked by the pine-destroying beetle.
EXHIBIT: Work. Section of top of western yellow pine, showing galleries of adult beetles in inner bark.

261. The Companion Bark-Beetle.

Tomicus avulsus Eich.

A common species infesting pine in the Southern States. When abundant it attacks and kills healthy trees, but it is especially common as a secondary enemy in company with the destructive bark-beetle *Dendroctonus frontalis* Zimm.
EXHIBIT: Adults, work.

CASE 46.

262. The Lawson Cypress Bark-Beetle.

Phlœosinus cupressæ Hopk.

Attacks transplanted Lawson and Monterey cypress in California. It also attacks redwood.
EXHIBIT: Adults, work.

263. The Hickory Bark-Beetle.

Scolytus quadrispinosus Say.

A common bark-beetle in hickory, frequently causing the death of trees. The adults also do some damage by gnawing the base of small twigs, causing their death.
Exhibit: Adults, work.

CASE 47.

264. The Mountain Pine Dendroctonus.

Dendroctonus n. sp.

Attacks living, injured, and recently felled mountain or silver pine, sugar pine, and lodgepole pine in the Northwestern States. Very common and capable of great destruction to the best timber.
Exhibit: Adults, work.

265. The Arizona Dendroctonus.

Dendroctonus n. sp.

A common bark-beetle in the southern Rocky Mountain region, attacking healthy western yellow pine, and, in company with several closely allied species, causing great destruction of large quantities of the best timber.
Exhibit: Adults, work.

266. The Bald Cypress Bark-Beetle.

Phlœosinus n. sp.

Attacks recently felled and girdled bald cypress in the Southern States.
Exhibit: Adults, work.

PREDACEOUS AND PARASITIC ENEMIES OF DESTRUCTIVE FOREST INSECTS. THE CLERIDS. FAMILY CLERIDÆ.

CASE 48.

267. The Dubius Clerid.

Thanasimus dubius Fab.

The beetles destroy the adults, and the larvæ prey upon the developing broods of many species of bark-beetles in pine and spruce, and are frequently of the greatest benefit in holding in check the more destructive of these.
Exhibit: Adults.

268. The Spider-like Clerid.

Clerus sphegeus Fab.

The adults feed upon the adults and the larvæ upon the developing broods of numerous destructive bark-beetles in pine, spruce, and fir. Western States.
Exhibit: Adults.

269. The European Bark-Beetle Destroyer.

Thanasimus formicarius Linn.

Is very destructive to bark-beetles infesting pine and spruce in Europe, and was introduced into America in 1892 to act as a check to the alarming increase of the destructive bark-beetle (*Dendroctonus frontalis*) in West Virginia.
Exhibit: Adults.

270. The Orange-Banded Clerid.

Clerus ichneumoneus Fab.

The larvæ prey upon the developing broods of the hickory bark-beetle (*Scolytus quadrispinosus*).
Exhibit: Adults.

271. The Hairy Clerid.

Chariessa pilosa Forst.

The larvæ prey upon and do much toward preventing the increase of several of the destructive flat-headed borers (*Buprestidæ*) in deciduous trees.
EXHIBIT: Adults.

THE CLICK BEETLES. FAMILY ELATERIDÆ.

272. The Eyed Elater.

Alaus oculatus Linn.

As a larva preys upon numerous species of bark and wood boring insects in deciduous trees.
EXHIBIT: Adults.

273. The Small-Eyed Elater.

Alaus myops Fab.

As a larva preys upon the larger species of borers in coniferous trees.
EXHIBIT: Adults, larva.

274. The Four-Winged Parasites.

Order *Hymenoptera*. Families *Ichneumonidæ*, *Braconidæ*, *Chalcididæ*, etc.

EXHIBIT: Two larval galleries of the rigid cypress borer (*Œme rigida*), in one of which the insect attained full development, while in the other it was attacked and killed by a parasite, *Bracon* sp.
Adults and cocóons of several species which attack larvæ of butterflies and moths.
Adults and cocoons of several species which attack larvæ of wood-boring insects.

THE TROGOSITIDS. FAMILY TROGOSITIDÆ.

275. The Green Trogositid.

Trogosita virescens Fab.

A very important enemy of nearly all the larger and more destructive bark-beetles. The adults conceal themselves in the outer bark, and the larvæ enter the galleries and prey upon the insects therein.
EXHIBIT: Adults.

THE COLYDIIDS. FAMILY COLYDIIDÆ.

276. The Tuberculate Colydiid.

Aulonium tuberculatum Lec.

The adults enter the galleries and with the larvæ feed upon various species of bark-beetles in all their stages.
EXHIBIT: Adults.

277. The Line-Marked Colydiid.

Colydium lineola Say.

The adults enter the galleries and their larvæ feed upon the developing brood of various species of Ambrosia beetles.
EXHIBIT: Adults.

SPECIAL EXHIBITS.

ENLARGED MODELS OF INSECTS, AND OF INSECTS AND INJURED PLANTS.

MALARIA MOSQUITO.

Anopheles maculipennis Meig.

Enlarged model. This and other species of Anopheles are the only known transmitters of human malaria. The parasitic organism causing malaria inhabits the red-blood cells of human beings. It is taken with the blood into the stomach of the mosquito. There it undergoes a sexual development, reproduces, and the offspring are carried with the mosquito poison into the circulation of healthy human beings.

YELLOW FEVER MOSQUITO.

Stegomyia fasciata Fab.

Enlarged model. This mosquito transmits yellow fever, and it is now the opinion of the best-posted experts that only through its bite can one contract this disease.

SALT MARSH MOSQUITO.

Culex sollicitans Walk.

Enlarged model. This mosquito is not known to carry any disease, but is very annoying at many seaside resorts.

THE HOUSE FLY.

Musca domestica Linn.

Enlarged model. The house fly is not merely a nuisance, but also acts as a carrier of many diseases, especially of typhoid fever in the United States.

HESSIAN FLY.

Mayetiola destructor Say.

One of the most injurious enemies of wheat in the northern and central States. The larva attacks the stem. The average yearly damage to the wheat industry in this country from this insect is $60,000,000.

Enlarged models of the adult fly, and of an infested stalk of wheat showing the puparium or so-called "flaxseed," which encloses the pupa stage of the insect.

Two natural-size models, one representing a healthy, unaffected young wheat plant to contrast with the same attacked by the Hessian fly; the other illustrating the effects of the attacks of the Hessian fly.

THE SILKWORM.

Bombyx (*Sericaria*) *mori* Linn.

Enlarged model of the larva, showing its complete anatomy; the muscles, nerves, tracheæ, viscera, the silk apparatus in its whole extent, the silk-secreting gland, and the gland discovered by Auzoux, which secretes a liquid the use of which is most probably to convert the silky matter into insoluble threads. In one of the prolegs may be seen the muscles which move the claws and sucking disks which enable the animal to walk with its true feet in the air.

Enlarged models of the moths, male and female. In each model is shown the atrophy of the digestive tube and the development of the marvelous organs by which the species is perpetuated. (After Auzoux.)

HOP APHIS.

Phorodon humuli Schr.

Unaffected Hop Plant.—A spray of hops, modeled in wax, representing the plant as it appears in vigorous growing condition and free from the attacks of its principal enemy, the hop aphis. This is to call attention to the stronger foliage and the more abundant and larger hops produced by plants from which the hop aphis has been eradicated by the use of proper remedies.

Affected Hop Plant.—A spray of hops, modeled in wax, representing the vine as it appears when attacked by the hop aphis, showing the blackening and discoloration of the leaves and the small and inferior hops, which are also discolored and otherwise unsuitable for market.

Winter Eggs.—Enlarged model of the winter eggs, which are attached by the sexual female to the terminal twigs of the plum, in crevices around the buds.

Stem-Mother.—The stout female aphis shown in this enlarged model hatches from the winter egg and is characterized by shorter legs and honey-tubes. It gives birth, without the intervention of the male, to living young, of which three generations are produced on the plum trees, the last being winged and migrating to the hop.

Winged Migrant.—This enlarged model represents the first winged generation, the third produced on the plum. It instinctively flies to the hop plant and is the progenitor of from five to twelve wingless generations of virgin females, which infest the hop plants until autumn and are the sole forms which depredate on the hop. In autumn the last generation again produces winged females which fly to the plum trees.

Hop-Affecting Stage.—This enlarged model represents the structure and appearance of the five to twelve wingless generations of virgin females which people the hop plant until autumn. These are the progeny of the *winged migrants* and are the sole forms which injure the hop.

Return Migrant.—This enlarged model represents the last generation produced on the hop, the winged migrant form which in September returns again to the plum and gives birth to three or more young, which are the true sexual females, the first perfect sexual females produced in the cycle up to this point.

Pupa of Return Migrant.—This model represents the pupal stage of the *return migrant*. The striking features are the wing pads, which with another molt become the ample flight organs seen in the model of the adult.

True Sexual Female.—This enlarged model represents the generation born of the return migrant, which never acquire wings and never leave the plum tree. Maturing in a few days, according to the temperature, they are fertilized by the true winged males which have been subsequently developed on the hops and have come from the hop fields to the plum. Shortly after fertilization the winter eggs, like those with which the cycle started, are deposited.

Young Sexual Female.—This enlarged model represents the newly hatched stage of the only perfectly developed sexual female produced in the life cycle of this insect.

Winged Male.—This enlarged model represents the first and only male generation produced in the life cycle of the hop aphis. This is developed in the autumn and flies from the hop to the plum and fertilizes the true sexual females.

CHINCH BUG.

Blissus leucopterus Say.

The Eggs.—This enlarged model represents the form of the egg and the terminal cap. The eggs are three-hundredths of an inch long, the top being squarely docked and surrounded by four round tubercles near the center. Color from pale whitish to amber.

First Larval Stage.—This stage, represented enlarged in this model, differs from the adult in being more elongate and in having two-jointed tarsi, the head broader and more rounded and the joints of the body subequal. The prevailing color of the whole body is red.

Second Larval Stage.—After the first molt the form represented in this enlarged model is assumed. The red becomes a brilliant vermilion and contrasts with the pale band across the middle of the body, while the head and prothorax are dusky and coriaceous. Two broad marks appear on the mesothorax and the second, fourth, and fifth abdominal sutures, and one at the tip of the abdomen.

Pupa.—The pupa shown in this enlarged model approaches still more nearly the form of the adult, and is not unlike the last larval stage except in being darker and in the appearance of wing pads, which extend almost across the pale basal abdominal joints.

The Imago.—The mature insect which is represented enlarged in this model is elongate, blackish, and with numerous hairs, or pubescence. Its length is about three-twentieths of an inch. The outer wings are whitish, with a strong distinctive black spot.

THE SAN JOSE SCALE.

Aspidiotus perniciosus Comst.

Ten enlarged models are exhibited illustrating the life cycle of this pest, which has caused more damage to the fruit industry and been the object of more legislation than any other insect. Its small size and inconspicuous appearance often leave it undetected until the infested trees are beyond recovery. The scale may be killed by fumigation or spraying.

Enlarged models are exhibited of the *first* and *second larval stages*, of the *young crawling larva, nearly full-grown larva, male pro-pupa, male pupa, adult male, adult female*, and of the *half-grown scale, full-grown male scale*, and *full-grown female scale.*

THE ASIATIC LADYBIRD.

Chilocorus similis Rossi.

Two enlarged models are exhibited illustrating the adult and the larva of this insect, which was introduced by the U. S. Department of Agriculture from China, where it is the important agent in keeping the San José scale in check.

THE CODLING MOTH.

Carpocapsa pomonella Linn.

Four enlarged models illustrating the life history of this insect, which is the cause of the "wormy apples." The damage from it in this country is estimated at $11,000,000 annually.

Models are exhibited of the *larva* and of the *adult moth;* and also an enlarged section of a *piece of bark*, cut so as to show a cocoon and pupa of the codling moth beneath it, and an enlarged section of "wormy" apple showing egg, young and mature larva and their work.

THE MEXICAN COTTON BOLL WEEVIL.

Anthonomus grandis Boh.

Enlarged model. This insect is a native of Cuba and Mexico; upwards of ten years ago the weevils crossed the Rio Grande near Brownsville and have now spread over nearly the entire cotton belt of Texas and into the western parishes of Louisiana. Its rapid extension, great destructiveness, and the unusual difficulties in the way of its control have caused grave fears for the future of the cotton industry in the United States. The Federal Government last year appropriated $250 000 for combating this insect.

THE HONEY BEE.

Apis mellifera Linn.

Enlarged models, showing the insect in six different forms—queen, male, wax-worker, worker, bee with propolis, and the bee with pollen. In these are shown the external and internal characters which distinguish each type. Also a model of a comb in the same proportion, in which are seen the cells for honey, for pollen, and for the eggs to produce queens, drones, and workers, with eggs, larvæ, and pupæ in different stages of development. (After Auzoux.)

FLUTED SCALE.

Icerya purchasi Mask.

Model in wax of a twig of orange infested with the fluted scale (*Icerya purchasi*) copied directly from nature, the actual scales being transferred to the model plant. Illustrates the characteristic appearance of the infested plant.

Model of Noninfested Orange.—The model in wax contrasts with the one representing the characteristic appearance of infested plant.

Illustrations from the publications of the Division of Entomology, representing the different stages of the fluted scale and its principal enemies.

AUSTRALIAN LADYBIRD.

Novius (Vedalia) cardinalis Muls.

(Principal enemy of the fluted scale [*Icerya purchasi*].)

Enlarged model of the adult of this insect, the introduction of which from Australia has effected what was impossible by any other means—the practical annihilation of the fluted scale in California.

Enlarged models showing structure and characteristic appearance of the larva and and pupa.

THE "KISSING BUG."

Reduvius personatus Linn.

Enlarged model of one of the group of true bugs, generally known as "assassin bugs," which of late years have acquired a certain newspaper notoriety through their supposed preference for the human lips.

They feed on other insects, which they pierce with their strong beaks; some species are frequently found in houses, attracted by light, and they may, if they believe themselves in danger, accidentally or in defense, pierce the human skin with their beaks, causing a painful wound, and often blood poisoning through the introduction of the germs of putrefaction.

ORANGE RUST-MITE.

Eriophyes (Phytoptus) oleivorus Ashm.

Wax models of oranges showing work of the orange rust-mite.

ENLARGED MODELS OF THE PARASITE CAUSING MALARIA (ÆSTIVO-AUTUMNAL FEVER).

Plasmodium malariæ.

Twenty-nine enlarged models, illustrating the life history of this parasite in the blood of man and in the mosquito (*Anopheles*).

The models exhibited show: Development of spores in the blood of man; development of "crescent" in the blood of man; development of "gamete" in stomach of mosquito; development and fertilization of "zygote" in stomach of mosquito; development of "zygote" in stomach wall of mosquito; "zygote" filled with "blasts" and ready to burst; free endospores, free blasts, and spermatozoa.

PHOTOGRAPHS OF INSECT DAMAGE TO FORESTS.

Western yellow pine trees killed by the pine-destroying beetle. Black Hills, South Dakota.

Section of shortleaf pine tree killed by the destructive pine bark-beetle. North Carolina.

Trunk of western yellow pine killed by the Arizona Dendroctonus, showing work of beetles. New Mexico.

Western yellow pine tree, showing injury caused by the dark-red turpentine beetle at base. New Mexico.

Monterey pine tree, showing injury of the dark-red turpentine beetle at base. California.

Western hemlock trees killed in 1892 by the hemlock span-worm. State of Washington.

Trunk of hickory tree killed by the hickory bark-beetle, showing growth of white fungus following attack. Detroit, Mich.

Silver pine trees killed by the mountain-pine Dendroctonus. Priest River Forest Reserve, Idaho. (2.)

Bark from trunk of giant arborvitæ, showing mines of the cedar bark-beetle. State of Washington.

Log of Douglas spruce, showing galleries of the Douglas spruce Dendroctonus. State of Washington.

Storm-felled Douglas spruce offering favorable conditions for the propagation of the Douglas spruce Dendroctonus and other bark-bettles. State of Washington.

Bark from storm-felled log of Douglas spruce, showing galleries of the Douglas spruce Dendroctonus. State of Washington.

Group of longleaf pine killed by so-called "worm deadening." Eastern Texas.

Young Sitka spruce, showing top killed by western spruce-weevil. State of Washington.

Cottonwood tree killed by the bronzed Agrilus, showing the galleries of larvæ in trunk. Priest River Forest Reserve, Idaho.

Young chestnut killed by the two-lined chesnut borer. Western North Carolina.

Large chestnut, the death of which was hastened by insect injury. Western North Carolina.

Girdled bald cypress tree injured by timber beetles. South Carolina.

Trunk of hickory killed by hickory bark-beetle, showing galleries on surface of wood. Western North Carolina.

LIVING INSECTS.

By means of aquaria, vivaria, and other forms of insect cages, living insects will be on exhibit, subsisting on their natural food and undergoing their usual transformations.

In the aquaria, stages of some of the species of mosquitoes occurring on the Pacific coast will be shown, as also aquatic beetles and bugs and the aquatic larvæ of various insects which are terrestrial in the adult state.

INDEX TO SYSTEMATIC NAMES.[a]

[a] Many of the forest insects are species which have not yet been described. The reader will, therefore, find these under the generic name, or in the Index of Common Names.

INDEX TO COMMON NAMES.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ENTOMOLOGY—BULLETIN No. 54.

L. O. HOWARD, Entomologist.

SOME MISCELLANEOUS RESULTS OF THE WORK OF THE BUREAU OF ENTOMOLOGY.

VIII.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905

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U. S. DEPARTMENT OF AGRICULTURE.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., May 1, 1905.

Sir: I have the honor to transmit herewith the manuscripts of several articles and shorter notes, none of which are of such a nature as to justify their publication at this time in separate form. The matter presented is similar to that which has been published in seven earlier bulletins, and I recommend its publication under the title "Miscellaneous Results of the Work of the Bureau of Entomology—VIII," as Bulletin 54 of this Bureau. The initial article on the sugar-cane beetle is a report of an investigation conducted during 1904, which was made necessary by the fact that the insect in question had received practically no attention at the hands of entomologists for a quarter of a century. The suggestion as to remedies will, it is hoped, be found useful to sugar planters of the South. The report on "Conchuela," a cotton pest of Mexico, contains an account of investigations conducted because of an unusual outbreak during the year, which afforded the possibility of a thorough study of this insect. It may be in time a dangerous enemy to cotton cultivation in Texas, and possibly in other near-by States in which it also occurs. The sugar-beet crown borer has not previously been detected injuring sugar beet or other useful plants. The dock false-worm, considered in the next article, is also new as a pest, as is the pepper weevil, so far as regards published records. Everything points to the accidental introduction of the weevil from Mexico. The article on cold storage for cowpeas is of value for obvious reasons, one of which is that the experiments reported have been conducted over a considerable period and the cost of this method of treating seeds has been definitely ascertained; it is also shown that the vitality of the seed is not injured by treatment. The larger canna leaf-roller and pond-lily leaf-beetle have been unusually destructive during the year, and have not previously been treated in any publications of this Department. The report on the grasshopper conditions of the West shows that grasshoppers have been, on the whole, very much less destructive during the year 1904 than is usual. It also demonstrates the value of remedies, which are more effective when the insects are not overabundant, and should then be practiced as a means of limiting injurious occurrences in the immediate future. The article entitled "Collective Notes on the Behavior of the Colorado Potato Beetle in Great Britain" indicates that this American insect does not now exist in England, but that it is capable of flourishing to a remarkable degree on the Continent. Some interesting facts in regard to the use of hydrocyanic-acid gas as a remedy for indoor insects have been gained during the year, a portion of which are embodied in an article and a note in this series. During the year Mr. Frederick Maskew, of California, has cooperated with this office in several investigations, two of which are made public—one on the subject of Fuller's rose beetle and the other on the success of an introduced ladybird beetle. Among general notes are short accounts of a very injurious caterpillar enemy of velvet bean in Florida, an instance of the complete destruction of the imported cabbage worm by parasites, and other notes of minor interest.

Respectfully,

L. O. HOWARD,
Entomologist and Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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VIII.

THE SUGAR-CANE BEETLE.

(*Ligyrus rugiceps* Lec.)

[With notes on associated species.]

By E. S. G. Titus.

In 1880, in southern Louisiana, there occurred a serious outbreak of the sugar-cane beetle, so disastrous in its effect on the sugar yield that many planters gave up the growing of this crop and turned their energies to rice cultivation. This was especially true along the Mississippi River north of New Orleans and at some points along the Southern Pacific Railroad.

From 1880 until the present time there have been many reports of injury caused by this beetle (and some other closely related species) to sugar cane, corn, and other crops. Throughout Louisiana, Mississippi, and other Southern States, and even so far north as North Carolina in the east and Iowa in the west, have come reports of a beetle that "eats into the plant to the heart." The injury to corn in the north is usually caused by *Ligyrus gibbosus* DeG., a species very closely related to the sugar-cane beetle. The reports of injury to sugar cane appear to be on the increase throughout the sugar-cane growing States, doubtless partially owing to the fact that considerable new land is each year being opened for cultivation and also to the fact that the planters are beginning to notice more closely when they see their crops suddenly cut down.

Under instructions from the entomologist, two trips were made by the writer in 1904 to Louisiana to study the life history of this insect—one in April and May and the other in the latter part of October, when the cane harvesting was in progress.

An investigation of the 1880 outbreak was made by Dr. L. O. Howard in the spring of that year, his report being published as Special Report No. 58 of the Department of Agriculture, and later appearing in the report of the Commissioner of Agriculture for 1880.[a] In this report there is given a very complete account of the history of the

[a] 1881: Rept. Comm. Agric. f. 1880, pp. 236–240.

beetle as known at that time, its method of attack, and some suggestions regarding remedies.

The sugar-cane beetle measures from one-half to five-eighths of an inch (15 to 18 mm.) in length, is jet black above and black and piceous beneath; head roughly shagreened; thorax with minute rather sparse punctures; elytra with longitudinal striæ and many small punctures; thorax and elytra polished and shining; on each wing cover near the tip a smooth, slightly elevated prominence, beyond which the elytra are abruptly truncate; abdomen projecting slightly beyond the tips of the elytra. The legs are coarsely spined, the front tibiæ being broad and armed with four large, broad teeth. This species can be readily separated from the rice beetle (*Chalepus trachypygus* Burm.) by its smaller size and more parallel sides. The rice beetle is more rounded across the thorax and elytra. The carrot beetle (*Ligyrus gibbosus* DeG.) is distinguished readily by the under side of the abdomen being quite densely covered with reddish hair.

HABITS AND METHOD OF ATTACK.

At the time of the first trip in 1904 much of the sugar cane was from 10 to 18 inches high. The previous season had been rather unfavorable, owing to excessively dry weather, and in some fields the cane was sprouting poorly. Plant cane continued to sprout and push through the ground until late in June, and many of the buds on mother cane that were examined in April and May had died from lack of sufficient moisture.

During the four weeks of the first trip the principal cane-growing regions of Louisiana were visited, special attention being paid to plantations at Olivier, Berwick, Morgan City, Broussard, and St. James. At all places visited the beetle was found injuring cane severely. In some of the districts it was reported that this was the first year there had been serious injury, but most of the planters interviewed stated that they had had more or less loss from the beetles for several years. Those who had been raising cane for long periods could recall records of injuries at varying intervals for the past forty-five or fifty years. Especial injury was reported to have occurred in 1884, 1880, 1876, 1872, and once before the civil war—about 1856–57. At times, in some areas, almost the entire cane and corn crops had been cut down.

This past year (1904) the beetles commenced work on the cane before the tips had appeared above the ground and continued until early in July to do serious damage. The injury to corn began as soon as the corn appeared above ground, whole fields being, in many cases, completely laid bare; and even the second planting was destroyed.

The injury is usually made a few inches below the surface of the ground, in cane generally 1 or 2 inches above the base of the stalk.

Fig. 1.—*Ligyrus rugiceps:* cane showing injury—one-half natural size (original).

The depth below the surface of the ground of course depends much upon the previous treatment of the cane and the amount of dirt thrown up by the early cultivations. The beetles cut a horizontal burrow into the growing stalk until they reach the center, the center roll of leaves usually being cut through. The coarser fibers of the outer sheaths are shredded away with the mandibles and front tarsi, the latter being used more especially to pull away the stringy fibers after they have been cut loose at one end. As soon as the hole is large enough for the head and a portion of the thorax, the beetle uses the middle legs as braces while it cuts its way deeper into the stalk (fig. 1). Some instances were noticed where small and tender shoots had been entirely cut through and in a few cases shoots that stood against a larger stalk had been cut through, the beetle continuing its work into the next stalk. The beetles seemed indifferent to the size of the stalk attacked, larger older shoots being injured as often as the small tender ones, even when growing in the same clump of cane. The effect on the shoots is very different from that on the older stalks, the latter sometimes recovering from the injury if not too severe, while the former soon wilt, the center leaves dying first. On account of the beetles' habit of working underground it was found very difficult to determine the length of time necessary to cut a hole to the center of the stalk. One beetle was seen to enter the ground, and twenty minutes later it had reached the center of a a stalk three-fourths of an inch in diameter, as was readily determined by pulling out the central core of leaves. At times stalks containing several partially completed and one complete burrow are to be found. Usually but one cutting is made on a stalk, and, if this reaches through the central core of rolled leaves, the shoot quickly dries up and in a few days falls to the ground. When examined, the point at which the cutting was made now appears decayed, and in and on the rolled leaves in the interior may often be found small dipterous larvæ feeding on the fermenting and decaying cane or corn.

FIG. 2.—*Ligyrus rugiceps:* corn showing injury (after Comstock).

Corn is attacked in the same manner as cane (fig. 2), but the injury is usually closer to the base of the stalk and more disastrous in its effect, since corn rarely suckers when thus cut back. On grass, on account of its small diameter, the beetles nearly always sever the attacked stem.

LIFE HISTORY.

The female beetle does not appear to attack the stalk, primarily at least, for the purpose of obtaining food, but in order that the cane may be deadened and the roots may soften and decay so as to afford a place for the young larvæ to live and feed. The female, after cutting the hole in the stalk, burrows down among the young rootlets alongside the stalk, sometimes going beneath the old stalks of mother cane, and there deposits an egg. It was not possible to ascertain the number of eggs laid by a single beetle. Under natural conditions the beetles appear to always lay the egg after having made the cut in the stalk. Usually but one egg was found for each cut in a cane stalk, but some instances were discovered where there were two or more and in one case ten. The case where the ten eggs were found was in stubble cane, a large clump having but a single sprout growing from it. Some stalks were found that had been attacked by beetles as many as six times, and in one there were four of the cuts that reached to the center or beyond. No attempt was made to ascertain the exact number of eggs contained in the ovaries of the female, but from those examined I should judge it would exceed a hundred. Eggs of this beetle were first found in the ground April 28, but the size of young larvæ present at that time in the cane fields—which I could not distinguish from those later hatched from the cane beetle eggs—would show that the egg-laying period begins much earlier.

The egg of *Ligyrus rugiceps* is pure white, shining, smooth, polished, globular, 0.75 mm. in diameter, and does not appear to differ from the egg of *Chalepus trachypygus*, *Ligyrus gibbosus*, or *Cyclocephala immaculata* except in size. It is slightly smaller than the eggs of the first species mentioned, somewhat larger than the second, and nearly twice the size of the last.

The young larvæ begin to show in the egg the third day after deposition, but the time of emergence varies greatly, from six to fifteen days being required in those under observation in the field. Hot, moist soil hastens their development, while cold soil with either excessive wet or dry weather retards it, and cold, wet weather even causes some larvæ to die in the egg.

The larva on emerging makes but a small cut and then splits the shell open by movements of the head and body. The newly hatched larva is almost transparent; the anal end is densely white, while the head and appendages (except the white palpi and the black tips of the mandibles), the tips of legs, and the first thoracic segment are dark brown. Young larvæ hatching from eggs lying on top of the soil in a warm, damp box made no attempt to enter the soil until from fifteen to twenty-nine hours old. Young, apparently freshly hatched larvæ in the field were often found in the soil near to the eggshell from which they had probably emerged. Those larvæ observed were not seen to feed until at least twenty-four hours had elapsed, and then a slight discoloration began to show through the thin skin. Fine particles of dirt were found at this time in the digestive organs. The larvæ are very sluggish in their movements, unless turned out on a dry, warm soil in the sun, when they hasten to burrow beneath the surface, going only a short distance and soon making a tiny cell in the earth, where they curl up in the characteristic manner of white grubs.

The life history from the middle of May until the last of October is not yet definitely known. The last of October larvæ were found in the fields in considerable numbers in the same positions as those seen in the spring; also in the mother cane, upright stubble cane, and even at the bases of growing cane stalks. Quite a number of the larvæ are now in our breeding cages in Washington (April 1), but none have as yet transformed. Many of those dug out of the cane fields in October had formed earthen cells of considerable solidity and were evidently full grown. These cells were usually placed 5 to 6 inches below the surface and often close to the canes. A few were found in the mother cane. Some were discovered at the summit of stubble cane, 3 to 4 inches beneath the surface, where they had apparently fed for most of their lives (see fig. 4). None of the cells found in the cane fields had parasites in them, but *Erax lateralis* larvæ, one to two-thirds grown, were several times found near injured white grubs. But two pupæ were found in the fields, and from one of these, early in November, there emerged an adult of *Ligyrus rugiceps*. The other pupa was injured in transportation and died.

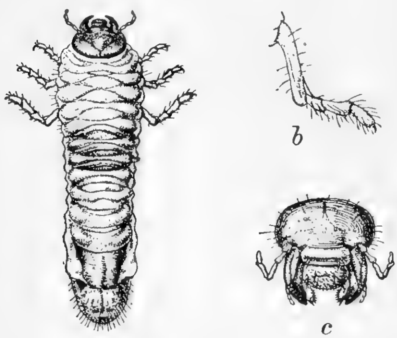

FIG. 3.—*Ligyrus rugiceps:* larva slightly enlarged; *b*, leg; *c*, face view of head, more enlarged (original).

A few adults of *Ligyrus rugiceps* and one of *L. gibbosus* were found in earthen cells at Olivier and St. James. Adults are not usually common in the fields in October, but a few may be found in the soil of fields that have shown the most injury the previous spring, some being in earthen cells, others in the loose soil. A few adults were also found in the soil at the bases of clumps of "Grand Marais" grass (*Paspalum dilatatum*). Adults did not appear at lights at any time in October and very rarely in the spring, nor were they seen flying in the daytime in the fields, as was the rice beetle. In April and May collections of beetles coming to light were made at Morgan

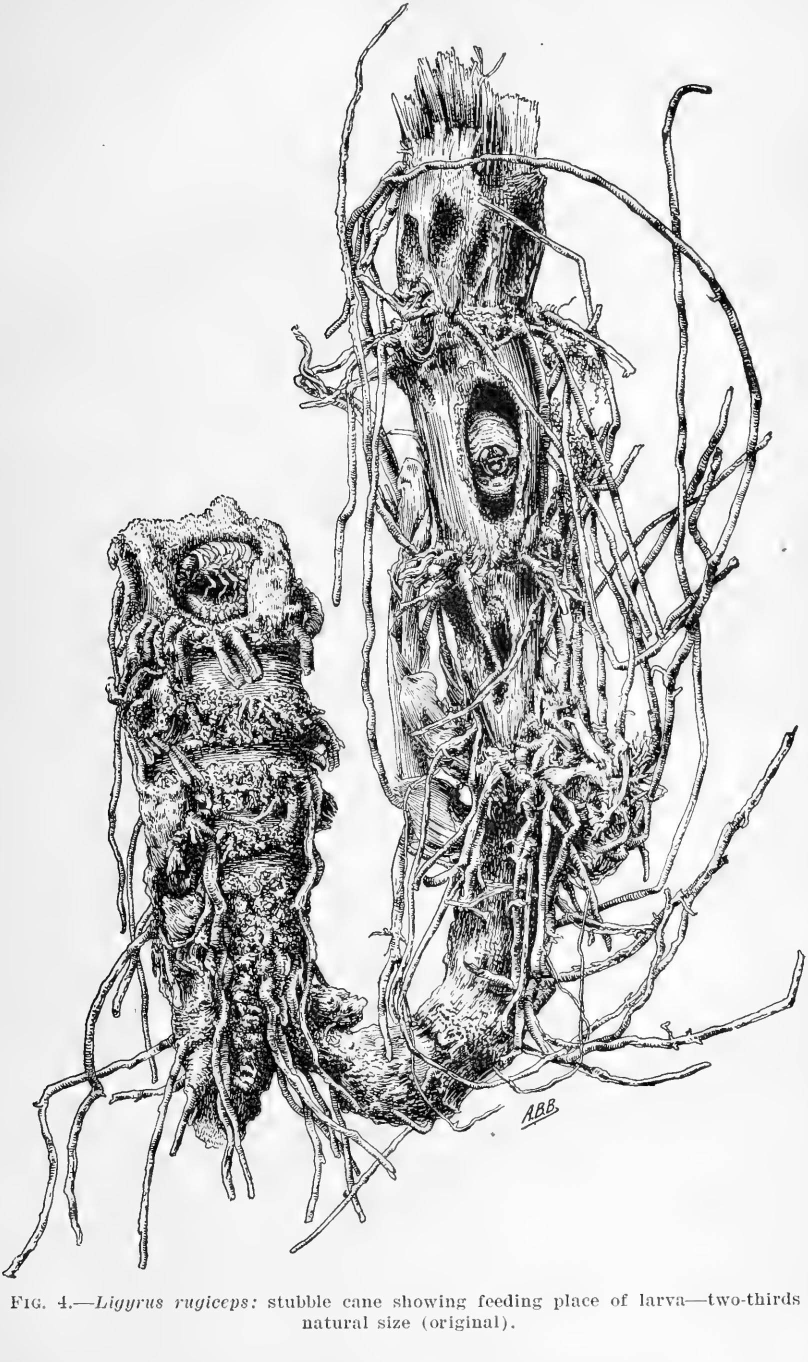

FIG. 4.—*Ligyrus rugiceps:* stubble cane showing feeding place of larva—two-thirds natural size (original).

City, on the shores of Atchafalaya River, Berwick, Olivier, St. James, Donaldsonville, Lafayette, New Iberia, and St. Charles in Louisiana, and at Beaumont in Texas. The percentage of cane beetles coming to light was extremely small when compared with *Chalepus trachypygus*, the rice beetle. In the fields in the spring practically no rice beetles occurred, while at lights fully 90 per cent of the beetles belonged to this species. The remaining percentage was divided among Hydrophilidæ, Lachnosterna, and the sugar-cane beetle. *Ligyrus gibbosus* was rarely seen at lights, and not over 3 per cent of the beetles were *L. rugiceps*.

OTHER SPECIES OCCURRING IN FIELDS.

Of the other white grub larvæ occurring in the cane fields in early spring and summer, the most common appears to be that of *Cyclocephala immaculata* Ol. The adult of this species is a much smaller beetle, pale in color, and with dark markings. Nearly full-grown larvæ were found not uncommonly in the fields in April and May. They occur at the bases of the stubble cane and beneath grass roots along the margins of the fields. It may be this species that is reported as cutting suckers of the cane late in the summer. The injury is reported to be of nearly the same character as that of the cane beetle, but the holes are smaller. Adults appeared in our breeding cages in Washington early in July and laid their eggs freely in rich soils. The eggs hatched from six to fifteen days after deposition, the white grubs at once forming tiny cells in the soil and within twelve hours beginning to show traces of soil in their intestinal tracts.

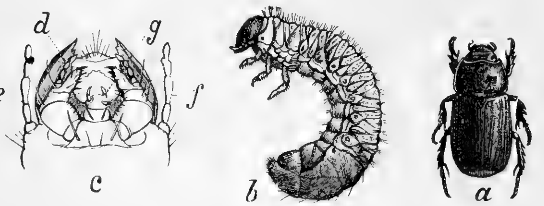

FIG. 5.—*Chalepus trachypygus*: *a*, beetle; *b*, larva, natural size; *c*, under side of head in detail, enlarged (after Comstock).

It is quite probable that the eggs in nature are laid in the same general way as those of *Ligyrus rugiceps*, but since the species appears so late in the year there will rarely be sufficient damage to cause remedies to be sought for other than those later on recommended for the sugar-cane beetle.

It is probable that the rice beetle does some damage to the cane fields, especially in the rice regions, where it occurs in enormous numbers. Very rarely was it found in the spring, in the soil around the cane, or cutting cane, as was the cane beetle. Eggs were twice found that apparently belonged to this species, but they could not in the field be distinguished from those of the Ligyrus. Attempts to get eggs from adults in captivity were unsuccessful, but eggs, apparently fully developed, were dissected from these beetles.

Ligyrus gibbosus occurs in the fields, but not commonly. It was bred from larvæ found beneath young cotton plants in recently manured soil. It was also noticed in a few instances cutting cane. Its eggs are a trifle smaller than those of the sugar-cane beetle and are placed in the same positions about the roots of the cane. Adults bred from the cotton fields emerged early in May from pupæ formed in captivity about ten days previous. In the northern part of Louisiana this species has at times been very destructive to corn in early spring, and its ravages in the northern corn States are well known. At times it occurs in truck gardens and will doubtless be found breeding wherever the soil is enriched sufficiently with stable manure.

ENEMIES.

Birds.—Blackbirds may be considered as one of the most efficient enemies of white grubs throughout the South. Unfortunately, however, they are becoming each year more scarce in many parts of Louisiana, owing to the fact that the class of immigrants now coming into the State as plantation laborers are constantly, in their spare time, on the outlook for birds, and especially all small birds, for use as food. In the evenings I have several times noticed laborers coming home from a hunt with blackbirds, quail, sparrows, and other small birds. None of these seem to come amiss for food and the direct result is rather hard on the bird population.

Insects.—Cocoons of a hymenopterous parasite, probably a species of Tiphia, were found in the cells of a Cyclocephala and a Ligyrus in a few fields at Olivier, and in several places in cells of white grubs beneath the roots of Grand Marais grass. But one specimen was bred out, and this was too badly damaged to admit of identification.

Dipterous larvæ (*Erax lateralis* Macq.) (fig. 6), were not uncommon at several places in the sugar-cane region. These usually occurred at the base of stubble cane or in decaying mother cane, but a few were found among grass roots. In almost every instance there were found with them either injured white-grub larvæ or portions of the harder remains of such larvæ or pupæ. From nearly full-grown larvæ taken in the spring there emerged, during the latter part of June and early July, several specimens of a predaceous fly determined by Mr. Coquillett as *Erax lateralis* Macq.

The full-grown larvæ are about 20 to 25 mm. long, very slender, shining white, with darker spiracles and a dark chitinous head.

The puparia are deep brown in color, the spines being almost black.

Adult flies vary considerably in size, being from 20 to 28 mm. in length; the thorax is dark brown, more or less covered with a gray pubescence; abdomen black, shining, with a narrow band of gray hairs at tip of first segment, sometimes interrupted in the middle; second and third segments with apical triangular gray patches at sides; anal segments pale or covered with pale pubescence; the other segments may have gray patches on the sides. Adults of this fly were not uncommonly taken in October, and were at that time seen capturing wild bees of several species and an unidentified butterfly. They are very swift fliers. Small dipterous larvæ, found in the fall in the cane fields with injured larvæ of white grubs and in cells made for pupation, will doubtless prove to be this same species.

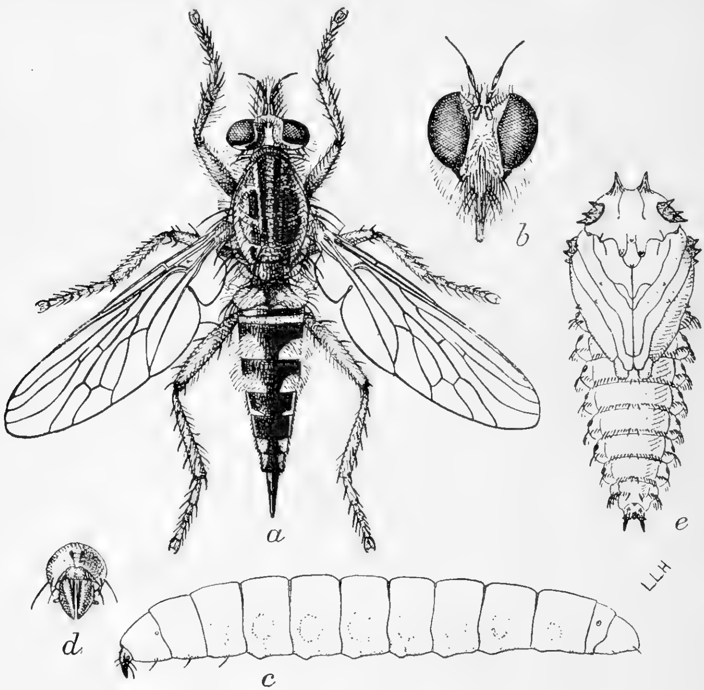

FIG. 6.—*Erax lateralis:* *a*, adult; *b*, face view of head of adult; *c*, larva; *d*, head of larva; *e*, puparium—all enlarged (original).

Several carabid larvæ were seen in the fields feeding upon young white grubs, but none were reared to maturity.

REMEDIES.

Cultural remedies.—These will doubtless prove to be most successful. Doctor Howard, in his report on this insect in 1880, advised postponing the planting of infested fields until spring. This will prove to be one of the best remedies, especially on the higher, lighter soils. On two large plantations at Broussards it was suggested by the writer that the owners "offbar" the cane in April and May and keep the dirt away from it as late as possible. This suggestion was also tried at St. James on a portion of one plantation. The other fields on this plantation were handled in the ordinary manner. The offbarred stubble-cane yielded from 15 to 17 tons, while that handled in the ordinary way was yielding from 8 to 12 tons per acre, and much of this was of a rather poor grade. The offbarred cane suckered well, and the suckers grew well and were not nearly so badly injured as those growing on the other cane. Mr. Leche, at St. James, put in a few acres of cane in the fall of 1904, but will plant most of his cane in the spring. This will give him opportunity to thoroughly clean the stalks and also to stir the soil in the spring and disturb the beetles that are hibernating or the pupæ of those not yet fully developed. No fall cane was put in on one large plantation at Broussards, while at most of the other places visited the planters have planted as much cane this past fall as the season would allow.

It is the custom on many plantations to allow the trash to remain on the field as it falls from the knives at the time of cutting. This is plowed under, either in the fall or the next spring, and the plant cane thus gets the full benefit. It serves, however, as an admirable hiding place through the winter for all kinds of insects that are present in the fields, and even when plowed under serves the same purpose for other insects that prefer to go beneath the soil for winter.

It is the general practice to follow stubble-cane with corn. Some planters, however, are still attempting to run stubble-cane for two or three years before making the change. Cornfields that follow second or third year stubble suffer a much greater percentage of injury than those following only first-year stubble. Where plant-cane was injured badly it was found that the cane had been laid in the same rows that were in corn the previous year, the furrows being cut out down the corn row, the canes laid in, and then dirt, stubble, and trash turned back over them. In any of the plans used, there is bound to be more or less trash buried with the cane at the time of planting, and often three successive layers of decaying vegetable matter are found, the two lower of which are scarcely disturbed throughout the year. It will readily be seen that this affords an ideal place for the breeding of white grubs of all kinds, as well as the larvæ of several other insects.

The headlands and roadsides in the fields almost invariably contain grass sod, sometimes sufficient to enable quite a cutting to be made for hay. In this sod were found the larvæ of several species of white grubs, wireworms, and rootworms, all of which are injurious to corn or cane in either the larval or adult stage or both.

It would appear that some such simple remedies as the following would materially aid in reducing the ravages of these insects, especially that of the sugar-cane beetle: Clean culture of headlands, ditch banks and roadsides; burning off in the fall of all trash on stubble field—both corn and cane ground; thorough cleaning of cane before planting; running no second or third year stubble, and offbarring stubble-cane as late in the spring as the weather will allow.

Hand-picking of the beetles in the spring was quite successfully employed by one planter. Children were paid small sums to follow the "hoe gangs" and plows and pick up the beetles turned out.

While further studies on the life history and habits of this insect are necessary and desirable, there are some points in its control which will readily be evident. One of the most important of these is the disturbing of the grubs in the ground after freezing weather sets in. Rather deep fall plowing will turn them out and kill many, and if this is followed by a heavy harrow many more will be destroyed. Planters in almost all the districts visited have stated that this would also be of advantage to the soil.

REPORT ON A MEXICAN COTTON PEST, THE "CONCHUELA."

(*Pentatoma ligata* Say.)

By A. W. Morrill.

INTRODUCTION.

A report reached the Bureau of Entomology in March, 1904, to the effect that a considerable falling off in the cotton crop for the season of 1903, on a large plantation in the Laguna district of Mexico, was believed to be due to the work of an insect. It was desired that the matter be investigated by this Bureau, owing to the possibility of obtaining information of value in connection with the study of cotton pests in the United States. The writer was consequently detailed to visit the plantation, the headquarters of which are at Tlahualilo, State of Durango, Mexico, and to ascertain if an insect was concerned in the reduction of the yield of cotton for the previous season.

At this plantation can be seen probably the most extensive continuous cotton fields in the world, covering from 25,000 to 30,000 acres of land very nearly level, and comprising a portion of an old lake bed, with fine alluvial soil, the great fertility of which would be almost entirely unavailable but for water which comes through irrigation ditches from the Nazas River, some 40 miles distant. Surrounding the many thousand acres of cultivated lands is a desert, the principal vegetation of which consists of scattered mesquite trees. At the time of the writer's first visit (March 7 to 10) there was absolutely no green vegetation on the estate, except a few cactus plants in the outlying uncultivated portions, thousands of poplar trees growing along the banks of the irrigation canals, and a few ornamental trees and shrubs growing about the offices and living quarters of the managers.

The decrease in yield per acre of *planta* (planted) cotton[a] on this plantation for the season of 1902–3 as compared with the average yield per acre amounted approximately to one-third bale, or a total in round numbers of 6,000 bales. The resident manager of the plantation ascribed a considerable part of this difference to lack of water for irrigation at the most advantageous times on certain parts of the estate. In the cotton fields an examination of various portions indicated that fully 10 or 15 per cent of all the bolls had been rendered valuless by some agency. A conservative estimate would place the loss on this plantation at between 1,200 and 1,500 bales. The resident manager of the plantation believed this injury to the bolls to have been caused by a bug which occurred in abundance on the cotton plants the previous season. Fragments of several pentatomid bugs found among the fallen leaves under the cotton plants were identified by Mr. O. Heidemann as *Pentatoma ligata* Say. The injured bolls showed no boll weevil attack and less than 1 per cent of injury which could be traced to the bollworm.

Specimens of the insect believed to have caused the injury during the previous season were sent to the writer in July, and an accompanying letter from the resident manager stated that the bugs had appeared in the cotton fields for the first time in the season. It was impossible, however, to again visit the locality until several weeks after these specimens were received. The second visit to Tlahualilo was from August 30 to September 8, 1904, and it was during this period that the observations recorded in this paper were made on the life history and habits of the insect believed by many to have occasioned damage to the cotton crop of a single plantation amounting to many thousands of dollars.

HISTORY.

The species is known to the natives of Mexico, more especially in the northern part of the country, by the name of "conchuela," a Spanish word, meaning "little shell." That this species should have received a common name and that it should be so generally known among the cotton growers and laboring classes in the leading cotton-producing district in Mexico, indicates in itself that it has long been a common pest in the cotton fields. The species was first described in 1831, but, while mentioned in entomological literature several times since, the writer is unable to find mention of it as a pest,[b] except for a few

[a] The yield of seppa, or *zoca* cotton as it is known in the Laguna, is not here considered, as it receives only surplus water varying in amount from year to year.

[b] Doctor Fitch referred to what he supposed to be this species feeding on juniper and grape in New York State, but it seems probable that his insect was *P. juniperina* Linn. See footnote, page 20.

allusions to it in the newspapers in the summer of 1904 as being destructive to cotton in Mexico. Several specimens of *Pentatoma ligata* were received by this Bureau in August, 1902, from Doctor Dugés, taken at San Pedro de la Colonia, Coahuila, Mexico. The labels bear the inscription, "Injuring cotton."

DISTRIBUTION.

The original description of *Pentatoma ligata*, by Thomas Say,[a] was based on a specimen from Missouri. Uhler[b] notes that the species occurs in Missouri and Texas, doubting the statement of Fitch[c] that it occurs in New York. Herrich-Schaeffer[d] described what is now generally considered Say's species under the name of *Cimex rufocinctus*, from specimens from Mexico, and Kouchakevitch[e] described specimens from "Russian America," under the name of *Cimex rufomarginatus*, which Van Duzee[f] places as a synonym of *P. ligata*. Smith[g] records *P. ligata* Say as occurring, though "rare," at Caldwell, N. J. Van Duzee[f] says of the distribution of this species: "*P. ligata* ranges from Mexico northward through the Rocky Mountains to Vancouver Island, and apparently still farther north to Alaska."

In the collections of the Bureau of Entomology and of the United States National Museum are specimens bearing locality labels, as follows: Pecos, N. M. (Ckll), July 17, 1903; Los Angeles, Cal. (Coquillett); Arizona; San Diego, Texas (Schwarz); Abilene, Texas (Morrill), Nov. 8, 1904; Tlahualilo, Dgo., Mexico (Morrill), Sept. 3, 1904; San Pedro de la Colonia, Coahuila, Mexico (Dr. Dugés), Inj. cotton, Aug. 12, 1902.

DESCRIPTION.

The egg.—Diameter about 0.9 mm. and height about 1.2 mm. There are three distinct parts of the egg which may be termed body or lower part, neck or intermediate part, and the lid or cap. The last-named portion usually remains attached by a hinge after the hatching of the young. The body, the height of which is about two-thirds

[a] Description of New Species of Heteropterous Hemiptera of North America, 1831.

[b] Say's Entomology of North America, Vol. I, p. 315.

[c] The following references to *P. ligata* by Fitch and subsequent writers seem to refer to *P. juniperina* Linn.: Fitch, Ann. Report N. Y. State Agric. Soc., No. 3, p. 389, No. 4, p. 748; Packard, Guide, p. 546, 1869; Glover, Manuscript Notes from My Journal, p. 30, 1876; Provancher, Petite Fauna Entomologique du Canada Hemipterès III, pp. 41–42, 1886; Lintner, Fourth Report State Ent., p. 25, 1888, Tenth Report State Ent., p. 432, 1895.

[d] Wanzewartigen Insecten, p. 94, 1839.

[e] Hor. Soc. Ent. Rossicae, Vol. IV, p. 99, 1867.

[f] Trans. Am. Ent. Soc., Vol. XXX, p. 41, 1904.

[g] Cat. Ins. N. J., p. 120, 1900.

of that of the entire egg, is subcylindrical, being constricted in the middle, rounded more or less at the lower end, and at the upper abruptly curving inward to meet the neck. The width of the neck on the side (dorsal) opposite the hinge of the cap is about one-sixth of the entire height of the egg, and on the ventral side about one-third as wide as on the dorsal side. On the upper margin of the neck are pure white blunt processes, numbering as a rule 22. The cap is subconical, diameter at base two-thirds of diameter of body of egg, height one-fourth or one-fifth the diameter of base, apex rounded or somewhat flattened. The appearance of the egg is affected by translucent and opaque areas, which seem to be due to the absence and presence of a coating of wax. The cap is translucent, except for the

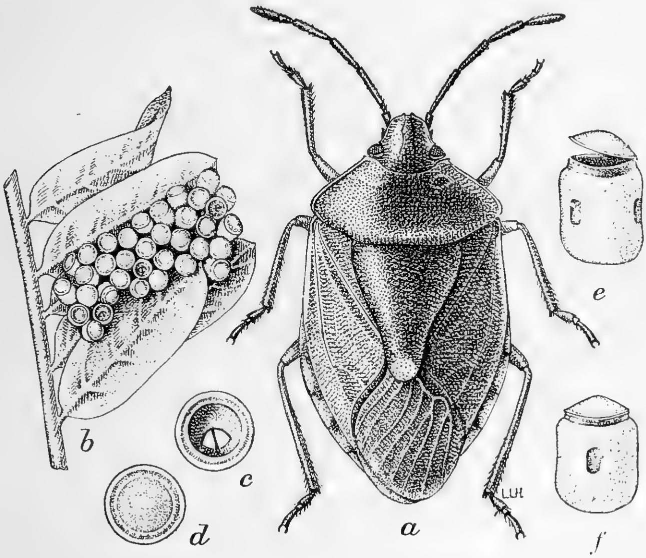

FIG. 7.—*Pentatoma ligata:* *a*, adult bug; *b*, egg mass on leaves; *c*, egg just before emergence of nymph; *d*, egg at an earlier stage of development; *e*, egg from side, showing exit hole at top; *f*, egg closed. *a*, *b*, enlarged; *c–f*, greatly enlarged (original).

edge, and the neck is translucent, except for its upper edge adjoining the cap, the translucent edges of the neck and cap thus combining to make a distinct ring of pure white. The body of the egg is opaque, except for three or four small translucent areas, usually present on the side. When the nymph is nearly ready to hatch the translucent areas are quite dark. In some of the empty shells of the same batch of eggs the translucent areas remain clear, though not transparent, and in some they become yellowish. The entire chorion is closely and finely punctate, the punctures in the translucent parts being smaller than on the opaque parts. The eggs are deposited in compact batches in the hexagonal system, each egg, except those on the outside, being in contact with six others.

Nymphs.—As only three of the five nymph stages were observed and described by the writer, it has seemed advisable not to publish at this time a technical description of any stages except the egg and adults. A brief description follows, which will suffice to give a general idea of the appearance of the immature stages.

The newly hatched nymph appears to the naked eye entirely black, but under a lens the abdomen is seen to be very dark slate-colored, with light spots on the lateral margins and a pair of shining black tubercles at the middle of the second and third abdominal segments above. This stage is about 1 mm. in length and nearly as broad as long; the head is appressed, making the broadly oval outline almost unbroken; the dorsum is rounded, giving the insect the appearance of a minute turtle. The next two stages are much alike, with reddish or orange border on thorax and abdomen, thorax otherwise black, head black, abdomen sometimes entirely black, but more often dark violaceous with black punctures. The fourth and fifth stages—although as stated above not seen by the writer—are without much doubt characterized by a general black, violaceous, or olivaceous black color with a reddish or orange border to the thorax and abdomen as in the first three instars. Also reasoning from what takes place in other pentatomids, without exception as far as known the wing pads first make their appearance in the fourth stage as backward-curving extensions of the sides of the mesonotum, not reaching the posterior margin of the metanotum. In the fifth or last nymph instar of all pentatomids observed by the writer, including representatives of three genera, the wing pads extend to the middle or slightly beyond the middle of the third abdominal segment.

Adult.—The original description of the adult of *P. ligata* by Say is as follows:

P. ligata. Dull olive green, external edge sanguineous.

Inhabits Missouri.

Body olive green, rather dull; confluently punctured; antennæ black; second joint rather longer than the third; thorax, lateral margin sanguineous passing to yellowish on its inner side; scutel at tip bright sanguineous; hemelytra sanguineous on the lateral margin nearly to middle, abdomen on the lateral margin from the middle to the tip sanguineous; beneath tinged with yellow on the pectus; feet greenish, yellowish at base.

Length, eleven-twentieths of an inch.

Presented to me by Nuttall as a native of Missouri. The edge of the head is not reddish.

The top of the head is more closely set with punctures than the thorax and is quite black in all the specimens I have seen; when there is an olivaceous or pale tinge it is scarcely noticeable. The basal joint of the antennæ is sometimes, but not always, pale. The eyes may be entirely black, or, as sometimes occurs, the outer rows of facets are olivaceous or more rarely slightly reddish. The under side of the head is more or less pale or bright olivaceous. The lateral margin of the pronotum is acutely carinated. The ground color of the body above, while usually a dull olive green, may have a slight purplish tinge. Lateral margin of prothorax above and below and the basal third to the basal two-thirds of the costal margin of the wing corium varies in color from dull yellowish to bright crimson; among the specimens seen by the writer the brighter shades being the more common. The tip of the scutellum corresponds in color to that on the margin of the thorax. In some specimens the legs are entirely black, but in most specimens there is more or less greenish or olivaceous on the coxæ, trochanters, and bases of the femora. The lateral margins of the abdominal segments above and below are colored like the margin of the thorax. The wing membranes are fuscous. The venter is quite variable in color, sometimes almost black, but more commonly olivaceous. One specimen at hand exhibits distinct purplish spots at the base of the prothoracic legs, another with a very large olivaceous venter has a pair of large light-green spots, one on each side of the middle, on the venter of the second, and a pair on the venter of the third abdominal segment. In all specimens seen the stigmatæ are paler than the surrounding area and not black, as in *Cimex rufomarginatus* A. Kouch., which Van Duzee places as a synonym of *P. ligata*.

The length given by Say, equaling about 14 mm., is within a fraction of a millimeter the average of ten specimens at hand, which range from 13 to 14½ mm. The greatest width of the prothorax in the same lot varies from 6.75 to 7.50 mm., averaging about 7.25 mm.

FOOD PLANTS.

Besides Doctor Fitch's mention of *P. ligata* feeding on grape and hemlock, which, as I have indicated in the footnote on page 20, probably refers to another species, I am unable to find any reference in scientific literature to the food plants of this insect. Specimens in the collections of the Bureau of Entomology and of the National Museum show it to have been taken on cotton at Abilene, Tex.; Tlahualilo, Durango, Mexico; and San Pedro de la Colonia, Coahuila, Mexico. Mr. John Conduit and others connected with the Tlahualilo Agricultural Company believe the insect identical with one which occurs in more or less abundance on mesquite trees, feeding principally on the bean. In confinement adults fed on stems of mesquite leaves and also on the berry of the China tree (*Melia* sp.). Immature insects have fed, in confinement, on leaves of hackberry and on fresh mesquite beans. It is probable that the species can subsist on a large number of plants, but prefers those with succulent stems or fruits. In September, 1904, examinations were made of corn in fields at Tlahualilo, of weeds along the roadside, of the desert vegetation of mesquite (the beans being dry at this time) and cacti, and of ornamental trees and shrubs at the headquarters of the estate; but on none of these were the insects found.

SEASONAL HISTORY.

For the information concerning the seasonal history of the conchuela, here presented, the writer is indebted to Mr. John Conduit, who, owing to the immense tract of cotton grown under his supervision, gives particular attention to cotton pests, and in addition to personal examinations in the fields, encourages the "bosses" of the various parts of the estate to send in to the office specimens of insects taken on the cotton plant, with information concerning their abundance and injury. The "bosses" in their turn make personal examinations and send dozens of laborers into the various subdivisions of the estate to search for any particular insect concerning which information may be desired at headquarters. This system made it possible to obtain accurate information concerning the abundance of the pentatomid bug here considered.

In 1903 the conchuelas were abundant only during the month of July, and reached a maximum in numbers about July 20. Their first appearance was in the outlying districts, next to the mesquite, but they soon spread all over the cotton plantation, though they were more abundant in certain parts than in others. The insects disappeared early in August and did not reappear in noticeable abundance during the season, although the cotton plants remained green until the 17th of October, when the first frost occurred.

Although a constant watch for the insect was kept during the late spring and early summer of 1904, the first specimen was not taken in the field until July 6. Several specimens were soon after this forwarded to me at Victoria, Tex. During the following seven days a rapid increase in their numbers was noted, causing considerable fear lest they seriously damage the cotton crop. On July 17, however, it was observed that a marked decrease in their numbers had occurred. Nowhere on the estate were the insects as abundant as in July of the previous year, nor were they so generally distributed. On August 31, the date of my first examination in the cotton fields on my second visit to Tlahualilo, the insects were so scarce that but five specimens were found during the first search of one and one-half hours. They were afterwards found in somewhat greater abundance in another portion of the estate. No nymphs and only a single batch of eggs could be found in the field, this latter having been deposited in a field cage. Several hours each day for nearly a week were spent in the cotton fields before any adults were seen in coition. During this period many adults were seen at different times of the day. In the afternoon of the seventh day of these observations a male was observed courting a female, and later in the same afternoon, in a brief stop in a field, two pairs of the bugs were seen copulating. During the last three days spent in investigating this insect many pairs were found mating. The reason for the reappearance of the mating instinct was not apparent. Messrs. Conduit and Vaughan, both in the employ of the Tlahualilo Company, assert that five or six weeks earlier in the season the adults were frequently seen copulating on the cotton plants.

LIFE HISTORY AND HABITS.

ADULTS.

Methods.—Owing to the scarcity of the bugs during the investigation and to the ease with which they can be detected when present, the plan of tagging bolls and plants in the field and making records twice a day, was found to give good results. Some observations were made with adults in confinement in tumblers, and with others confined in large wire screens in the fields.

Feeding habits.—The adults seem to be able to detect food from a distance, though this point was not definitely determined. In each of three cases when an adult escaped from a cage out of doors in a field where the plants were widely separated, it was afterward found on the plant nearest in its direction from the cage; in other words, the bugs did not pass over or near any other cotton plants in going to the plant upon which they were found.

In confinement, the adults fed on the fruit of the China tree and twigs of the mesquite tree, as well as upon cotton bolls. Five adults left in a glass with a two-thirds grown bollworm for six hours showed no carnivorous tendencies.

Although the adults feed upon all parts of the cotton plant in the field, the bolls are much preferred to the stems and leaves. Fifty-seven field records show the total number of times the bugs were recorded as feeding on bolls to be 43; on leaves, 4; on stems, 10. The bugs were recorded resting on bolls in the field ten times; on the leaf, once; and on the stem, once. The bolls are undoubtedly preferred on account of the rich juice of the seed which the insect is able to reach (except probably in the older bolls with well-matured lint) by means of its mouth setæ. The examination of many bolls shows that the immature seeds are the objective points of the insect's attack. A preference is almost invariably shown for bolls growing near the tops of the plants.

In feeding on the cotton plant, the adult generally occupies a conspicuous position, especially when on a boll. The writer has never found them inside the bracts of a square, and when on a boll, never entirely hidden by the bracts.

When feeding upon a cotton boll the mouth setæ do not remain in the usual position in the groove of the rostrum, but the insect, after inserting the setæ into the tissue of the plant, either folds the rostrum directly back, freeing the setæ entirely from it, or doubles it up in the form of the letter "Z," the upper angle representing the joint between the first and second, and the lower angle that between the second and third segments. At the latter joint the setæ remain in the groove. When feeding, the bug constantly raises and lowers its head. When the setæ are entirely withdrawn from the boll, the spine, located on the inner side of a fore tibia slightly beyond the middle, is used to replace them in the rostral groove. The setæ are pressed into place by one stroke of the tibia.

These insects have been observed to feed upon a cotton boll for ten minutes without withdrawing their setæ. One adult under observation in the field visited four bolls, two on each of two plants in two days, and remained for over thirty-six hours on the last of the four bolls. Another adult bug remained on the same boll for two and three-fourths days. Three remained on the same plant for over thirty hours, and three others were found on the same plant thirty-two hours after they were first recorded. In none of these cases was it known how long the insects had been on these plants previous to their being first noted. They do not always remain so long, but have been observed to alight for but a few minutes on a cotton plant and then fly to another without feeding.

In cages in the field during the middle of the day the insects are more restless and are more frequently seen crawling about on the screens; after sundown they are usually found quietly feeding.

Flight.—When liberated in a room the adults fly readily and invariably nearly straight toward the light. In the field their direction of flight is usually curving and the greatest distance obtained in any of six flights observed and recorded was 25 feet. In four successive flights from the hand, held at a height of 4 feet from the ground, an adult female covered on an average $15\frac{3}{4}$ feet per flight. An adult male, apparently in normal condition, taken when feeding on a boll, in attempting to fly from the hand dropped directly to the ground. It is probable that these records are not indicative of the distance which these bugs are capable of flying when newly matured.

Gregariousness.—It very frequently happens that more than one conchuela is present on a plant, even though no others can be found on plants for a considerable distance in any direction. The belief that this gregariousness is not due to the adults found on a plant having developed from eggs laid on that plant is supported by the fact that careful search failed to reveal the remains of the egg batch, by the fact that adults under observation did not remain on the same plant in any case for as long as three days, and also by the frequently noted occurrence of two or three adults appearing at nearly the same time on a plant which had been free from the insects, as shown by examinations for two or three previous days. The following is the record of 34 specimens of *P. ligata* collected in the cotton fields. Each record refers to collection from a single plant when none could be found on near-by plants: August 31, 2; September 1, first plant, 2, second plant, 3; September 2, first plant, 3, second plant, 1; September 3, first plant, 2 (male and female), second plant, 5 (3 females, 1 male, and 1 escaped); September 3, first plant, 1, second plant, 1, third plant, 2; September 4, first plant, 1, second plant, 2; September 6, first plant, 3, second plant, 2, third plant, 3, fourth plant, 2. The average number of bugs per plant in the instances recorded above was $2\frac{1}{2}$. In addition to the instances where two or more were found on a single plant, it might be mentioned that not infrequently after searching for the insects without results one is found on each of the two adjacent plants, while, as in the case for single plants referred to above, none could be found on any other plants near by. To determine whether this gregarious tendency is due to sexual attraction or to sight would require more careful attention than it was possible to give on the occasion on which these observations were made.

Egg laying.—All of the eggs of *Pentatoma ligata* which were obtained were deposited by females in confinement. They were deposited in batches of from 18 to 43 eggs. One batch was deposited on a mesquite leaf, the others on the bracts of cotton bolls and on cotton leaves. It is believed that three and possibly four batches were deposited by the same female. The three batches probably deposited by the insect referred to numbered together 107 eggs. A female pentatomid bug of another genus (Podisus) has been known to deposit nearly 500 eggs, a fact which not only gives weight to the supposition that these 107 or more eggs were deposited by the one specimen of *P. ligata*, but which indicates that this number does not necessarily give an idea of the maximum number a single female may deposit.

EGGS.

The following table shows the duration of incubation and the approximate number hatching under indoor conditions, the last four batches being kept most of the time in small pill boxes:

Egg laying, incubation, and hatching.

When deposited.	Number of eggs in batch.	When hatched.	Number hatched.	Period of incubation.
				Days.
September 4	43	September 10	21	6
September 6	18	September 14	[a]6	8
Do	39	do	24	8
September 7	28	September 15	14	8
Do	40	do	21	8

[a] Eleven eggs became separated from the batch and were lost before any of them hatched.

The average period of incubation, as shown by the above figures, is nearly seven and a half days under the conditions noted.

NYMPHS.

For several hours after hatching the young nymphs remain closely clustered upon the top of the egg batch, with scarcely any perceptible movement. In all cases where the eggs of this species have come under the writer's observation, less than two-thirds of the total number in the batch have hatched, although those which failed to hatch contained nymphs. It was found that, as in many other species of pentatomids, the nymphs of the first instar which first hatch begin to feed, after a few hours' quiescence, upon the contents of the unhatched eggs. It is not impossible that some or all of the nymphs thus fed upon were already dead. Some of the nymphs which have been observed obtained enough food from the unhatched eggs to pass through the first instar. Others became quite plump by feeding upon the eggs, but fed readily upon fresh cotton leaves when placed upon them. The first molt occurred the seventh day after hatching, and the second molt on the third and fourth days after the first. It was impossible to give the young insects the attention necessary to breed them to maturity, and all of them died before molting a third time.

INJURY TO COTTON.

Injury to Cotton at Tlahualilo in 1903.

As stated in the introduction, it was estimated after a personal examination of the dry stalks in the cotton fields at Tlahualilo on March 8, 1904, that an average of 10 to 15 per cent of the cotton bolls were injured by some agency to the point of worthlessness. The nature of much of this injury was found to be, to all appearances, identical with that resulting from the attacks of the conchuela, as observed in fields of growing cotton at Tlahualilo from August 30 to September 8. Concerning some of the bolls, there was more doubt as to the cause of the injury, which consisted in the locks dying after reaching a late stage in their development. The opened bolls showed more or less stained fibers remaining closely matted together, and at the extreme tip noticeably shriveled. In consideration of the possibility that this injury was due to a vegetable disease, dry specimens were submitted to Dr. A. F. Woods, pathologist and physiologist of the Bureau of Plant Industry, with a request that they be examined for evidence of trouble of this nature, but it was found that no fungous disease could have been responsible for their condition. There being no evidence of a disease of a bacterial or physiological nature, there is but little doubt that the condition described above is due to injury by heteropterous insects, principally by the predominating species in this particular locality, *Pentatoma ligata*. The difference in the nature of the damage produced can probably be explained by the difference in the degree of development attained by the bolls before they receive the first injury.

INJURY TO COTTON AT TLAHUALILO IN 1904.

At the time of the second visit of the writer to Tlahualilo it was possible to obtain more definite information concerning the character of the injury caused by the conchuela. This was done principally by means of tagging in the field cotton bolls known to have been fed upon more or less by the insect.

External evidence of injury by this bug never appears, except when a boll is fed upon when very small and one or more locks are injured, so that growth ceases in the injured portions and a deformity of the boll results. The inner side of the carpels of green bolls which have been fed upon by the conchuela show a minute dark spot, indicating the point at which the seta entered, and surrounding this may be an abnormal wart-like growth which is of more frequent occurrence in small bolls, or a smooth circular area which becomes dark green and contrasts sharply with the lighter background. Large bolls nearly mature have been examined with as many as twenty-five or thirty of these spots, but with uninjured seeds, these probably having been protected by the resistance of the lint to the entrance of the insect's mouth organs. This difficulty probably increases with the increasing age of the boll. In examining smaller bolls it was found that a single spot on the inside of the carpel was good, though not positive, evidence of injury, which could be seen only by breaking open the developing lock. In fields where no bugs of any kind could be found none of the bolls showed these spots, while in every case a certain injury to seeds and surrounding lint, which I learned to ascribe to *P. ligata* and a few less common species of heteroptera, was accompanied

FIG. 8.—Supposed work of *Pentatoma ligata* on cotton boll (from photo by W. E. Hinds).

by one or more of these spots directly opposite on the inner side of the carpel.

The conchuela usually inserts its mouth setæ through the carpel and developing lint into the seed. An injured immature seed at first is characterized by a watery appearance, later it takes on a brownish color and appears decayed, finally shriveling. Two or three days after the seed is injured by the feeding of the bug, the surrounding lint becomes slightly discolored. If only a short time was spent in feeding upon the seed of a nearly matured boll, the injury consists simply in a yellow staining of the lint, but if the boll be less than two-thirds grown the injury is likely to be more serious. The decayed appearance then spreads throughout the lock, which shrivels and is spoiled. The observations thus far made show that a bug must spend at least several hours to destroy the usefulness of a lock of a cotton boll instead of only the few minutes necessary to deposit an egg, as is the case with a female boll weevil.

Several observations were made in the field to establish the connection between the conchuela and the injury described above. A few of these will be outlined. Bug No. 1 was found on a plant upon which it remained for over twenty-four hours, it being unknown how long it might have been on the same plant previous to discovery, or how many, if any, other bugs had been present. On examination of the unopened bolls it was found that there were uninjured 5, slightly injured 1, badly injured 6. Two opened bolls were uninjured. As a check for this plant, the bolls on the next one in the row were examined, and of the 12 unopened and 3 open bolls all were perfect. This same insect moved 4½ feet to another plant and was found upon the same boll at each of the several visits to the field during the following thirty-six hours. The insect then disappeared and was not afterwards found. An examination of the 15 bolls on this second plant showed only 2 injured ones, the one on which the bug was known to have fed for thirty-six hours, which was badly damaged, and another the injury to which was apparently caused by a bacterial disease of the nature of anthracnose.

On September 4, 1904, at 11.45 a. m., two specimens of *P. ligata* were found in the cotton field on a plant, surrounding which for at least 50 feet in all directions were plants which after careful search were found to be free from the insect. Six hours later two more adults were found on this plant, an examination as before showing the surrounding plants to be free. Two days later the plant under observation was entirely free from the insects, and on September 8 all the bolls on the plant were opened and each lock was examined. Of the 15 bolls 7 were badly injured; 4 (3 of which were produced on the lower branches close to the ground) were perfectly sound in every way. As a check, an examination was made of the 16 bolls on a very similar plant standing 3 feet away in the same row; 14 of these were perfect in every way, 1 boll was injured by a boll worm, and the remaining injured boll had the appearance of having been fed upon when quite small by *P. ligata* or some other heteropterous insect. One lock of this boll was decidedly stunted, giving it a deformed appearance. The inside of the carpel of the stunted portion showed the characteristic mark of injury already described, as did several seeds with the surrounding lint.

On September 8 an examination was made of the bolls of a plant upon which three specimens of *P. ligata* were taken on September 6. As before, the surrounding plants were free from the insects and their bolls only in few instances showed injury of the nature described as occasioned by this species. Of the 64 bolls over 1 inch in diameter which were on the plant, 20 were selected at random and carefully examined, and but 2 of them were found to be uninjured.

As the above observations might lead to an exaggerated idea of the injury believed to be caused by the insect here considered, it should be explained that in the field where the above instances occurred the conchuelas at the time were more abundant than elsewhere on the plantation, and even here (with the exception of a limited area) on not more than 5 or 6 stalks to an acre could the insects be found. The observations indicate, however, that when they are very numerous the conchuelas are capable of causing considerable damage to the cotton crop.

The exceptional area referred to above consisted of about 300 square feet in the cotton field, which was slightly lower than the general level. The plants were consequently growing more vigorously, and more adult conchuelas were found at work here than elsewhere. An examination of all the bolls over 1 inch in diameter on 10 representative stalks showed that 33 per cent of them were injured, and of the open bolls on these plants 19 per cent had at least one lock damaged by shriveling, apparently caused by the attack of a heteropterous insect.

As a check to this examination, 30 bolls, from one-third to three-fourths grown, were examined on a portion of the plantation which was remarkably free from insects, and where no heteropterous insects of any kind could be found. Each lock in each boll was carefully examined as before, with the result that only 2 bolls were found to show the slightest internal discoloration, and this did not extend to the seed, nor was it accompanied by the spot on the inside of the carpel, which the evidence obtained showed to result from the puncture of *P. ligata*.

Cage experiments were conducted for the purpose of learning how long after a boll is fed upon the injury becomes apparent and also how long feeding must be continued to work an injury. Neither of these points was satisfactorily determined, owing to the brief period available for this investigation. As has been stated, the size of the boll is an important factor; probably a single bug in a few hours, or perhaps minutes, can produce an injury to a boll one-fourth or one-third grown which will prevent its developing perfect lint. On the other hand, it seems that after the lint reaches a certain degree of development, perhaps when the boll is about three-fourths grown, it is beyond the limit of danger of serious injury from the conchuela. The following records show the only information obtained from the cage tests relating to the question of how long after being attacked, the injury to the boll appears:

Results of cage tests with Pentatoma ligata, 1904.

Cage No.	Number of bugs.	Apparently sound bolls.	When caged.	When examined.	Injured bolls.	Severely injured bolls.
1	5	8	September 3	September 7	4	2
2	6	26	September 4	do	16	0

The cage tests were made in a portion of the plantation apparently free from the conchuela and other bugs, and where no injury to bolls could be found which was likely to have been caused by such insects.

Relation of Mesquite to Infested Fields.

The conchuela is believed by Mr. Conduit to be identical with an insect which breeds upon mesquite beans.[a] In the early summer of 1903, owing to specially favorable weather conditions the crop of mesquite beans was unusually large, and it is generally believed in the Laguna district that an unusually large number of the conchuelas developed in the mesquite, and upon the maturing and drying of the beans the insects made their way into the cotton fields in correspondingly large numbers. Both of the writer's visits to Tlahualilo, made at times when there were no green mesquite beans, and no specimens of *P. ligata* could be found in the mesquite or anywhere else except in the cotton fields, nor could any remains of their immature stages be found, except a batch of eggs from which the nymphs had emerged, which was found on the ground among the dead leaves on March 8.

Although no direct evidence could be obtained concerning the origin of the large numbers of the insects which infested the cotton fields in 1903, the statements of Mr. Conduit concerning the portions of the estate where the insects occurred in greatest numbers, both in 1903 and 1904, seem to show a connection between these portions and the parts of the uncultivated land surrounding the estate on all sides, upon which the mesquite growth was most abundant.

[a] Since the above was written this has been verified by the writer.

Injury to Cotton at Tlahualilo, Mexico, by other Heteroptera.

The injury to cotton by *P. ligata* is probably the same as might result from the attacks of many other heteropterous insects. Several species of pentatomid bugs were collected feeding on cotton bolls, but none were numerous enough to cause appreciable damage. Next to *P. ligata*, the most abundant heteropteron found feeding on cotton bolls was *Leptoglossus zonatus* Dall. The injury found on the examination of bolls upon which bugs of the latter species had been feeding I was unable to distinguish from that resulting from the feeding of the former. The individuals of the above coreid were not common enough in the cotton fields during the first few days of September to interfere with observations on the conchuela. The following heteroptera, in addition to the species above mentioned, were found on cotton at Tlahualilo between August 31 and September 8, 1904. For their identification the writer is indebted to Mr. O. Heidemann, of the Bureau of Entomology: *Apiomerus spissipes* Say, *Zelus renardii* Kol., *Largus cinctus* H. S., *Oncopeltus fasciatus* Dall., *Murgantia histrionica* Hahn, and *Thyanta perditor* Fab.

Injury by this and other Pentatomids in the United States.

The species here considered has been taken on cotton in our own cotton States, but neither it nor any other pentatomid has ever, so far as the writer can learn, proved of much consequence as a pest in the cotton fields. The eggs of pentatomids are attacked by several hymenopterous parasites, which probably more than any other factor prevent many of the species from becoming serious pests. Occasionally, however, we find reports of a species of this family, previously unknown except, perhaps, for a scientific description, springing suddenly into prominence as a pest in one locality or another and the following season becoming of the same slight importance as usual. An instance of this kind is briefly mentioned in a previous bulletin of this Bureau,[a] *Pentatoma sayi* Stål being there referred to as appearing as a serious wheat pest in Colorado, Arizona, and New Mexico in the summer of 1903. Many pentatomids and other heteropterous insects, which probably all cause damage to cotton similar to that of *P. ligata*, occur in the cotton fields in this country. It is possible that this species may be sporadically of more or less importance locally, especially under circumstances where, by the unavoidable losses occasioned by the boll weevil, the small margin of profit makes it necessary to reduce to the lowest practicable limit injuries from the minor pests. Assuming the truth of the report that this species breeds upon mesquite beans, it is evidently much more likely to

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[a] Bulletin No. 44, Division of Entomology, p. 86.

appear in cotton fields in injurious numbers in such irrigated districts as the Laguna of Mexico, where, when their chief food supply in the desert becomes unfit for them, they are driven to the cotton plants from necessity, there being almost nothing else available for food. In other localities the insects might become widely distributed among various crops and only small injury be done to any one of them.

SUGGESTIONS FOR CONTROL.

As these insects in the cotton field almost invariably occupy a conspicuous position on the cotton plant, usually on a boll, there is little trouble for even an inexperienced person to find them when present. Their habit of segregation is of much importance in this connection. Whenever they become abundant enough to deserve attention from the cotton grower, hand picking, or knocking into collecting pans containing oil, will probably be preferable to spraying with contact insecticides, the value of the former depending in a measure upon the availability of cheap labor. Clearing up the fields in the fall, destroying both the cotton stalks and the weeds surrounding the fields by burning, would prevent, in a large measure, the hibernation of this, as well as many other cotton pests, and constitutes a practice the adoption of which by all cotton growers is strongly urged by economic entomologists. It may be advisable under some circumstances to provide for the treatment of the conchuelas on mesquite trees when it is found that they are developing thereon in threatening numbers, and when experience shows that these trees growing close to cotton fields are an element of danger, it might even be good policy to remove them entirely.

THE SUGAR-BEET CROWN-BORER.

(*Hulstea undulatella* Clemens.)

By E. S. G. Titus.

While investigating the general insect enemies of the sugar beet the past season (1904), the writer found at Waverly, Wash., Echo, Oreg., and Spreckles and Oxnard, Cal., evidences of an injury to sugar beets that could not be traced to any insect at that time occurring in the fields. The injury at these places was quite local, usually occurring in small patches over some of the fields, and was most noticeable on the richer soils. The beets had been injured earlier in the year and their growth practically stopped. Some of the tops had lived on for some time, but had eventually dried down. When these were lifted only a small portion of the beet usually came with them, and this a rather ragged portion of the crown. Digging into the soil, the remainder of the root could usually be found, shriveled and dried up, but rarely showing marks of injury.

Vacant spaces could be seen extending sometimes 10 or 15 feet down a row and covering an area from 2 to 5 rows wide. Those few injured beets that had survived the attack were dry, almost lifeless, the leaves being small and the root of no value.

Upon reaching the Santa Ana Valley and neighboring beet regions in southern California, especially at Chino, the work of this insect became more common and the damage in places was quite severe. The owners attributed the loss to plant lice and cut worms, but a very slight examination was sufficient to show that the beets had been attacked by some borer, and that work on them was still in progress. At Huntington Beach, near Los Angeles, and at Chino, the larvæ causing the injury were found in several fields, and at the latter place moths, which later proved to be the adult form of this phycitid borer, were rather common in one field on the beet-sugar company's ground.

From examination of the beets it is evident that the young larva at first works on the beet just below the bases of the leaves, eating through the outer skin and either boring directly into the beet or working its way around the crown beneath the epidermis, thus making a swollen line that has the appearance of a mine, often much like early work of *Pegomya vicina* and similar species mining in leaves. As the larva grows in size it forces its way farther and farther into the beet until it reaches the center, when it may bore directly downward or pass on through the beet and then return and feed up and down inside the root. In all the galleries examined I found more or less evidence of a silken tube. Those of the older larvæ that were feeding on the outside of the beet had constructed tubes covering their operations and protecting them from contact with the soil. Sometimes these tubes extended for a considerable distance away from the beet. These tubes are very fragile, and not nearly so firm in construction as those made for hibernating purposes by the sugar-beet webworm (*Loxostege sticticalis*).

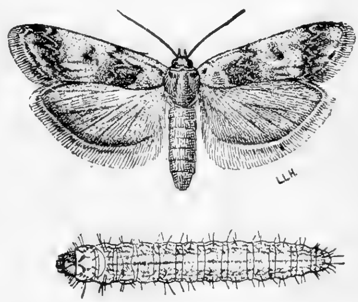

FIG. 9.—*Hulstea undulatella:* adult and larva—enlarged (original).

Several larvæ were usually found attacking a single beet, and, from the fact that tubes were found extending from beet to beet down the rows, it is probable that the larvæ after killing one beet may pass on to another one in which they will complete their growth. Pupæ were usually found in the tubes outside the beets, but a few pupa cases were noticed in the burrows.

FIG. 10.—*Hulstea undulatella:* longitudinal section of beet and small beet showing injury—natural size (original).

There are apparently two broods of this insect, eggs being laid in early spring upon the young beets and the adult appearing in June or July, when the second brood eggs are laid. The larvæ of the second brood develop and become full grown in the fall, and probably most of the adults emerge at this time, although two of the larvæ taken last October are still (April 1) in that stage in our breeding cages. It may be that in southern California the adult emerges in the fall and lays eggs on some native food plant. Adults were quite common in that region in late September, especially in the early evening before dark. They would fly quickly when disturbed, but only for short distances, and usually alighted on the under side of beet leaves or on the ground, the color of which they closely resemble. Some minute white eggs were found at the bases of leaves of beets, which may belong to this species or to the tortricid mentioned below.

This moth has a wide distribution, having been taken in many parts of the United States. Specimens in the National Museum bear labels from the following localities: Maine (Packard); Massachusetts; New York (Burnett); Anglesa, N. J., June 23 (Kearfoot); Hastings, Fla., April (Kearfoot); Wisconsin; Stockton, Utah, numerous specimens, dates, June 24, 29, August 4, 6, 7, 8, 11, 23, and September 1, 8, 11 (Tom Spalding); Denver, Colo., May 1, 15, and September 15; Pueblo, Colo., July (Kearfoot); Pullman, Wash. (Piper); Kaslo, British Columbia (Dyar & Caudell); San Francisco, Santa Clara, and Alameda, Cal. (Koebele); Williams, Ariz., July 7, 10, 23 (Schwarz & Barber); Flagstaff, Ariz., July 8, 24 (Barber); Sapello Canyon, N. Mex. (Oslar). The species was described by Clemens[a] under the genus Nephopteryx in 1860 from specimens "From Dr. Charles Girard, Washington, D. C., Pennsylvania, Canada, and Massachusetts."

FIG. 11.—Upper portion of beet injured by *Hulstea undulatella* (original).

The statement that the insect was reared from elm, which has

[a] 1860: Clemens, Proc. Acad. Nat. Sc. Phila., p. 205.

several times been accredited to Clemens, has very little foundation. Following his description he says:

> Early in October I found the pupa of this insect at Niagara Falls, on the Canada side, under shelter of loosened portions of the bark of American elm. They were inclosed in a cocoon of silk, mixed with particles of bark. On the same tree I took a number of larvæ which were ascending the tree to undergo pupation. I did not, however, obtain imagoes from any of the specimens. The body was nearly uniform in diameter, with the ordinary number of feet. Head as broad as the body and dark green. Body dark green, between the segments yellowish and dotted with yellow; first rings with two black dots on the sides.

Doctor Hulst,[a] after giving the following localities for this species—"Canada, Massachusetts, New York, Pennsylvania, Illinois, Virginia, Texas, Colorado, Utah, California"—states that he has received it from Texas in August and September, and then quotes Clemens's remarks given above, but omits the important statement that *no specimens were bred to maturity.* The other published references to the species simply record it as feeding on elm, an error evidently derived from the original reference or from Doctor Hulst's paper.

Doctor Clemens's description of the larva he found does not accord with the larvæ taken on sugar beet, and from which specimens were bred that were identified by Dr. H. G. Dyar, of the United States National Museum, as belonging to this species. Our larvæ when fully mature were 16 to 18 mm. in length, head slightly narrower than first segment following; pale brown in color, darker on tip of clypeus and tips of mandibles, antennæ and palpi paler, almost yellow; body varying from pale green to dirty yellow, paler between segments, usually a single black dot on each side of the first segment; feet all tipped with black. The larva is very transparent, so that the internal anatomy is clearly visible.

The adult measures 12 to 16 mm. across wings when fully spread. Fore wings dark gray, varying to a pale gray, with traces of fuscous and black scales interspersed, a red spot usually present within the basal line, irregular dentate lines along outer margin are darker; hind wings dark fuscous, shading out darker on outer margin, fringe very pale; thorax with a dark spot on each side near front; abdomen varying from gray to almost black; antenna gray, half the length of the fore wing; palpi varying from white to brownish red, darker at tip.

Many of the larvæ or pupæ were parasitized. A dipterous parasite was identified by Mr. D. W. Coquillett as *Exorista pyste* Walk.

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[a] 1890: Hulst, Trans. Amer. Ent. Soc., v. 17, pp. 187–188.

(fig. 12). It bred from pupæ taken at Chino and Oxnard, Cal. This parasite was also reared from the pupæ of an unidentified tortricid found feeding on the leaves of sugar beet at the same places. Three species of Hymenopterous parasites were reared, but with the exception of the one noted below it was impossible to tell whether they were bred from larvæ or pupæ. They were identified by Dr. W. H. Ashmead, of the United States National Museum, as *Chelonus iridescens* Cr., *Spilochalcis torvina* Cr., and *Habrobracon hebetor* Say.

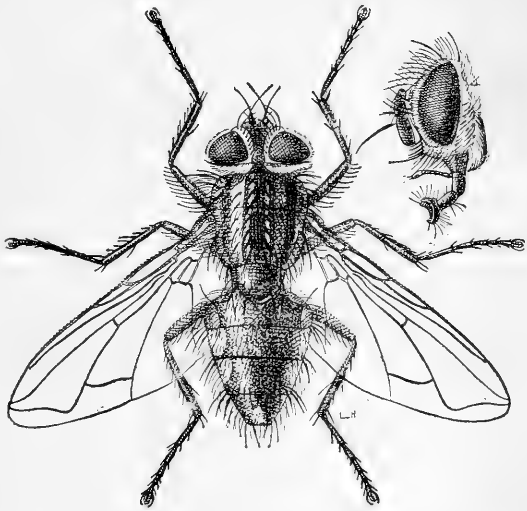

FIG. 12.—*Exorista pyste*—much enlarged (original).

Specimens of *Chelonus iridescens* (fig. 13), issued from pupæ of the crown borer in early October. This parasite is represented in the National Museum collections by specimens from Agricultural College, Mich.; Washington, D. C.; South Dakota; Colorado; Wyoming; Corvallis, Oreg.; Garland, Utah; Kukak Bay, Alaska; Easton, Wash., and San Diego, Cal. The last of these specimens (bearing the U. S. Dept. Agr. No. 797P°) was bred from a phyticid larva (or from the pupa) found feeding in the seed pods of *Aphyllon tuberosum*. This species is entirely black except the legs, which are marked with pale yellow; about 4 mm. in length; very rugosely punctured on thorax with longitudinal striæ on abdomen.

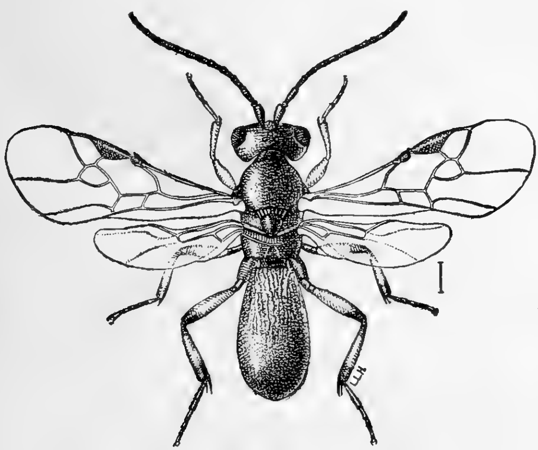

FIG. 13.—*Chelonus iridescens*—greatly enlarged (original).

But one specimen of *Habrobracon hebetor* Say was reared from the crown borer; this issued October 5, 1905. This species has been reared from several of the flour and meal moths [a] in this country. A European species, *Bracon brevicornis* Wesm., is, as stated by Dr. Chittenden, quite probably a synonym of Say's species. It has been reared from two species of Ephestia and from lepidopterous larvæ in Europe. The species has black antennæ, head, and thorax; abdomen fuscous; leg more or less pale yellow; femora usually black at base; ovipositor of female black.

Spilochalcis torvina (fig. 14) was bred from the crown borer, and also from pupæ of the unidentified tortricid before mentioned from Chino, Cal., in early October. This dainty little chalcid is jet black, with many pale markings, though usually there is a brownish-red shading from white into the black; the abdomen is somewhat fuscous on the side beneath.

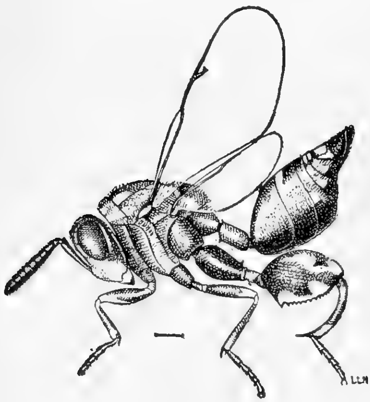

FIG. 14.—*Spilochalcis torvina*—much enlarged (original).

REMEDIES.

Cultural remedies tending to thoroughly disturb the soil at the time the larvæ are nearly mature and destruction of the beets showing injury will doubtless aid the control of this pest. It will complete the destruction of the injured beet, since the larvæ will in all probability breed out even if the beets are removed from the soil. A more complete study of the life history of the insect may show opportunity for other remedies.

THE DOCK FALSE-WORM.

(*Taxonus nigrisoma* Nort.)

By F. H. CHITTENDEN and E. S. G. TITUS.

September 5 and 6, 1904, the junior writer observed larvæ of this species of tenthredinid at Menominee, Mich., attacking sugar beet and a yellow dock (*Rumex patientia* or *brittanicus*).

The larvæ were feeding on the upper sides of the leaves, usually placing themselves parallel with the larger veins; often several larvæ were found feeding side by side, reminding one of colonies of the grape social caterpillar (*Harrisina* [*Procris*] *americana* Guer.). From 6 to 20 larvæ were counted on single leaves both of sugar beet and dock, and as many as 70 were taken from a single plant.

[a] 1897, Chittenden, Bul. 8, n. s., Div. Entom., Dept. of Agric., pp. 39–41.

They are quite active, readily curling up when disturbed and usually rolling down the leaf into the mass of young leaves at the base. It is interesting to note that larvæ were also active in confinement, but not easily disturbed, not curling up unless considerably agitated. This was doubtless due to the handling they had received in packing and unpacking and to the jarring incident to their long journey, all of which had the effect of causing them to be less easily disturbed than under normal conditions.

Dock was rather scarce in the field at this time, the beets having been recently cultivated, and their leaves at this season of the year so covered the ground that the young dock leaves had not had opportunity for growth. It is probable that the larvæ on the beet leaves had been hatched from eggs deposited on dock, and that they had

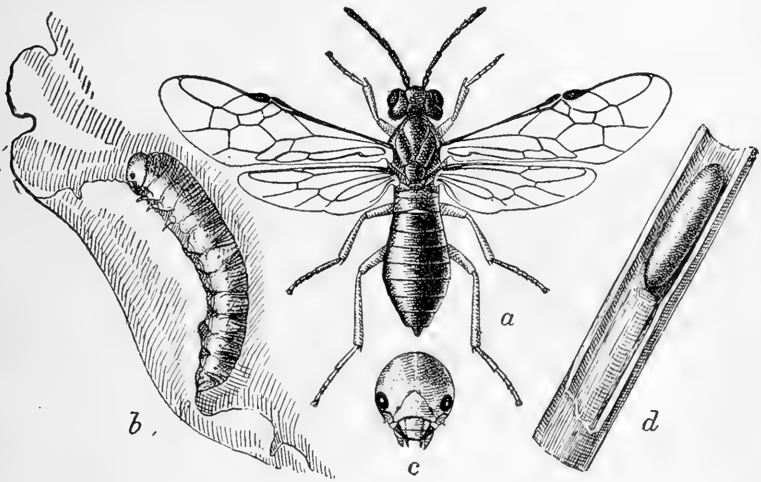

FIG. 15.—*Taxonus nigrisoma: a*, adult; *b*, larva; *c*, head of same; *d*, cocoon in stalk—all enlarged (original).

resorted to the former when the dock was cut down. Several beet plants were seen that had been seriously injured, and the dock leaves remaining in the fields were riddled. Dock plants growing along roadsides and in uncultivated fields were not infested. The larvæ seen showed a preference for leaves more or less protected by other leaves; they usually rest flat on the leaf, but some were noticed slightly curled when resting near the edges.

At this time the larvæ belonged to several stages, three at least, one being the mature stage.

DESCRIPTION.

Mature larva.—The prevailing color of the mature larva is leaf green, slightly paler than that of either of the leaves on which it feeds, this paleness being, perhaps, due to the presence of a faint bloom on the surface. The larva is of the normal tenthredinid form, the surface not very strongly wrinkled, 6-annulate, smooth, and not shining; the head is pale, nearly white, or pale green tinged with brown, clypeus with a distinct brown spot, a brown band sometimes present above the clypeus, head usually darker on the upper third; eyes black, mouth-parts dark brown, tips of mandibles darker; the lateral surface, as well as the lower, varies from pale yellowish to pale but distinct green, this color extending from the line of the spiracles, the darker coloration of the dorsal surface often almost enveloping the spiracles; body slightly brownish in the folds; spiracles small, elongate-oval, black. Segment 13 is much paler dorsally than the remaining segments. Besides the three pairs of nearly white thoracic legs, which are more or less infuscated at the sutures, there are eight pairs of abdominal legs (segments 6 to 13), which are also pale. Length, 13 mm.; width, nearly uniform from the second thoracic to the antepenultimate segment, 1.5 to 2 mm.

Antepenultimate stage.—What appears to be the antepenultimate stage closely resembles the mature form, but is less greenish in color and has a proportionately larger head. In this stage, larvæ are pale green, with a somewhat irregular, ill-defined, broad, darker green space on the sides just above the spiracles; white piliferous tubercles, somewhat faint, but quite noticeable in living specimens, occur in this stage. Length, 10 to 11 mm.; width, 1.2 mm.

Younger stage.—A still earlier stage was represented by very few specimens and was very much darker. Dorsal surface pale brown, shading into black at the sides; piliferous tubercles distinct, large and white, arranged in regular sets; head almost uniformly dark brown. Length, 7 to 10 mm.; width, 0.9 to 1 mm.

Larvæ placed in a rearing cage in the insectary did not feed on sugar-beet leaves, but when dock was substituted fed until maturity. From these larvæ three adults issued September 24. Larvæ kept by the junior author with him on his trip westward were confined in a small tin box and fed on beet leaves. From these one adult issued October 3. The larva from which this adult came formed a naked pupa in the box September 23, and this pupa was kept wrapped in a beet leaf until the adult issued.

The pupa.—The pupa is at first pale green, with dark extremities and tips of feet and palpi brownish. Before the adult emerges the pupa darkens considerably. Length, 10 mm.

The adult.—The general appearance of the adult sawfly and the arrangement of the venation of the wings is shown by figure 15, *a*. A brief characterization of the genus was given by Norton in 1868,[a]

[a] Trans. Amer. Ent. Soc., Vol. II, p. 211.

with a description of the adult. As the latter is also brief, it is transcribed herewith. The original description appeared in 1862.[a]

♀. Color blue black; abdomen rather long, flattened, acute; antennæ slender, basal joint enlarged, third longer than fourth, apical joint as long as the preceding; clypeus angulate emarginate; labrum and base of mandibles pale rufous; legs rufous or honey yellow; base of coxæ and tarsi black; wings faintly clouded, stigma and costa black.

The length of the body, including the head, is three-tenths of an inch, and the expanded wings measure double that, three-fifths or about five-eighths of an inch in length. The type locality is Dorchester, Mass. It has also been reported from Canada by Provancher and from New York City by H. G. Dyar.

This species has been reared by Doctor Dyar from larvæ taken in New York City feeding on *Rumex* sp.[b] and knotweed (*Polygonum lapathifolium*),[c] and the larvæ have been described by him under the name *Strongylogaster abnormis* Prov. (a synonym).

Quite recently Dr. James Fletcher has mentioned the occurrence of this species in Canada. During 1902 the larvæ were reported in several localities in western Ontario, as also at Ottawa, injuring apples, the damage being of so serious a nature that the fruit was much disfigured and in many instances it was rendered unfit for market and was fed to pigs. The larvæ have also been observed feeding on Rumex and Polygonum in Canada.[d]

REMEDIES.

The remedy is to prevent the growth of dock and knotweed in beet fields and apple orchards, a matter not difficult of accomplishment if the weeds are hoed out in spring before the sawflies appear for oviposition.

THE PEPPER WEEVIL.

(*Anthonomus æneotinctus* Champ.)

By C. M. Walker, *Temporary Field Agent.*

October 26, 1904, Mr. J. F. Nooe, Boerne, Tex., brought to the writer's attention specimens of sweet peppers which were infested with a species of Anthonomus. The close resemblance which this insect bears to the Mexican cotton-boll weevil has given rise to some confusion regarding the two species on the part of those interested in the growing of the affected crop.

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[a] Proc. Boston Soc. Nat. Hist., Vol. IX, p. 119.

[b] Trans. Amer. Ent. Soc., Vol. XXII, p. 311, 1895.

[c] Jour. N. Y. Ent. Soc., Vol. V, p. 199, 1897.

[d] Bul. 40, Div. Ent., U. S. Dept. Agric., p. 81 (1903); 34th Ann. Rept. Ent. Soc. Ont., 1903 [1904], p. 70; l. c. 1902 [1903]—brief mention.

DETERMINATION OF THE SPECIES.

Specimens of the pepper weevil were submitted to Mr. Schwarz, who reports as follows:

It is a species of Anthonomus hitherto not recorded from the United States, and is no doubt *A. æneotinctus*, described by Mr. G. C. Champion in the Biologia Centrali-Americana.[a] The few specimens found at San Antonio in November by Mr. Walker and myself on pepper plants agree perfectly with Champion's description. However, all the numerous specimens bred by Mr. Walker from pepper plants at Boerne, Tex., uniformly differ in having the legs throughout of a bright orange-yellow color, whereas in the more typical specimens the thighs are dark except at base. The difference, striking as it is, is most probably due to the immature condition of the Boerne specimens and the mature condition of the types. The pepper weevil, which is often confounded by farmers with the cotton-boll weevil, is much smaller and much shorter than the smallest specimens of the cotton-boll weevil. The legs are much shorter; the elytra are more convex and much less elongate than in the cotton-boll weevil; and, more especially, the front legs do not have a double tooth as in the boll weevil, but are furnished with a single, not very conspicuous tooth.

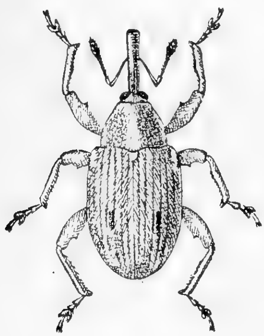

FIG. 16.—*Anthonomus æneotinctus:* weevil, much enlarged (after Hunter and Hinds).

DISTRIBUTION AND DESTRUCTIVENESS.

According to Mr. Louis Lamm, of Boerne, Tex., upon whose farm the insects occurred in large numbers, the weevil had been noticed there for two seasons, having been seen for the first time in October, 1903, and again during the summer of 1904, causing a loss of more than one-third of the crop each year. At San Antonio, Tex., a number of farms were so seriously infested during the previous season that the growing of sweet peppers as a market crop was discontinued by a number of market gardeners. Reports received at the San Antonio market show that a pepper weevil had been common for three or four years in that vicinity; there is not, however, conclusive proof that the insect referred to is identical with the species here considered, since a similar species has been reported on peppers in Texas. There exists an erroneous idea that peppers are often infested with the cotton-boll weevil, and it is possible that a confusion of these two species has given rise to some of the reports. According to present information, this species is not abundant in the State in localities other than those above mentioned.

[a] Coleoptera, IV, pt. 4, February, 1903, p. 169, Pl. X, fig. 5.

INDICATIONS OF INJURY.

The first indications of injury by the pepper weevil may be seen in the dropping of the peppers and the general unhealthy aspect of the plant and of the fruit remaining thereon. The small peppers, becoming infested immediately after the blossoms fall, drop in large numbers, so that the ground at the base of the plants becomes strewn with the decaying fruit. This condition may be taken as a tolerably certain sign of infestation. Not only is the small fruit affected, but the full-grown peppers also fall to the ground; and if one of these be opened the interior will be found either wholly or partly blackened and decayed, the seeds having been eaten into and the pulp consumed, until finally decomposition completes the work of destruction. The author of this damage may be found, in most cases, within the pepper, either in the larval or pupal stage (Pl. I), or the adult itself may be found in the pod, from which it would ultimately have escaped by cutting away a hole just large enough to allow the passage of its body (Pl. I, fig. 2, *d*). In the small fruit the occurrence of eggs or young larvæ is indicated by the presence of scars made by the weevils either for oviposition or feeding. The large fruit often appears unsightly and misshapen from this injury. The absence of blooms is another indication of the presence of this pest. Although only a small proportion of the buds are usually infested, still, as those that have been punctured fail to bloom, the lack of blossoms is undoubtedly due, to a considerable extent, to the work of this insect.

LIFE HISTORY.

As is common with other species of Anthonomus, the eggs are placed in such a position as to be invisible to the naked eye and well protected from any conditions detrimental to their future development. Eggs are laid in the very small buds of the pepper plant, in the blooms, or in the young fruit just after the blossoms fall. The intermediate and also the mature stages of the fruit offer favorable conditions for the deposition of eggs. The weevils apparently prefer, however, to oviposit in the peppers immediately after the blooms fall, observations made in the field showing that fruit affected at this stage contained a relatively larger number of eggs than did the more mature peppers.

The female, with her long snout, bores a small hole through the pod (Pl. I, fig. 1, *b*, and fig. 2, *b*) and, if necessary for the reception of the egg, excavates a cavity in the adjacent seeds of the fruit. If the pepper has already attained sufficient growth so that the seeds do not come in contact with the outer wall of the pod, the egg may be left protruding, with about one-half of its length exposed on the inner side of the pod. When oviposition occurs in small buds the egg is placed in a cavity excavated among the immature anthers.

The egg is pearly white when first deposited, but turns somewhat darker with advanced development. The form is quite regularly elliptical, tapering slightly toward the micropylar end, but varies somewhat according to the conditions of pressure encountered within the pepper. The average length is about 0.5 mm. and the width 0.3 mm. ($\frac{1}{50}$ by $\frac{1}{80}$ inch). There appear to be no characteristic markings on the outer membranes of the egg, which are soft and delicate and easily ruptured. Under normal conditions the egg hatches in from two to four days.

The newly hatched larva is about 0.5 mm. in length and has the appearance of a minute, white, legless grub. As it grows larger its color is modified by the contents of the alimentary canal.

The larva has the characteristic crescentic form common to most curculionids, with a large, light-colored head bearing darker colored mouth parts. Its growth is at first very rapid, especially during the first three days, and at the end of this time it is about three times its size when first hatched. At this stage the head is very large in proportion to the body, the latter being deeply wrinkled and covered with tubercles. At the age of 2 weeks, after undergoing at least one molt, the length averages nearly 5 mm., while the body has become much larger and stouter and the body wall more deeply wrinkled. Viewed laterally, the body tapers considerably from the middle toward the extremities. The head is of a light amber color, with conspicuous mouth parts. This stage appears to be that of the full-grown larva.

The amount of food available and the climatic changes naturally influence the growth of the larvæ, but under normal conditions the size of the same stage varies but little. This conclusion is borne out by the resulting slight variation in the size of the adults. The larvæ retain their crescent-shaped form throughout their growth, except that when about to change to the pupal condition they become somewhat flattened and the lateral swellings are more apparent.

After attaining full growth the larva transforms to a pupa within a cell (Pl. I, fig. 1, *c*) formed of dried excreta and decaying matter, and situated within the pepper pod, usually occupying the space which has been eaten away among the seeds. The cell is oval in form and varies somewhat in size, the average length being about 6 mm. Two or three cells are often present in a single pepper, and in some cases each one of the four interior compartments into which the pod is divided has nourished a larva. The location of the pupal cell appears to be a matter of no significance, as cells may be found at many different positions within the seed pod, the larvæ evidently

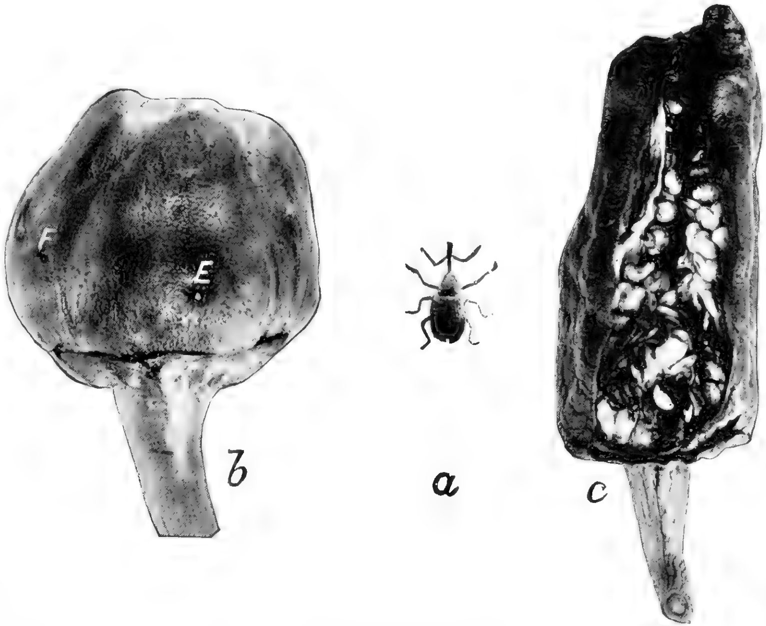

FIG. 1.—ANTHONOMUS ÆNEOTINCTUS.

a, Weevil, enlarged; *b*, short pod, showing an egg puncture (E) and a feeding puncture (F); *c*, opened pod, showing pupa in cell beneath.
[Photograph by W. E. Hinds.]

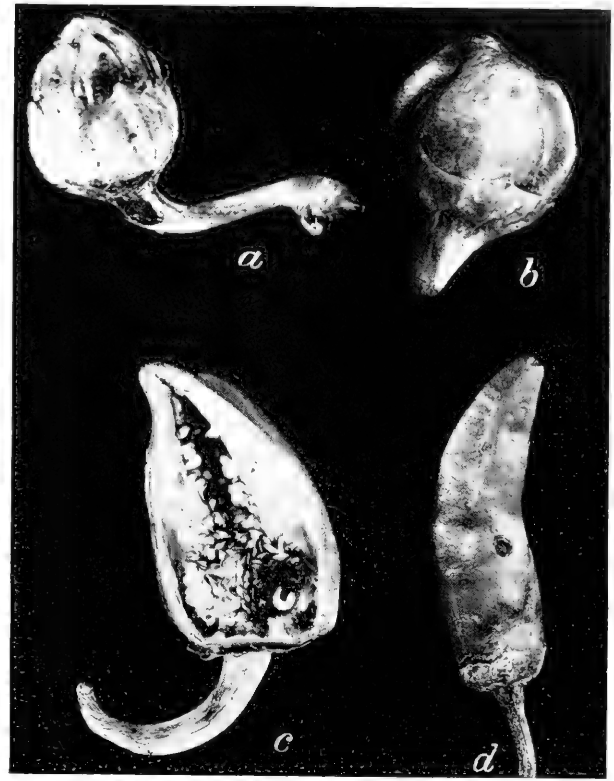

FIG. 2.—WORK OF PEPPER WEEVIL.

a, Bud of sweet pepper, showing many feeding punctures; *b*, small pod, showing one egg puncture above; *c*, section of pod, showing larva in opened cell beneath; *d*, small pod, showing exit hole of weevil.
[Photograph by W. E. Hinds.]

pupating near the portion upon which the last feeding was accomplished.

The pupa is short and robust, about 4 mm. in length, and nearly 3 mm. in breadth at its widest part. In color it is pale amber, with dark-brown eyes. The snout lies close to the ventral surface of the body. Above, the wing pads are conspicuous, and below them the legs protrude. The antennæ, arising from the snout, are folded below the head, and appear dorsally as knobbed appendages at the sides of the wing pads. The abdomen tapers to a point behind and, the outer segments being free, the tip can wriggle nervously, as it often does when the pupa is disturbed. The pupa is covered with tubercles, from each of which arises a long hair or spine. A short time before transformation to adult the color becomes much darker, the abdomen, however, retaining the original hue. The pupal stage occupies from six to ten days. Upon the full development of the adult the cell is broken open and the weevil emerges into the cavity of the pepper pod, remaining there until hardened, after which it cuts its way out through the pod wall (Pl. I, fig. 2, *d*). The color immediately upon emergence is light yellow, but in a few days this changes to a darker yellow-brown, becoming, finally, almost black, with the exception of the bases of the femora, which are orange.

FOOD AND FEEDING HABITS.

So far as is known to the writer, this insect has no other food plants than peppers; yet it is certain that it can exist upon at least three varieties of the plant, including the common "sweet pepper" and two varieties of the so-called "hot pepper." The weevil may also, perhaps, live upon a wild pepper which is common in wooded localities in southwestern Texas. The fruit of this plant, a small red berry, has an exceptionally pungent flavor and is used rather extensively in the manufacture of a variety of pepper sauce. There is a possibility that this "wild pepper" may prove to be the original food plant, but thus far the weevil has not been observed feeding upon it.

The young larva, when first hatched, feeds upon the soft, pulpy tissue forming the interior lining of the pod. This food it can obtain in abundance, since it is here, in the majority of cases, that the egg is deposited. Usually the larva does not attack the seeds until it has attained considerable growth, except in those cases in which the egg is placed in a cavity excavated for its reception in a seed. The seeds, extending out laterally in a cluster from the bases of attachment, offer secure lodgment for the larva, which eats away the outer edges and excavates the interior, thereby causing serious injury (Pl. I, fig. 2, *c*). The adult weevils appear to feed equally well in the fruit at different stages of growth, although the small, tender buds seem to be the most seriously injured (Pl. I, fig. 2, *a*). By means of the sharp mandibles at the end of the snout the weevil will bore its way through the pod, eating from the center in a circle as far as the length of the proboscis will permit, sometimes increasing the distance by forcing the head and thorax into the opening made. A number of such punctures in a tender bud or young pepper will soon cause it to fall to the ground.

REMEDIAL SUGGESTIONS.

In view of the fact that the discovery of the work of this insect was made so late in the season that no experiments in the application of insecticides or other remedial measures could be performed, it is impossible at present to describe any sure method of destruction. A few suggestions, however, may prove of value to those who are directly interested. From the knowledge already gained concerning the feeding habits of the adult insect, which are very similar to those of the Mexican cotton-boll weevil, it is evident that the use of internal or stomach poisons, such as Paris green, would not give satisfactory results. Since the area devoted to the cultivation of peppers is not, as a rule, very extensive, there is one remedial measure which may be advised with some assurance of success, i. e., the gathering and destroying of the infested fallen fruit. As a general rule the peppers found upon the ground contain larvæ, pupæ, and even adult weevils in large numbers. If the fruit thus fallen be collected and destroyed by burning, or some other equally certain method, immense numbers of the weevils will be killed and the future crop protected to a certain extent from further infestation. If the fruit is allowed to remain on the ground, however, it will furnish a favorable opportunity for the development of the immature stages within the pods, and the adult weevils emerging therefrom will at once attack the peppers which may have escaped previous injury. The expense involved in this procedure would be slight, since the work may be done by unskilled persons with a reasonable chance of success. Judging from what has been learned of the life history of the insect, it is safe to say that, beginning as early in the season as the young buds or peppers begin to drop, a collection should be made as often as every fifth or seventh day, gathering not only all fallen fruit, but also all buds and pods still on the plants showing an unhealthy color, a deformity of shape, or any other sign of having been attacked. Whether the infestation be severe or slight, the interval between the collections, if this method of control be adopted, will be the same, since the interval depends upon the developmental period and not upon the abundance of the fallen fruit. If the collection of the fallen fruit be steadily followed up, the damage done by the weevil can, in all probability, be very largely prevented.

COLD STORAGE FOR COWPEAS.[a]

By J. W. T. Duvel, *Seed Laboratory, Bureau of Plant Industry.*

INTRODUCTION.

The value of cowpeas for the improvement of the soil as well as for forage has long been recognized. In recent years the area on which cowpeas are grown has been greatly extended. With the increased acreage there has been a more widespread distribution of the weevils destructive to cowpeas. Large quantities of seed are destroyed annually in this way, entailing a great loss to seedsmen.

Carefully conducted experiments, extending over a period of nearly two years, have shown that cowpeas can be kept free from weevils if stored at a temperature of 32° to 34° F. It is understood that this method is practiced to a limited extent by a few seedsmen, who find it

Fig. 17.—*a, Bruchus obtectus; b, B. chinensis; c, B. quadrimaculatus*—all much enlarged (after Chittenden).

far more satisfactory than the methods of fumigation which have been so generally used.

WEEVILS INFESTING COWPEAS.[b]

There are three kinds of weevils which do considerable damage to cowpeas during storage—the common bean weevil (*Bruchus obtectus* Say), the cowpea weevil (*Bruchus chinensis* Linn.), and the four-spotted bean weevil (*Bruchus quadrimaculatus* Fab.). The adult beetle of each of these species is shown in figure 17, *a*, *b*, and *c*. The

[a] What is here said concerning the storage of cowpeas applies equally well to garden peas and beans, and presumably to other seeds of a similar character which are attacked by weevils.

[b] The notes on the ravages and life history of these weevils are based on Dr. F. H. Chittenden's "Insects injurious to beans and peas," Yearbook United States Department of Agriculture for 1898, pp. 233–260. Figure 17 is taken from the same paper.

first-named species is met with in cowpeas much less frequently than the last two.

The species breeding in the cowpeas which served as check samples to the series kept in cold storage were the cowpea weevil and the four-spotted bean weevil. The principal food of these two species is the cowpea, and they are found in most countries where cowpeas are grown. The first eggs are usually deposited in the field, but the greatest damage is generally done after the seed is stored. The beetles continue to develop in the dried and stored seed for several generations. Under favorable conditions, depending chiefly on the temperature, six or seven broods may develop within a year, according to Doctor Chittenden's observations. If not checked their ravages continue until the cowpeas are unfit for any practical purpose, not even serving for the sustenance of the weevils. Plate II, fig. 1, shows cowpeas which have been destroyed in this way.

CONDITIONS AND RESULTS OF EXPERIMENTS.

The experiments herein discussed were conducted with Clay cowpeas grown in Georgia in 1902. A germination test made of the bulk lot in February, 1903, showed a vitality of 83.5 per cent.

March 7, 1903, duplicate sets of twelve lots each, put up in cloth bags, were stored in "trade conditions," and in cold storage at Washington, D. C., Richmond, Va., Jacksonville, Fla., and New Orleans, La. At each of these places the "trade conditions" were represented by seed warehouses. The cold-storage samples were subjected to a temperature of 32° to 34° F. The remainder of the original bulk was kept in the seed laboratory at a temperature varying from 55° to 80° F. Samples from the entire series were tested from time to time for germination. The results of the tests are given in Table I.

TABLE I.—*Percentage of germination of cowpeas stored at various places under "trade conditions" and in cold storage on March 7, 1903, and returned from storage at various dates.*

Date of return of seeds from storage.[a]	Percentages of germination.								
	Original bulk lot kept in seed laboratory.[b]	Washington, D. C.		Richmond, Va.		Jacksonville, Fla.		New Orleans, La.	
		Trade conditions.	Cold storage.	Trade conditions.	Cold storage.	Trade conditions.	Cold storage.	Trade conditions.	Cold storage.
May 1, 1903	81	84.5	92	83.5	90.5	90.5	91.5	83	82.5
June 1, 1903	(c)	96	93.5	97.5	92.5	94.5	92	94	90
July 1, 1903	(c)	93	94.5	74.5	87	(c)	90.5	[d] 11	90
Aug. 1, 1903	(c)	[d] 68.5	92.5	(c)	87	(c)	83.5	[d] 27	88
Sept. 1, 1903	(c)	(c)	84	(c)	83.5	(c)	83.5	(c)	85
Nov. 1, 1903	(c)	(c)	96.5	(c)	94.5	(c)	97	(c)	93
June 1, 1904	(c)	(c)	87.5	(c)	70.5	(c)	85	(c)	75
Nov. 1, 1904	(c)	(c)	92	(c)	84.5	(c)	50	(c)	77

[a] The dates given are approximate only, varying slightly from actual dates of return of seeds from storage. Germination tests in all cases were made within a very few days after return of seeds from storage.

[b] The original bulk sample germinated 83.5 per cent in February, 1903.

[c] Destroyed by weevils.

[d] Many destroyed by weevils.

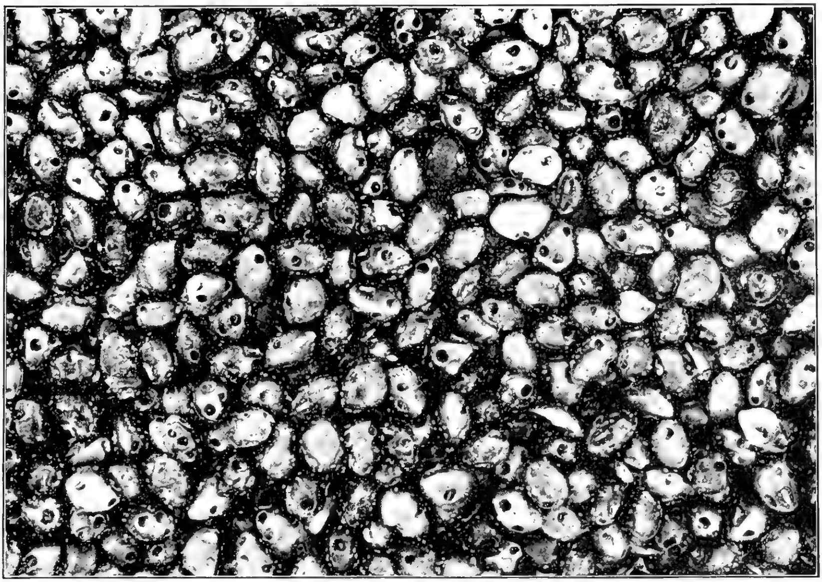

FIG. 1.—WEEVIL-EATEN COWPEAS FROM "TRADE CONDITIONS," WASHINGTON, D. C., SEPTEMBER 1, 1903—NATURAL SIZE (ORIGINAL).

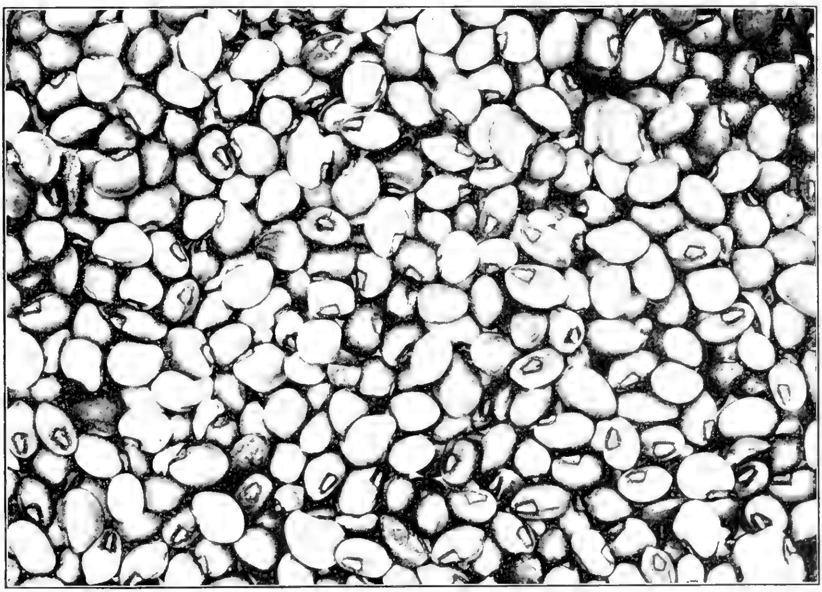

FIG. 2.—COWPEAS FROM COLD STORAGE, WASHINGTON, D. C., SEPTEMBER 1, 1903—NATURAL SIZE (ORIGINAL).

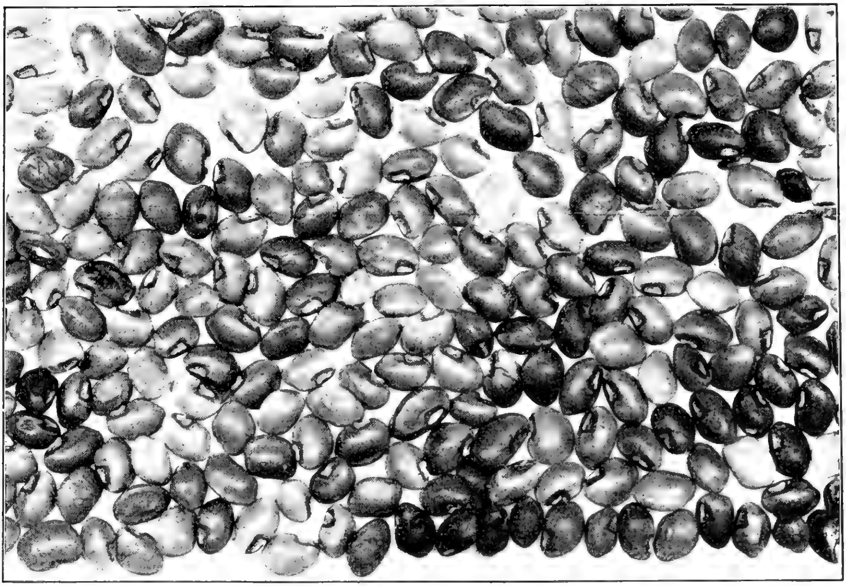

FIG. 1.—COWPEAS IN COLD STORAGE FROM MARCH 7, 1903, TO MAY 1, 1903, AFTER WHICH TIME THEY WERE STORED IN THE SEED LABORATORY (ORIGINAL).

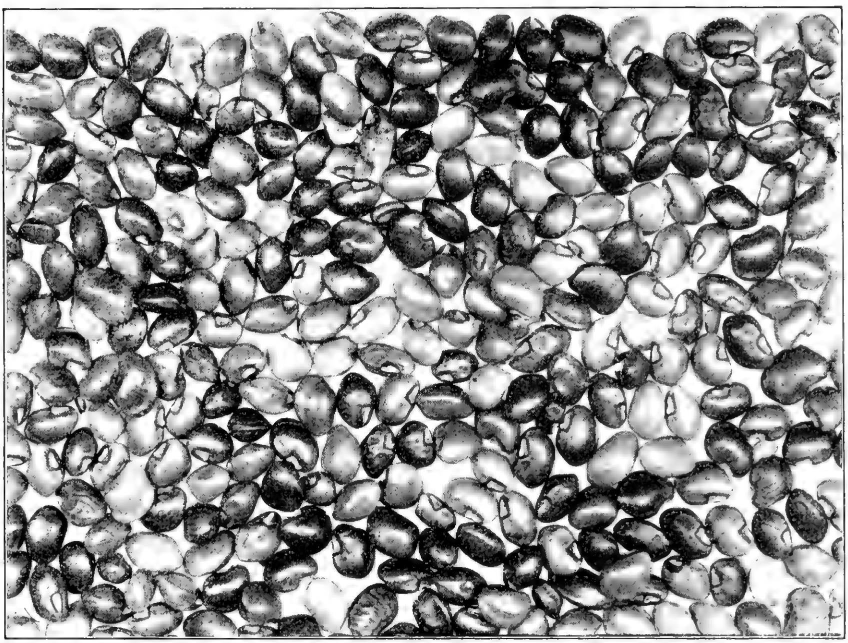

FIG. 2.—COWPEAS IN COLD STORAGE FROM MARCH 7, 1903, TO NOVEMBER 1, 1904 (ORIGINAL).

The table shows that the period of storage extends over two summers, from March 7, 1903, to November, 1904. Throughout this entire period the cowpeas kept in cold storage were not injured by weevils and showed practically no deterioration in vitality. On the other hand, the cowpeas stored in "trade conditions" were all destroyed by weevils during the first summer. The bulk lot kept in the seed laboratory, Bureau of Plant Industry, where the temperature was very favorable for the development of the weevils, was the first to be destroyed. In May, 1903, this seed germinated 81 per cent, but one month later the weevils had destroyed every seed. At this time the beetles were present in such numbers as to cause a rise in temperature within the bag of seed of 11.5° C. (20.7° F.). Samples from Jacksonville germinated 90.5 per cent in May and 94.5 per cent in June, 1903, but by the 1st of July the seed had been destroyed by weevils. The seed stored at Richmond was not all destroyed until the August test. The Washington and New Orleans series showed complete failure in the September test, but in each of these cases many seeds were destroyed at the time earlier tests were made.

The foregoing results with the cowpeas kept in "trade conditions" illustrate exactly what has been experienced by every seedsman who has attempted to carry cowpeas over the summer in his warehouse. However, where the seeds are handled in large bulk they will be destroyed much earlier in the season, as a result of the heat generated by the weevils during the transformation stage. As a result of this heat the second brood will develop much more quickly than was the case with small lots as used for these experiments. The actual commercial conditions with seed stored in quantity would be much the same as shown in the control sample stored in the seed laboratory—that is, the seed would be destroyed earlier in the season. Plate II shows cowpeas which were kept in "trade conditions" (fig. 1) and in cold storage (fig. 2) at Washington, D. C. The photographs were taken September 1, 1903, approximately six months after the seeds were stored. Figure 1 shows the weevil-eaten cowpeas, which failed to show a single germinable seed; figure 2, the cowpeas after six months in cold storage. These cowpeas had not deteriorated in vitality and germinated 84 per cent.

EFFECT OF COLD STORAGE ON THE VITALITY OF THE SEED AND THE FUTURE DEVELOPMENT OF THE WEEVILS.

The samples of seed were tested for germination as they were taken from cold storage. The remainder of each sample was then stored in tin boxes. The temperature of the laboratory where the seeds were stored was slightly higher than that of the ordinary living room

It was supposed that the weevils would develop in the cowpeas after they were taken from cold storage and subjected to a higher temperature, but in no case did the weevils ever develop, not even in the samples which were taken from cold storage May 1, 1903, less than two months from the time they were first put into the cold-storage room.

The samples from cold storage were tested again for germination March 11, 1905, two years after the beginning of the experiment. The results of the germination tests are shown in Table II, together with the approximate time the samples were in cold storage and the time they were subsequently stored in the seed laboratory.

TABLE II.—*Percentages of germination of cowpeas stored at various places at a temperature varying from 32° to 34° F. for from two to twenty months, and then in seed laboratory at a temperature varying from 60° to 80° F. for from four to twenty-two months.*[a]

Duration of storage.[b]		Percentages of germination.			
In cold storage, 32°-34° F.	In laboratory, 60°-80° F.	Washington, D. C.	Richmond, Va.	Jacksonville, Fla.	New Orleans, La.
Months.	*Months.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2	22	79.5	80	81.5	77.5
3	21	81	84.5	86.5	84.5
4	20	73.5	83	77.5	76
5	19	80.5	77	81.5	71
6	18	81	82.5	83.5	86
7	17	75	78	92	79
15	9	83.5	85	79	79
20	4	70.5	79.5	64.5	79
Average		78.06	81.21	80.75	79

[a] Seeds placed in cold storage March 7, 1903; tested March 11, 1905.
[b] Durations of storage here given are approximate only, varying slightly from actual number of days of storage.

Table II shows that the vitality of the samples remained practically uniform, regardless of the length of time they were kept in cold storage. This fact should clear up any doubts, which so many seedsmen have entertained, that seeds kept in cold storage would deteriorate very rapidly if afterwards subjected to atmospheric changes of temperature. The results, it is true, are somewhat lower than those given in Table I, and the average percentages of germination are likewise lower than the germination of the original control sample. But this must be considered as a natural deterioration, inasmuch as the peas at the time of this test were two and one-half years old. The test showing the lowest percentage of germination, No. 8, was from Jacksonville. When this sample was received it bore indications of being damaged by moisture, and the test made at that time (November 1, 1904) showed a vitality of only 50 per cent.

There was, however, a marked difference in the color of the cowpeas. The earlier samples taken from cold storage had darkened in color, while the peas fresh from the cold storage room were not discolored, save, perhaps, an occasional seed. These differences in color are shown in Plate III (figs. 1 and 2).

COST OF COLD STORAGE.

While a few seedsmen have adopted the method of keeping cowpeas in cold storage, the majority contend that it is too expensive. Those who practice the cold-storage treatment, however, find it entirely practicable and economical. Data obtained from a number of the largest and best equipped cold-storage houses in the United States show that the cost of storing a bushel of seed of this kind varies from 3.6 to 7.5 cents a month, depending chiefly upon the quantity stored. The former price is for seed stored in carload lots and the latter for quantities of 100 bushels or less. The cost of cold storage for the season, from four to seven months, ranges from 15 to 25 cents per bushel, depending upon the length of time and the quantity of seed stored. A number of the cold-storage men are already familiar with the handling of stock of this kind, and from those the lowest prices were submitted. But to pay the highest price, 25 cents per bushel for the season, is analogous to paying that price for a new stock of seed.

HOW SEED SHOULD BE STORED.

Cowpeas, when kept in cold storage, should be handled in bags, just as in the warehouse. The objection frequently raised by those who are unfamiliar with the cold-storage method is that of excessive moisture, the contention being that cold storage would necessitate special containers. This objection, however, is not a valid one, for, at a temperature of 32° to 34° F. the air can retain but a comparatively small quantity of water vapor. Furthermore, at low temperatures moisture is much less deleterious to vitality than at temperatures such as are found during the summer months in warm, moist climates, where seeds of all kinds soon lose their vitality. It is, however, desirable to keep the seed as dry as possible, and separate cold-storage rooms should be provided for stock of this character.

If the bags of seed are taken from cold storage and placed in a warm, moist room, there may be in exceptional cases a sufficient condensation of moisture to cause "sweating." But if the cold storage room has been dry and a good circulation of air is maintained between the bags for a short time after they are taken from cold storage, the temperature of the seed will soon be the same as that of the surrounding air and the danger of "sweating" will be overcome.

SUMMARY.

Cowpeas can be kept free from weevils if maintained at a temperature of from 32° to 34° F.

The vitality of the seed is in no way injured by the cold-storage treatment.

Cowpeas can be carried through the summer in cold storage at a cost ranging from 15 to 25 cents per bushel for the season.

It is not necessary that the seed be planted soon after it is taken from cold storage and subjected to atmospheric temperatures; for this is not followed by a more rapid deterioration in vitality.

The storage room should be kept as dry as possible, and the seeds handled in bags as in the warehouse.

THE LARGER CANNA LEAF-ROLLER.

(*Calpodes ethlius* Cram.)

By F. H. Chittenden.

During the past two years the leaf-rolling caterpillar of *Calpodes ethlius* Cram. has attracted considerable attention from its ravages in fields of canna in portions of South Carolina and Alabama.

In September, 1903, Mr. H. M. Simons wrote of its attacking the foliage of the canna plant in the vicinity of Myers, S. C., sending specimens in all stages except the egg, the first adult issuing September 21.

In September, 1904, a similar lot of specimens were received from Mr. L. H. Read, Fruitdale, Ala., who wrote of the difficulty of capturing the butterflies, although they were quite plentiful among the canna plants. Thousands of the caterpillars were in the fields, and hand-picking was out of the question. All bronze varieties of canna were injured, including eight or ten varieties. Among those most attacked were Mississippi, Mont Blanc, Explorateur, Crampbell, and Italia. A few green varieties were somewhat affected, but as a rule were scarcely touched, obviously owing to their thicker and tougher leaves. The caterpillar was observed at work only at night.

In 1904, also, the species was observed somewhat abundantly at Baton Rouge, La., by Mr. A. L. Quaintance, and sparingly at New Orleans, La., by Mr. E. S. G. Titus. Although only two instances of severe injury are cited, these are doubtless merely representative of many which were not reported.

This species and its injuries have been known for many years, yet no comprehensive article on it has, to our knowledge, appeared in any work on economic entomology, although the insect in its various stages was described in detail by Dr. S. H. Scudder in his Butterflies of the Eastern United States and Canada.[a] The entire appearance of the insect from the larval stage to the adult is indicative of its tropical origin, and it is still somewhat restricted to the South. There is a possibility, however, that it might gradually extend its present distribution if it could obtain a footing in greenhouses where cannas are grown.

DESCRIPTIVE.

The butterfly.—The parent of this singular leaf-roller is a butterfly belonging to the subfamily Pamphilinæ of the family Hesperiidæ, or skippers. It is one of the larger skippers, with a wing expanse of between 1 and 1¼ inches. The head is very broad, with large eyes, and the body is thick and heavy. The upper surface of the head,

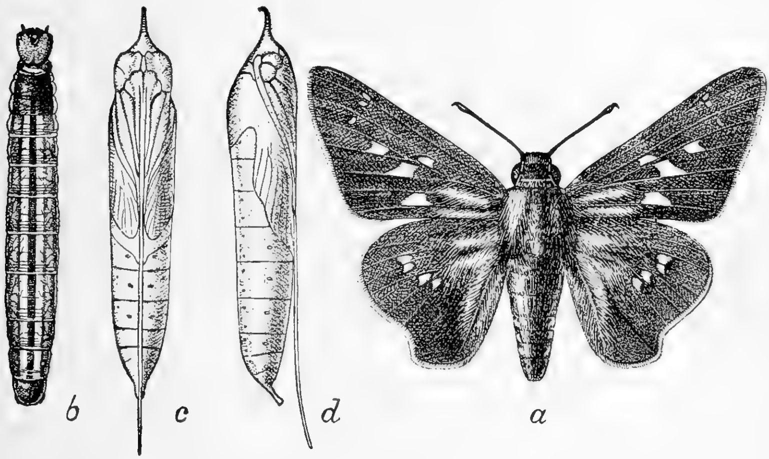

FIG. 18.—*Calpodes ethlius: a,* butterfly; *b,* larva; *c,* pupa, front view; *d,* pupa, side view—all enlarged (original).

thorax, and a portion of the abdomen is thickly covered with long olive hairs. The wings are dark brown, with white semitransparent spots, arranged as in figure 18, which also shows the location of the masses of yellowish hairs, the contour of the wings, and structure of the antennæ. The lower surface of the wings is much paler brown, or fulvous, and more nearly uniform in color. The head and body are still paler yellowish. The adult is sometimes called the Brazilian skipper.

The egg is illustrated by Scudder. It is subhemispherical in outline, as viewed from the side, and has a convex base, while the surface is very irregularly reticulated, in most cases pentagonally. The broadest diameter is 1.25 mm.; height about 0.7 mm. Eggs have not been

[a] Vol. II, pp. 1750–1757, 1889.

seen by the writer, and the color does not appear to have been designated.

The larva or caterpillar is quite remarkable because of its semi-transparency. Its surface is without hair and the general color is moderately pale green, with dark-orange subtriangular head, which is marked by a frontal subtriangular space. The thoracic segments are greenish testaceous and more or less tinged with orange, at least in preserved specimens. The remainder of the body is nearly transparent, presenting a view of the vascular and nervous system beneath the skin, as illustrated in figure 18, *b*. The length of the larva, when full grown, is about $1\frac{3}{4}$ inches.

The pupa is nearly as striking as is the larva. It is of similar pale greenish color and of the appearance shown in figure 18, *c*, *d*. The head is prolonged into a curved process, and the tongue extends in a nearly straight line considerably beyond the prolonged anal tubercle. Without the projections it is nearly as long as the larva.

DISTRIBUTION.

Scudder states that the principal range of this species is from Central America to the northern parts of the South American Continent, although it inhabits, also, the extreme Southern States of our Union. So far as can be learned it is still known only from the Gulf States, South Carolina, and Porto Rico in our domains. It also inhabits Cuba and Jamaica, however, and in South America occurs as far south as Argentina, where it was years ago reported to be common by Burmeister.

ACCOUNTS OF INJURY.

In the records of the Bureau of Entomology we have accounts of injuries and of other observations on this species, as follows: June 7, 1880, we received from Dr. J. H. Mellichamp, Bluffton, S. C., a report that the larva had utterly destroyed some luxuriant plants of *Canna flaccida* in his garden. August 9, 1887, we received from Mr. A. L. Townsend, Bay Ridge, Long Island, report that the species did much damage to French cannas and *Caladium esculentum*. In our rearing cages the butterflies hatched June 12 and August 26.

The caterpillars appear to affect only plants of the genus Canna, when they are obtainable, and sometimes they are so abundant as to do much damage, at times utterly destroying luxuriant plants. Dr. H. G. Dyar mentions a case where the larvæ were eating the leaves of canna planted in the grounds of a hotel at Miami, Fla., considerably injuring the appearance of the plants.

LIFE HISTORY AND HABITS.

Eggs are laid singly and separately, sometimes in groups of from 5 to 7, on the under surface of leaves. According to Miss Helen King[a] they hatch in Texas in six days, while in Florida, according to Wittfeld, they may hatch in four days.

On hatching, the caterpillar, as is common with many species, devours a portion of its eggshell, whereupon, after feeding lightly on a leaf, it folds the latter over and confines it in place with a few stitches of silk, enlarging its retreat as it develops. From the tubular case thus formed it feeds along the edges and retreats within when disturbed. It is careful to eject all excreta and exuviæ, but in spite of its cleanliness the caterpillar is frequently attacked by disease.

A good account is given by Miss King in the article above noted, which is largely republished in Scudder's work. Doctor Dyar has ascertained that there are customarily five stages of this larva, and describes them fully in Entomological News.[b] The larva, when full grown, develops to a pupa in its resting place, "held by a transverse loop and a band of silk for the cremaster." "The cremasterial band is attached at one end to the leaf; at the other to the transverse thread." This accurately describes the pupal case as observed in specimens received at this office. Under other conditions this case might be different, as described by Mr. Charles R. Dodge.[c]

According to data accumulated by Scudder, the butterfly is on the wing in southern Florida in May, and from eggs laid in the middle of the month the butterflies reappear in the first half of June. In South Carolina the season is a little later, and there mature caterpillars have been observed before the middle of June and fresh butterflies from the 12th of the month to the end. Scudder concludes that there are two generations before midsummer. Judging by recent experience there are likely to be two more generations before cold weather, but we do not know how the winter is passed. The moths from one of these generations appear in the latter part of September.

Of the butterfly Angus has stated that he was attracted to an individual, which he captured near New York City, "by the peculiarity of its movements on the wing; they were very undulating, like those of gnats, as they rose and fell almost perpendicularly and in a very easy manner." Wittfeld adds that one of the favorite times for flight of the butterfly in fair weather is after sundown. Miss Helen King describes its motion as "very rapid."

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[a] Psyche, Vol. III, pp. 322–324, 1882.
[b] Pages 163–165, 1898.
[c] Rural Carolinian, Vol. III, p. 593.

REMEDIES.

The large holes made by this leaf-roller in the leaves of canna and the rolled-up leaves, together with the excrement, which will be found below the affected leaves, will serve to indicate its presence, and its large size permits the control of the insect by hand-picking. Any of the arsenicals will kill it, but their use is not always desirable because of the presence of children in the vicinity and the fear of their being poisoned. An ordinary spraying with an arsenical, preferably arsenate of lead combined with Bordeaux mixture, could, however, be made without any real danger of poisoning. After an arsenical has been used, Bordeaux mixture should be tried alone as a repellent.

THE POND-LILY LEAF-BEETLE.

(*Galerucella nymphææ* Linn.)

By F. H. Chittenden.

During the first week of August, 1904, this leaf-beetle became so abundant in the District of Columbia that it deserted its natural food plants—aquatic species of the genera Nymphæa, Sagittaria, Brasenia, and Nuphar—and attacked near-by plants of other botanical families not at all related to those which form its normal food. Mr. George B. Sudworth, of the Bureau of Forestry, reported the species on basket willow, remarking that it appeared capable of doing considerable damage to this plant. Mr. Sedgwick N. Lander reported injury to beans. In both cases numerous living specimens of the beetles were furnished. August 4 Mr. J. L. Reeves visited Mr. Lander's place, and with little effort obtained a thousand or more of the beetles by sweeping the infested plants. In confinement the beetles fed for several weeks on the leaves of both willow and bean, gnawing minute holes from the epidermis of the upper surface, thereby producing the effect of fine network.

This species is evidently of foreign origin and is now common to both continents, and its semiaquatic habits are familiar to most collectors. The writer has in mind another report, made August 3, 1899, by Mr. R. Balluff, of injury to a native pond lily (*Nymphæa* sp.) growing on the grounds of the Executive Mansion at Washington. As this leaf-beetle does not appear to have been mentioned hitherto in any publications of this Department, a short account may be interesting.

The species has frequently received mention under the name *Galeruca sagittariæ* Gyll. It is related to the common cucumber beetles, belonging to the same tribe, the Galerucinæ, of the Chrysomelidæ or leaf-beetles. The beetle (fig. 19) measures about one-fourth of an inch in length, and may be distinguished from other species in our fauna by a number of characters, among which are its perfectly smooth thorax, pale elytral margin, acute sutural angles, and completely separated middle coxæ, this separation being due to a prolongation of the mesosternum meeting the metasternum. The thorax is dull yellow, with three piceous spots, and the elytra are darker brown, somewhat coarsely and densely punctate.

This insect occurs abundantly throughout northern Europe and Siberia, and in the northern portion of our own continent from the Hudson Bay region southward to the District of Columbia and Virginia. It is recorded also from Texas, California, and Oregon, but does not seem to have been recognized in neighboring States. It seems probable that it was introduced many years ago from the Eastern Hemisphere.

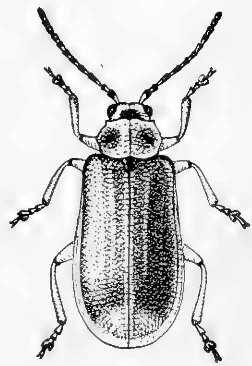

FIG. 19.—*Galerucella nymphææ*, about six times enlarged (original).

An account of the earlier stages of this species, with notes on its habits and illustration of larva, pupa, and adult, were given as early as 1775 by Baron De Geer.[a] Later writers have also described the earlier stages, the list including Bargagli, Gadeau, Weise, and Quilter.[b] The description by the last-mentioned author, in the writer's opinion, can only be doubtfully referred to this species. He states that the larvæ occur on *Polygonum amphibium* in England, concludes that the parent deposits eggs at the root of its food plant, and that the larvæ are consequently aquatic, coming up out of the water to pupate on leaves and stalks of aquatic plants. He also describes the beetles as turning black in two or three hours after transformation, which is not true of this species.

Of the earlier stages in America, the late F. G. Schaupp described the larva in 1883, briefly characterizing the eggs and pupa.[c] More detailed descriptions have been furnished by A. D. MacGillivray.[d] The eggs are ovate, shining yellow, and are laid in small patches of from 6 to 20 on the upper surface of the leaf. Larvæ, pupæ, and beetles in all stages of growth were observed near New York City in July. The larva is bluish-black above, and yellow on the

[a] Memoires pour servir a L'histoire des Insectes, Vol. V, pp. 326–329, Pl. 10, figs. 1–6.

[b] The Entomologist, Vol. XX, pp. 178–181, 1887.

[c] Bul. Brooklyn Ent. Soc., Vol. VI, p. 54.

[d] Bul. 68, N. Y. State Mus., 1903, pp. 325, 326.

under surface, of elongate form, when full grown measuring three-eighths of an inch in length; widest at the middle, and tapering toward either extremity. Many larvæ are frequently found together on a single leaf, where they eat the upper surface, doubtless because the lower surface of the leaves of the natural food plants rest on the water. As a result of these attacks the leaves become brown and unsightly. The white lily is less affected than yellow lilies.

As to remedies, the arsenicals are quite effective, and Paris green is reported by Mr. Sudworth as checking the ravages of the beetles on willow. When spraying bean plants, arsenate of lead is preferable, owing to the danger of scalding the more tender leaves if Paris green is used. When this species occurs in troublesome numbers on aquatic plants it might readily be destroyed in all stages, and especially as larva, if the ponds, fountains, or other places in which the lilies are growing could be flooded so as to bring the insects to the surface. A few drops of kerosene spilled on the water would then destroy the floating insects.

GRASSHOPPER CONDITIONS IN NEBRASKA, NORTHEASTERN COLORADO, WYOMING, MONTANA, AND WESTERN KANSAS DURING THE SUMMER OF 1904.

By Lawrence Bruner, *Temporary Field Agent.*

In compliance with instructions received last July, the writer spent the greater portion of the month of August in endeavoring to ascertain the existing status of the grasshopper, or locust plague, throughout the region lying to the east of the main divide of the Rocky Mountains and west of the Missouri River. In order to accomplish this work in a satisfactory manner several journeys were undertaken over the various lines of railroads located in the region under investigation. The officers of all of these roads cooperated in the work by kindly providing all transportation necessary for visiting the various localities known to have been infested by these insects during recent years.

In order to ascertain more clearly the conditions in Colorado, the entomologist of the State Agricultural College, Prof. C. P. Gillette was consulted. Visits were also made to the Agricultural College of Montana and to the State University of Wyoming, where important data bearing on the subject under investigation were obtained. Some additional records of grasshopper abundance were gathered from the daily press reports, while data bearing on the presence of locusts in other localities not visited were gleaned from various persons.

By carefully arranging and studying all the information accumulated it would seem that the general status of the locust pest, over the region embraced in these studies, is greatly improving. Practically everywhere these insects are rapidly decreasing and getting down to their normal numbers or even below the normal. Of course, the causes for this decrease are various, being somewhat different in each locality affected. These causes were given and discussed to some extent in my report at the close of the season's work during the summer of 1901.[a]

August 2, 1904, the writer left Lincoln for the purpose of visiting southwestern Nebraska and eastern Colorado, taking a daylight train. A careful outlook was kept from the car windows for signs of locust injuries or the presence of these insects in more than ordinary numbers. Not until after leaving Oxford, however, were such indications observed. But from a few miles west of that place all the way to McCook it was clearly indicated, both by the presence of the insects on weeds along the right of way and by more or less damage to the outer rows of corn growing near alfalfa and small grain, as well as by deserted and weedy fields. Each of these conditions was occasionally quite apparent, even from the moving train, and increased westward. The species of locusts most concerned in these ravages were two: *Melanoplus differentialis* Thos. and *M. bivittatus* Say. These two forms habitually frequent low ground and other areas overgrown with rank vegetation.

The morning of August 3 was spent in the vicinity of McCook. Here it was found that several additional species of locusts, like *M. femur-rubrum* DeG. and *M. atlanis* Riley, were quite numerous, both in alfalfa fields and on the prairies. The deserted fields which had grown up to rank weeds were the homes of still other species, of which *Æoloplus regalis* Scudder and *Melanoplus lakinus* Scudder were the chief forms. These latter were quite partial to Russian thistle and lambs-quarters as food plants. *Hesperotettix speciosus* Scudder, which is a feeder on Helianthus, was very common, while several of the grass-infesting species were present in numbers above the normal as observed during ordinary years. These latter, however, were concentrated at places where the grasses still showed green, and possibly, on account of this bunching, their abnormal abundance may have been only seeming. It might be well to state that this particular region was suffering greatly from drought, a fact which undoubtedly had much to do in causing the more than ordinary locust injury.

Leaving McCook, the writer had an opportunity of seeing the conditions along the Republican Valley almost to the southwestern corner of the State. Just beyond the junction of the Frenchman and the Republican rivers it was noted that the drought conditions were less severe, and vegetation improved as we progressed west-

[a] See Bul. 38, n. s., Divison of Entomology, U. S. Dept. Agr., pp. 39–49, 1904.

ward. Some species of locusts and a few signs of their injuries were still occasionally apparent, even as far as Haigler, Nebr. Here a halt of over a day was made. A comparison of the conditions as found here this year with those of a year ago showed a great improvement. Possibly only half as many of the insects were present this year as last, and these were pretty well bunched in certain weed patches and alfalfa fields located in the valley near the river, whereas last year they were quite generally distributed. Beyond Haigler but few locusts were found in hurtful numbers, indicating that this locality is almost on the western boundary line of the plague. From Wray, Colo., all the way to Denver, their numbers seemed to have dwindled to normal, or even below. At least, such appeared to be the condition along the line of the Burlington Railway. In fact, as nearly as I was able to ascertain, this condition prevails throughout most of Colorado east of the Rocky Mountains, save perhaps in two or three isolated localities in the valleys of the Arkansas and South Platte rivers near the State line. The diminution in their numbers appears to be due chiefly to fungous diseases and natural enemies, both of which seem to have been abnormally effective during the past two or three years.

All of the region lying along the eastern base of the range between Denver and Fort Collins was at this time remarkably free from these insects. None whatever were seen while riding between the two cities named, although a careful watch was kept throughout the journey, and an inquiry at the agricultural college located at the latter place elicited the information that hoppers were scarce in Colorado, while few or no reports had been received the present season concerning their presence or ravages.

Going east from Fort Collins, a few of the insects, it was learned, were to be found in and about alfalfa fields in the vicinity of Greeley. Northward from Greeley to Cheyenne, Wyo., no species of grasshoppers were seen in abnormal numbers. Nor were they found to be present along the Union Pacific Railroad between Cheyenne and Laramie in sufficient numbers to be noticeable. At Laramie few individuals of any species were to be seen, although several trips were made for the special purpose of obtaining specimens. Professor Buffum, director of the experiment station, who does the entomological work in that State, also informed me that, so far as he knew, similar conditions prevailed over much of the State of Wyoming.

Leaving Laramie and proceeding eastward over the Union Pacific Railway, no grasshopper signs were visible at any point between Cheyenne and North Platte. It was ascertained by inquiry that although considerable injury had been done by locusts for several years, and even as recently as the year 1903, they appeared to have dwindled to such an extent that this year they were not present in numbers above normal. Then, too, the person in charge of the branch of the Nebraska Experiment Station located near that place reported like conditions. As the train approached Gothenburg, and from that point as far eastward as Kearney, some signs of local abundance and slight injury by two or three species were apparent. Now and then corn fields and weed patches adjoining alfalfa fields showed their ravages. In two instances magnificent examples of the usefulness of birds as locust destroyers were noted. In both cases the birds in question were gulls, possibly Franklin's or the laughing gull. These birds were present in flocks of fifty or more and were congregated on alfalfa fields which showed decided marks of locust injuries; and it was plainly evident from their actions that the birds were feeding, since some of them were on the ground and others in the air. One of these flocks was near Gothenburg and the other not far from Kearney. Some days afterwards a gentleman from the latter place told me of a similar sight that he himself had witnessed. It is probable that these birds were nesting on the artificial lakes made by damming up the mouths of ravines in connection with irrigation and power ditches in the vicinity, and were occupied in foraging.

There appeared to be no locust injuries along the Platte Valley much lower down stream than Kearney, although it was followed as far as Grand Island, where a change was made to the Burlington road so as to reach Lincoln via Aurora and York.

Leaving home again on August 10, and going by way of the Chicago and Northwestern Railroad up the Elkhorn, the writer did not observe hoppers in hurtful numbers east of Chadron and Crawford on the Little White River. Even here a comparison with conditions as observed by the writer a year ago showed the pest to be largely on the decline. Scarcely any traces of injury were visible even about the edges of cornfields adjoining alfalfa and weed patches—the localities most commonly frequented by the species of locusts most abundant here. The journey was continued westward as far as Casper, Wyo., where in 1901 considerable grasshopper injury occurred, as observed by the writer during a visit made at the time. A trip into the country a few miles from Casper showed but few locusts. Even the usually abundant prairie or plains forms were below the normal in numbers, and in some places decidedly scarce. Inquiries among ranchmen elicited the information that the pest was gradually becoming scarcer throughout the alfalfa growing district to the southeast of the town, where some marked damage had been done by the insects as late as a year ago. Returning to Crawford, Nebr., a stop was made in order to observe conditions away from the town and railroad. The result was as stated for Casper. From here the writer returned to Lincoln over the Billings and Black Hills branch of the Burlington, but no locust depredations were encountered or reported en route.

Learning that several good rains had fallen since his former visit to the upper Republican Valley, the writer, on August 17 and 18, made a second trip to southwestern Nebraska. At this time vegetation was greatly improved in appearance and the hoppers were somewhat scattered as compared with two weeks before.

The last trip of the month was made to northern Wyoming and portions of Montana, where last year considerable locust injury occurred both in cultivated districts and on the ranges. While locusts were this year normally abundant in the valley of the Yellowstone River from a short distance above Billings nearly to Livingston, their work was only occasionally perceptible from the car windows. In this particular district the reports of greatest injury came from Red Lodge and vicinity, not far from the Wyoming line. Here the species concerned were chiefly *Aulocara elliotti* Thom., *A. femoratum* Scudd., and several other plains-inhabiting species like *Melanoplus infantilis* Scudd., *M. occidentalis* Thom., *M. packardii* Scudd., *Cordillacris occipitalis* Thom., and *Mestobregma kiowa* Thom. Besides being infested with abnormal numbers of these insects, the region in question, as well as much of the adjoining territory, was badly affected by drought. These two causes combined to render the grazing exceedingly poor. Considering the dwindling in numbers from last year to the present time it seems that the pest is quite certainly on the decrease, even in the district of greatest abundance.

August 23 to 25, inclusive, a drive was taken through the Gallatin valleys in company with President Reed and Professor Cooley of the Montana Agricultural College. No locust injuries of importance were found, but in certain areas several species were present in numbers most certainly above normal for the district. There were two species of Melanoplus, a form of *atlanis* and an undetermined species, and *Camnula pellucida* Scudd. Last year a much more extended district was overrun. *Encoptolophus sordidus* Burm., which was abundant in 1903, was rare this year.

A visit to Helena and the immediately adjoining regions showed the various local species of locusts to be much below the normal in abundance as compared with former years.

While no work was done in western Kansas and southeastern Colorado, it was learned through others that some locust damage occurred in the vicinity of Garden City, Kans., among the alfalfa fields, but efforts at remedying the evil were being made. Machines were in use, poisoning with the bran-arsenic mixture was regularly carried on, and large flocks of turkeys were being employed to rid the fields of the pest.

NOTES ON THE BEHAVIOR OF THE COLORADO POTATO BEETLE IN GREAT BRITAIN.

(*Leptinotarsa* [*Doryphora*] *decemlineata* Say).

By Fred. V. Theobald.

Wye Court, *Wye, England.*

The advent of the Colorado potato beetle into Great Britain in 1901 gave rise to grave apprehensions, which, judging from its behavior during its stay on our shores, were certainly not unfounded. For once the country was prepared to deal drastically with this unwelcome intruder, for a bill had been passed by both Houses of Parliament in 1877 by means of which the existing board of agriculture has power to take over land infested with the Colorado potato beetle so as to insure its eradication. The necessity of this measure was amply shown during 1901 and 1902 when the "spearman"[a] was present in this country.

The few notes I made on the general behavior of this beetle during its stay with us may not be unwelcome to those in whose land it flourishes, and of interest to others into whose country it may any day be imported. I believe the British invasion is only the third that has occurred in Europe, the two previous outbreaks having occurred in Germany some years ago.

The beetle was reported to the officials at the board of agriculture in August, 1901, as being present in some allotments in Tilbury Dockyard. On the 22d of that month I visited the dockyard and found the beetles very active and full of generative vitality. They were not numerous, some two dozen or more only being observed, but many more had evidently been at work and some had been collected and killed. At this time they were depositing eggs, and I found larvæ in all stages of development. At a glance one could see that the beetles had been at work some time; probably the colony had been there some months before it was detected. The potatoes were noticeably defoliated, but mainly, it seemed, by the larvæ and not by the adults. The beetles did not seem to take wing, but were most active, crawling about in the bright sunshine. I never saw one take wing in the open, but those I brought away for further observation became most active in the breeding cages, frequently using their rosy wings and dashing up against the glass of the cages. Later I noticed them in my garden taking short flights under their muslin tents.

The land where this colony had taken up its abode was treated in

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[a] A name sometimes given to the Colorado potato beetle, based on the old generic term Doryphora.

a very drastic manner by the board of agriculture's officials, but as we shall see, without clearing the land completely of this serious pest. The potato haulm [a] was cleared and fired with paraffin and the ground heavily coated with gas lime and later plowed up. The land was also soaked with paraffin, and gas lime was put on at the rate of 60 tons per acre. I may here mention that one of the inspectors of the board of agriculture and myself found that the beetles could live in a tin of gas lime unharmed; one would not, therefore, expect this unknown quantity to be effective against the adults, although its caustic properties should destroy larvæ and pupæ. It does not do so, however, for reasons which I shall point out.

The land and the neighboring plats of potatoes and the district for some 3 miles around were examined later and no further specimens were found. I went to Tilbury again on September 17, 1901, and could find no trace of beetles, larvæ, or eggs around the invaded area. I brought some twenty beetles and larvæ away with me on the first visit and kept these in confinement in breeding cages under safe guardianship in my garden. The larvæ all became mature by September 23. In very few cases did I notice the beetles feeding, but the larvæ, especially in their closing stages, were most ravenous. Besides potato, I fed some on tomato and found they did not thrive so well, others on deadly nightshade (*Atropa belladonna*) and on sow thistle (*Sonchus oleraceus*), on both of which they flourished admirably. Some eggs were found on the sow thistle at Tilbury; hence I tried it as a food plant. Soon after bringing the specimens home I found that the adults readily buried themselves in the earth when the weather was dull and cool. Several adults which I took in August lived until the following spring, a few died, and others deposited eggs. The eggs found at Tilbury varied greatly in color according to age, some being yellow, others deep orange. They varied in number in the last batch from 9 up to 40. The beetles, it seemed, did not mind whether they laid the eggs on the upper or under sides of the leaves. Those laid in my garden were nearly all on the upper surface, while those at Tilbury were mostly seen on the under surface.

The egg stage lasted with us ten days, and in one case seventeen, the larval stage from three to five weeks, and the pupal stage from seven to ten days in summer. One larva lived seven weeks and then died. A few larvæ existed for two weeks without any food and eventually transformed to adults after being fed.

To my surprise, one warm day in November, some dozen beetles came out of the ground and remained on the surface in a sluggish condition, but before nightfall they had buried themselves again. I dug up the ground in January and found they were all lying about

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[a] Dry stalks, stubble.—Ed.

6 inches down in the soil. Although the land was lumpy, they had gone into the solid soil and did not shelter under the clods or stones. Certainly all those I kept passed the winter in the adult condition.

In my laboratory they came out of their winter quarters in March, but in the open not until April 17, and the last on May 4. Some early potatoes had been planted with them and they commenced egg laying on May 20. All these check specimens were then killed. One could tell at a glance from their dingy color that they were hibernating, and as none had appeared to my knowledge by that date at Tilbury it was hoped the measures taken by the board had been sufficient. On the contrary, the beetles had survived the rough usage, and fresh specimens were reported at the end of May on the same land. I went there on June 2 for the board and found the beetles emerging from the ground in small numbers, and was at once struck by the difference in appearance between them and those I had so recently killed at home. One could easily see that they were only just hatched, the elytra being soft and almost cream colored between the dark lines. One of the inspectors noticed them emerging from the ground that had been treated in the previous autumn with gas lime and paraffin.

There is not the least doubt that these specimens had just hatched from pupæ. As is well known, the pupæ, especially in light, friable soil like that at Tilbury, are found at a great depth, so that in this case neither the gas lime, paraffin, nor plowing had affected them. The land was only plowed to a depth of 10 inches and many larvæ may well have previously burrowed deeper than that and so have escaped harm.

We thus had the insect living in two ways with us during the winter, namely, as adults and as pupæ. The latter is, I believe, exceptional in America, although my friend, Doctor Howard, tells me it has been observed by Professor Smith.

Very few specimens were found in 1902 and these were dealt with by constant hand picking. During the last two years none have been seen at Tilbury, so that we may safely say that the energies of the officials in charge have been rewarded with success.

Another scare occurred in 1904, live specimens being taken to the Hereford Museum, but these had been brought over by a lady from the United States as curios, little knowing the penalty attaching to the introduction of the live insects into this country.

I think we may safely say that *Leptinotarsa decemlineata* does not now exist in this country, but that it can flourish to a remarkable degree has become a well-established fact.

One point of interest I may mention in conclusion—namely, that it soon found an enemy in Britain in the form of the larval seven-spotted ladybird (*Coccinella 7-punctata* Linn.). These larvæ are normally aphis feeders, but I found quite a number at Tilbury, which were observed in several instances feeding on the Colorado potato beetle's eggs, devouring them most greedily; and I can not help thinking that they did much of the work in getting rid of the enemy. The eggs of this ladybird were deposited on the potatoes and were sent in, in many instances, as Colorado potato beetle eggs. They certainly present a general rough likeness, but can at once be told by their smaller size and paler yellow hue. The pupæ of this beneficial insect also bear a slight resemblance to those of the potato "bug" and have frequently been sent in as such. They are very much smaller in size, however, and could not be mistaken by an expert.

AN EXPERIENCE WITH HYDROCYANIC-ACID GAS AS A REMEDY FOR THE CIGARETTE BEETLE IN DWELLINGS.

By F. H. Chittenden and F. C. Pratt.

During the first week of September, 1904, two persons residing in the northeast section of Washington, D. C., complained of injury to furniture, rugs, and tapestry in their dwelling houses, submitting specimens of the larva and adult of the cigarette beetle (*Lasioderma serricorne* Fab.) as the cause of their troubles. The first householder was very fearful lest the insects would spread from the only room infested to others, including one containing a valuable library; and the other, a lady, was in an exceedingly nervous condition, brought about through her ineffectual struggles to evict the "bugs" from her domicile. Gasoline, benzine, "black flag," and various other insecticides, including formaldehyde, had been used without avail, as had also red pepper. The insects were believed, and with reason, to have fed and multiplied on the last-mentioned substance.

As no experiments had hitherto been made with the hydrocyanic-acid gas treatment for this insect, experiments were instituted in the second house. A visit to this house showed injury plainly visible on the upholstered furniture, and the edges of a carpet were frayed. Numbers of beetles and their larvæ were observed, the last in cells preparatory to pupation.

Experiment No. 1.—The gas was used at the usual strength—1 ounce of cyanide of potash to 100 cubic feet of space, the doors and windows being quite securely closed. The exposure was seventeen hours. Upon aerating the following morning many beetles were found apparently dead on the floor and were swept up and kept in a box to ascertain if they might revive. All died, however, and the result was looked upon as satisfactory.

Experiment No. 2.—About two weeks later more adults were noticed about the house, and as they continued to accumulate notice was given to this office, and a stronger test was recommended, three times the usual strength—that is, 3 ounces of cyanide of potash to 100 cubic feet of space—and a longer exposure. This was applied September 28, and renewal was made the following day, twenty-three hours later, arrangements having been made so that jars containing fresh acid could be introduced and charged with cyanide through a window. The second exposure lasted nineteen hours, or practically forty-two hours in all.

Prior to experiment it was ascertained that the insects had been breeding in the lower covering of the chairs. Dozens of larvæ were found between the covering and the webbing which was nailed across the latter.

After airing the infested room hundreds of larvæ were observed that had fallen from the lower covering of chairs (which had previously been ripped off to facilitate the effect of the gas) to the floor, and all adults observed were dead, as were also house flies. Some of the larvæ and beetles which had been subjected to treatment were placed in a vial to determine the effect of the experiment. They all died, but considerably later it was found necessary to dispose of the chairs, as they were still infested.

Owing to the failure of our first experiment with hydrocyanic-acid gas against the cigarette beetle, as also of another experiment on the confused flour beetle (*Tribolium confusum* Duv.), it was suspected that something might be wrong with the ingredients, and accordingly a sample of cyanide of potash was selected at random and submitted to Mr. J. K. Haywood, of the Bureau of Chemistry, for analysis. He reported that it contained 37.18 per cent cyanogen, 9.57 per cent chlorine, and the remainder a mixture of potassium and sodium, the analysis showing that this sample was not the product paid for; in other words, not 98 per cent potassium cyanide, but a mixture of potassium cyanide, sodium cyanide, and sodium chloride. The three compounds were present in such proportions that the mixture yielded 93 per cent of the amount of hydrocyanic-acid gas it should yield if the sample were pure potassium cyanide, and yet the amount of cyanogen which might be produced by this mixture could be 53 per cent, whereas in pure potassium cyanide it is 40 per cent.

In the second test against this species the potassium cyanide was used three times as strong as in the first. In the meantime, a sample was being analyzed by Mr. J. K. Haywood. His results were as follows:

	Per cent.
Potassium cyanide	51.70
Sodium cyanide	2.07
Sodium chloride	3.89
Potassium carbonate	39.28
Other impurities	2.76
Moisture	0.30

This analysis showed that the sample on treatment with sulphuric acid yielded only 54.50 per cent of the amount of hydrocyanic acid demanded by theory for pure potassium cyanide. An examination of the residue from the sample after treatment with sulphuric acid was also made, and it was found that the blue color of this residue appeared to be due to Prussian blue (ferric ferrocyanide), a compound left in the mixture by a faulty method of manufacture.

Mr. Haywood also made an examination of two samples of flour which had been treated with hydrocyanic-acid gas October 11 for *Tribolium confusum*, with the result that no traces of the acid were to be found in either sample, showing that the flour is not affected in any way by this method of fumigation.

NOTES ON FULLER'S ROSE BEETLE IN 1904.

By Fdk. Maskew, *Long Beach, Cal.*

The following notes are compiled from observations on Fuller's rose beetle (*Aramigus fulleri* Horn) made by the writer during the season of 1904 in Los Angeles County, Cal.

Throughout the month of May larvæ of all sizes were abundant in the infested berry fields, both in the strawberry plants and in the surrounding soil. The greatest depth at which larvæ were found in the strawberry fields approximated 5 inches. In the case of blackberry and logan berry they were found attacking the roots at a depth of from 15 to 18 inches.

May 23, in the soil surrounding a strawberry plant, the first pupa was found. This plant, while wilted, was still green, and contained no grubs in the borings in the stem. The writer was unable to estimate the depth at which the pupa was found, since it came up in a trowel full of loose soil.

June 17 the first beetle was noticed. It was feeding on the foliage of an ornamental shrub, *Lagunaria pattersonii*. During this month beetles became numerous.

July 29 the writer was asked by a local nurseryman what was the matter with a large potted ornamental asparagus (*Asparagus plumosus nanus*). The plant presented a very sickly appearance, the stems being hard and dry, and the foliage yellow. Finding no evidence of scale insects or mealy bugs, the roots were investigated, with the result that 84 larvæ and pupæ of Fuller's rose beetle were found in the soil and upon the roots contained in the 10-inch pot. The pot and plant had been suspended from the rafter of a lath house and had not been disturbed for eleven months.

August 19 a beetle was observed in the act of ovipositing. The eggs, 26 in number, were laid in an irregular mass upon the upper surface of the foliage of a crested wattle (*Albizzia lophantha*), a potted plant. The foliage was about 5 feet above the ground, and above the egg mass it was drawn together and fastened by a webby substance. These eggs, placed in a phial and carried in the pocket, hatched August 24. Many egg masses were subsequently found and hatched out.

The beetles were very numerous and destructive during the months of August and September on ornamental trees and plants in the nursery yards, no plants except different species of Auricarias being exempt from attack. They appeared to eat the foliage of the castor bean with as much gusto as that of the Lima bean, and the pungent flavor of the young growth of the camphor, pepper, and the different eucalypti apparently suited their palates equally as well as the succulent young growth of canna. They were repeatedly taken at work on these plants. The foliage of all species of acacia for sale here is greedily eaten, excepting perhaps *A. cultriformis* and *A. armata*, and the writer has seen the market value—$2.50—of potted camellias and *Sterculia acerifolia* destroyed by these pests in twenty-four hours.

While at Oceanside, San Diego County, September 9, the writer noticed, in the orchard of the Rev. Mr. Dodd, a large number of insect castings on the foliage. While searching for the cause, an immature and apparently sound apple dropped to the ground. An examination showed that its stem had been freshly severed by some insect. Mr. Dodd, on having his attention called to this, stated that he had found a brown beetle eating the stems, and upon investigation the writer traced the injury to Fuller's rose beetle, the culprit being found at work in several instances. Time was very limited here and no opportunity was offered of studying this interesting phase of the subject.

This insect, in all of its stages, has been found by the writer, from Carpinteria, Santa Barbara County, to El Cajon, San Diego County.

THE GIANT SUGAR-CANE BORER.

(*Castnia licus* Fab.)

By C. L. Marlatt.

The appearance of an important new sugar-cane pest in Demerara, British Guiana, has some interest for us, inasmuch as the West Indian sugar-cane borer, also known as the "larger cornstalk-borer" (*Diatræa saccharalis* Fab.), for many years an important enemy of cane and corn in the United States, traveled northward through the West Indian Islands from the same region, reaching Louisiana at an early date and now ranging as far north as Virginia and Maryland.

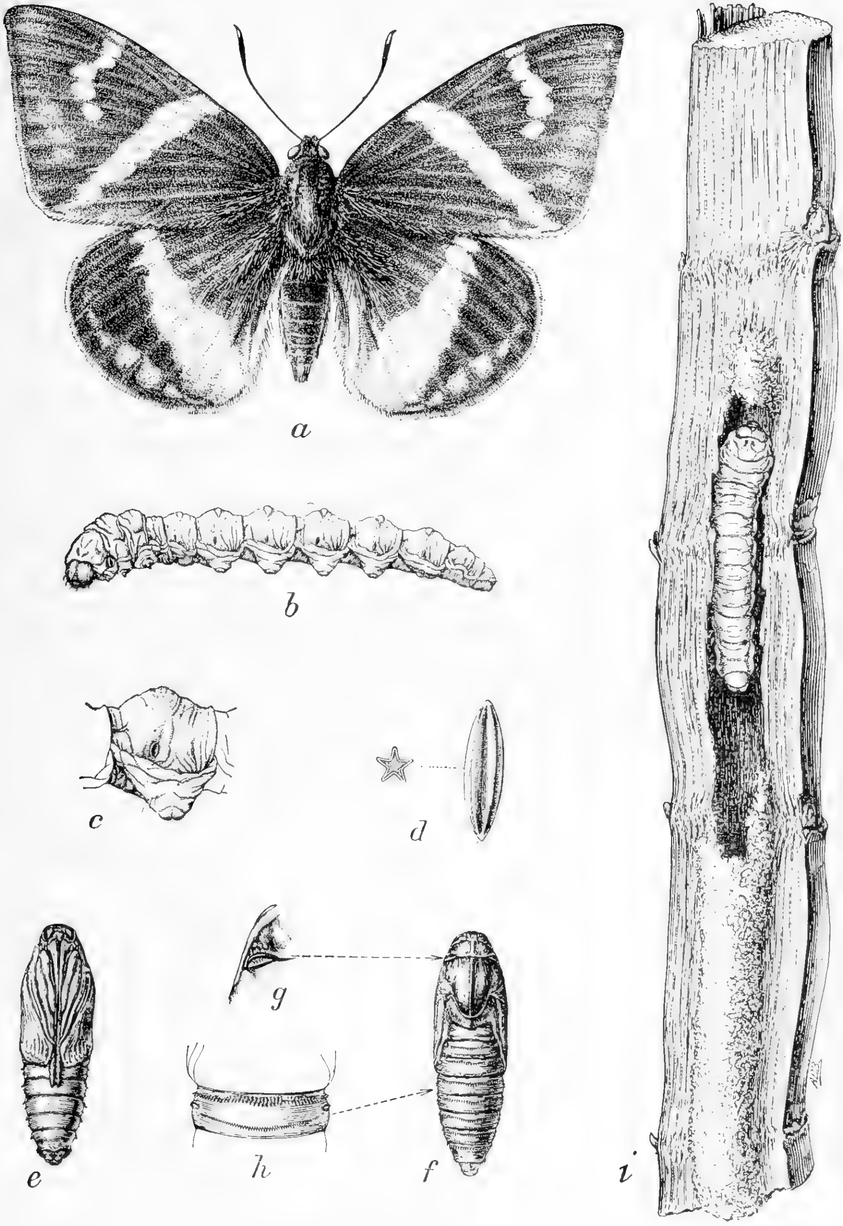
That this new cane insect may come north seems doubtful, as the family to which it belongs is essentially tropical. While belonging to an entirely distinct family, the habits of this new cane pest closely parallel the older and better-known enemy of this staple. The adults, larvæ, pupæ, and eggs of this insect, together with canes showing the larval burrows and containing the larvæ, were transmitted to Col. G. B. Brackett, pomologist of the Department, by Mr. B. Howell Jones, of Georgetown, Demerara, who gave a rather interesting account of it in a letter which is quoted below. The insect proved to be *Castnia licus* Fab., and the only known food habit hitherto recorded is the breeding of the larvæ in the Upper Orinoco in the roots of an orchid. As shown in Westwood's Monograph of the genus Castnia (Transactions of the Linnæan Society, 2d series, Zoology, Vol. I, p. 173, 1875, and by Herbert Druce in his Lepidoptera-Heterocera (Biologia Centrali Americana, Vol. I, p. 26, 1883), this insect has been collected in Nicaragua, Costa Rica, Ecuador, east Peru and Bolivia, Guiana, Trinidad, Amazons, and Brazil. According to Druce, it is a scarce insect in Central America, but seems to be more abundant in its more southern range.

The material sent by Mr. Jones was so ample and in such an excellent state of preservation that it seemed worth while to have careful drawings made, which are reproduced for this note. (Pl. IV.) The large size of this insect, in comparison with *Diatræa saccharalis*, commonly known in this country as the "larger cornstalk-borer" to distinguish it from the smaller cornstalk-borer (*Elasmopalpus lignosellus*), warrants the application of the term given at the head of this article to this new cane pest. The assumption of the cane-feeding habit by this insect is another illustration of the sudden development of an injurious food habit in an insect which for years has had no economic importance, and shows how little can be predicted of any insect from its known food habits. It is to be hoped that this insect will not develop a northern trend through the West Indies as did its forerunner, the larger cornstalk-borer. The fact that it is not especially abundant in its northern range in Central America is an element of security, but can not necessarily be relied upon, because this scarcity may be due to a lack of suitable plants in which it can breed. Mr. Jones's letter is a most interesting contribution to the knowledge of the history of this insect, and it is significant that now that it has found a food plant furnishing abundant means of reproduction it breeds in enormous numbers. I quote the letter referred to in full:

GEORGETOWN, DEMERARA, BRITISH GUIANA,
November 28, 1904.

G. B. BRACKETT, Esq.

DEAR SIR: I am taking the liberty of sending you a small box containing the eggs, caterpillars, chrysalis, and butterfly that has been doing some damage to some of our cane fields. It is entirely new to us here, though some planters say they have seen it before, but they did not think it did much damage. In the present case it is doing a great deal of damage, and a few children with nets



CASTNIA LICUS FAB.

a, Female moth; *b*, larva, lateral view; *c*, first abdominal segment with proleg; *d*, egg; *e*, pupa, ventral view; *f*, pupa, dorsal view; *g*, spiracular cleft; *h*, abdominal segment, enlarged to show rows of reflexed spines; *i*, segment of cane showing larval burrow and larva—larva, pupa, and moth natural size—egg and anatomical details variously enlarged—cane one-half natural size (original).

have caught upward of a thousand of the butterflies in a week. At present the attack is confined to one estate, but, of course, it may spread. This is the third year it has been noticed. In the two first years comparatively slight damage was done, but at present time a great deal of damage has been done. The caterpillars enter the cane both from the bottom, close to the root, and work upward through four or five joints, or enter above and work downward, forming a chrysalis at the bottom of the cane or in the ground at the base of the cane. The caterpillars appear in October and November, and, as this is our chief reaping season, many of them are destroyed by the mill. They have been found in fields of loose vegetable soil which have been top-dressed with filter-press refuse.

My object in writing to you is to ask you if you would put this before the entomologist of your Department to see if the butterfly is known, and to ascertain its name, if it is. It also might be interesting to those engaged in studying the cultivation of sugar cane and the disease from which it suffers.

Hoping I am not giving you too much trouble and trespassing on your kindness, believe me, yours faithfully,

B. Howell Jones.

In a subsequent letter, under date of February 2, 1905, Mr. B. Howell Jones gives the additional information that the plague of these insects still continues on the Enmore estate and many thousands of the moths are being caught weekly. He says the only remedies so far practiced are catching the moths and destroying the grubs when found. An attempt to attract the moths by putting a strong light in the fields at night was without success.

SYSTEMATIC RELATIONSHIP AND DESCRIPTIVE NOTES.

The family Castnidæ, to which this insect belongs, includes a considerable number of very showy and large moths limited to the neotropical region and more abundant in South America than in Central America and Mexico, one species, however, having been reported in the United States. The systematic position of this family has been the subject of some controversy among specialists. On account of the clubbed antennæ and general showy character of the moths they were originally assigned to the Rhopalocera and to the genus Papilio. The discovery of the larvæ and pupæ and something of the habits of some of the species has led to more correct ideas of their relationships. In larval and pupal characteristics one is reminded of Cossus. The examination of the material submitted by B. Howell Jones to Doctor Dyar led him immediately to place them in the family Tineidæ—an anomalous disposition in view of their great size, but warranted by evident structural characters. The habits of but few species of this genus are known, and these agree in being internal feeders, and this is probably true for all. In this particular species pupation occurs within the larval burrow. Other species, however, leave the burrow and form loose cocoons. The following brief description of the different stages is appended, not as a technical contribution, but as supplemental to the plate:

Adult.—The wing expanse of the adult female is 3 to 4 inches. The male is smaller, having a wing expanse of $2\frac{3}{4}$ to 3 inches. Considerable variation is exhibited in the ornamentation of the wings, two distinct varieties being illustrated in the material in the National Museum. The general color is rusty brown. The forewings are crossed with a broad diagonal white band; the posterior wings have a similar band, broader and less sharply defined, crossing them at right angles to the band of the forewings. The hindwings have also a submarginal row of 6 or 7 reddish-yellow spots, the central spots being much larger than the lateral ones. A variation in coloration, as in the example figured, is seen in some specimens in the presence on the forewings of an additional irregular row of spots forming a band exterior to and irregularly parallel to the broad transverse band. The notable feature of the wings is the brilliant opalescence, especially notable near the body. The antennæ are clubbed, giving them a resemblance to the true diurnal Lepidoptera. The under surface is lighter than the upper, with the markings approximately repeated and rather more distinct save for the yellow spots, which are faint. There is also an additional submarginal row of white spots on the anterior wings.

Larva.—The larva, illustrated on Plate IV, figs. *b* and *c*, varies from 2 to $2\frac{1}{2}$ inches in length, is white or flesh-colored, and very elongate. The head is relatively small and pointed, of a light chestnut, with mandibles and more or less of mouth parts black. The body is smooth and practically devoid of hairs, although minute ones which have significance in classification are found, as indicated in the drawing. The prolegs bear two transverse rows of stout curved spines or hooks. The spiracles are very large, oval, prominent; the prothoracic pair and the pair on the last abdominal segment are about twice the size of the others.

Pupa.—The pupa (figs. *e* and *f*) measures an inch and a half in length, is fairly robust, chestnut brown in color, and in general smooth and shining. There is a strongly excavated crescent-shaped spiracular pocket on either side of the pronotum. The prominent features are the two transverse rows of strong reflexed spines, or teeth, on the dorsum of each of the abdominal segments extending laterally, a little beyond the spiracles. The anterior row of spines is much stronger than the posterior, and the latter is wanting or nearly so on the two terminal segments. The tip of the pupa is squarely truncate and ornamented with a series of sharp ridges.

Egg.—The egg (fig. *d*) is flesh colored, white when empty, very elongate, and with five strong carinæ, giving in cross section the stellate figure shown in the illustration. Length, one-sixth of an inch.

The segment of cane showing the characteristic larval burrow with larva in situ (fig. *i*) was drawn from one of the canes sent by Mr. Jones. The pupa is formed in a little cell similar to that occupied by the larva in the cane.

GENERAL NOTES.

REPORTED SUCCESS OF AN INTRODUCED LADYBIRD SCALE ENEMY IN CALIFORNIA.

Under date of September 28, 1904, Mr. Frederick Maskew, Long Beach, Cal., sent specimens of the introduced ladybird beetle, *Rhizobius lophanthæ* Blaisdell, with the statement that it has very effectually controlled the purple scale (*Mytilaspis citricola* Packard) in the Chula Vista lemon orchards during the year, this report being based upon testimony furnished by Messrs. Allen and Copeland, extensive growers and competent close observers. Our correspondent's personal experience with this ladybird was limited to the lemon orchards of Pacific Beach. Reviewing his long acquaintance with the purple scale in the seedling orange orchards of Los Angeles County, his findings were highly gratifying. He reports as follows:

Old purple scale were abundant on most of the trees, but were in every instance dead, the eggs having apparently all hatched. The most diligent search failed to find any live young scale on either wood, foliage, or fruit. At the time of this investigation, September 7, the parasites were found only occasionally, but I was assured that they had been very numerous during the past year.

Knowing the vagaries of the different Rhizobiids, I am inclined to look upon these results in San Diego County as an adaption to local food supply, induced by the absence of other forms due to extreme drought rather than a case of true parasitism.

This same beetle is very generally distributed throughout Los Angeles County, and I have often found it in very singular locations. It has attracted much attention during the past year and has been identified by different local "authorities" as *Rhizobius toowoombæ*, *Scymnus marginicollis*, *Scymnus lophanthæ*, and *Rhizobius debilis*.

In commenting on the identity of these species, Mr. E. A. Schwarz of this office furnishes the following notes:

Rhizobius toowoombæ Blackburn is a synonym of *Rhizobius lophanthæ* Blaisdell.

Rhizobius debilis Blackburn is closely allied, but a little larger, more metallic, and with darker prothorax and darker underside of the body.

Scymnus marginicollis Mannh. is entirely different from Rhizobius, yet is frequently mistaken for *Rhizobius lophanthæ*. It is a native of California, and feeds, both as larva and imago, on plant lice that affect various fruit trees and many herbaceous plants. It never feeds on scale insects.

It is claimed that *Rhizobius lophanthæ* was probably in California some years before it was introduced by Albert Koebele from Australia, having evidently been introduced accidentally. It was noticed among the mountains north of Pomona, Cal., in 1891, and in San Diego the following year. Some notes on this and related species have been furnished by Prof. John B. Smith in an article entitled "Scale Insects and their Enemies in California," published in Bulletin No. 6, n. s., of the Division of Entomology, pages 46–48. There can be no doubt that the effectiveness of some of these ladybirds has been handicapped by the somewhat careful methods followed by growers of citrus fruits in California in spraying and fumigating scale-infested orchards. Nevertheless, it is extremely doubtful if any of these ladybirds, after having once obtained a foothold, could be exterminated by fumigation or spraying, as some affect to believe. If any species have died out, it has probably been due chiefly to natural causes, such as insect and other enemies, and climatic conditions deleterious to their development.

LOCUSTS, MALARIA, AND MOSQUITOES IN THE TRANSVAAL.

We have just finished a most successful locust campaign. I do not know how many swarms of locusts we have killed, but it will evidently run into thousands. In one little valley about 20 miles wide and 20 miles long our official force killed about 1,500 swarms, varying in size from 10 by 12 feet up to swarms occupying an area of 5,000 square yards. In this valley there were also 30 farmers working on their own farms, and I would not care to estimate how many locusts were killed. From evidence given by old residents and by the natives I find that this has been one of the worst locust years in their memory. They all agree that if these swarms had not been destroyed nothing would have been harvested in this locality, whereas at present all the damage could be easily compensated by a $5 note. The Kaffirs are especially keen on this question of destruction, and have turned out in hordes to aid the district locust officer. Our success in this valley is one of the many successes which we have had throughout the infested districts of the colony. We are placing our main reliance upon a strong arsenical spray. The spray consists of 1 pound of arsenic, half a pound of carbonate of soda, 1 pound of sugar, and 10 gallons of water. These chemicals are boiled together so as to make the solution arsenite of sodium, which is sweetened by the sugar. In order to show you how effective this is, I need only cite one instance of a farmer who noted a swarm of fully grown "voetgangers"—that is, grasshoppers in their last stage before obtaining wings—which was 200 yards long and 50 yards wide. These locusts were advancing down a hill toward his "mealies." (The term "mealies" is used in this country instead of corn.) This swarm was so numerous that it stopped a railway train, the latter being obliged to go back several times before it could cross it. The farmer sprayed a semicircle about 60 feet wide in front of the swarm, using the arsenical spray. As a result not a single locust escaped. It seems that the sugar in the spray has a great attraction for them, and they eat their fill of it to their utter destruction.

As to the prevalence of malaria on our eastern line of railway, we have at last succeeded in awakening the railway people to the seriousness of the situation. Next Tuesday we expect to start on a mosquito survey of about 150 miles of railway, in cooperation with one of the railway medical officers. I shall make accurate surveys of the breeding places and the kinds of mosquitoes found, while the doctor will make blood studies of the inhabitants, including the natives, horses, sheep, goats, birds, and other animals. We are being furnished with three cars—one for living purposes, one for a laboratory, and one for kitchen and dining room. If I am not mistaken, I think that this is the first time that any entomologist ever had the opportunity of conducting studies of this character under such favorable circumstances.—C. B. Simpson, *Entomologist, Transvaal Department of Agriculture, Pretoria, Transvaal, South Africa.*

THE CATERPILLAR OF ANTICARSIA GEMMATILIS INJURING VELVET BEAN.

October 8, 1903, we received from Mr. A. Fredholm, Fort Drum, Fla., numbers of the caterpillars of the Noctuid moth, *Anticarsia gemmatilis* Hbn., found on velvet beans (*Muerma utilis*). We have also received a communication relative to the great injury accomplished by this species in Florida (localities not stated). The insects were stated by Mr. John Parker to occur in great numbers and to destroy the vines by entirely denuding them of their foliage. Mr. Parker thought that several generations were produced each season, as they appeared to be well-nigh continuous breeders. The larvæ are exceedingly active, and at the slightest disturbance jump to the ground, where they wriggle about rapidly until a place of security is found. Blackbirds and rice birds eat them, but the insects are often too nimble for the more clumsy birds and many escape. When, however, the birds are in large flocks, as frequently happens, they must undoubtedly be of service. The "green sparrow" was said to be the most active as well as successful enemy of the larvæ. These birds, however, do not occur in great numbers, but one of them would get in under a vine and pick off larva after larva. The larvæ remain on the under sides of the leaves.

The velvet bean is highly recommended for winter pasturage in the extreme South, for hay, and for soil renovation; it is also used as a nitrogen gatherer in orange groves. The occurrence of this insect, according to Mr. Parker, is the principal drawback to the extensive planting of the velvet bean in that section for either winter pasture or hay, as it leaves no foliage on the plants to be fed to stock or to be cured, nor, in fact, vegetation to plow under for fertilizing. For several years velvet beans have been planted, and invariably the caterpillars alone were benefited. Many fields and a small grove have been badly damaged. In the groves 50 to 60 per cent of the plants were injured; in open fields injury was still greater.

Our correspondent had heard of several complaints of this caterpillar destroying velvet beans. A Mr. J. A. Willis, Alger, Fla., had had his crop ruined for several years.

The caterpillar of this species is long and slender, cylindrical, the last pair of legs projecting backward and spreading. The body is sparsely coated with rather stiff black hairs which arise from small white button-like tubercles. The head is large, a little wider and higher than the body, rounded, and with a slight notch in the middle. The head is orange yellow or greenish yellow with a few small blackish dots. The general color of the body varies from dull green to olive brown, which becomes yellow in inflated specimens. It has a number of fine white lines, one dorsal, two lateral—separated by a blackish shade—and a distinct yellow and white pair along the stigmata or breathing holes, with a little dark edging below. It has eight pairs of legs. The mature larva measures about one and one-half inches in length, and one-sixth inch in width. Altogether it is an attractive species, as will be seen by the illustration (fig. 20, *b*). The character of the head and the arrangement of the stripes on the sides of the body are shown at *c* and *d*, respectively.

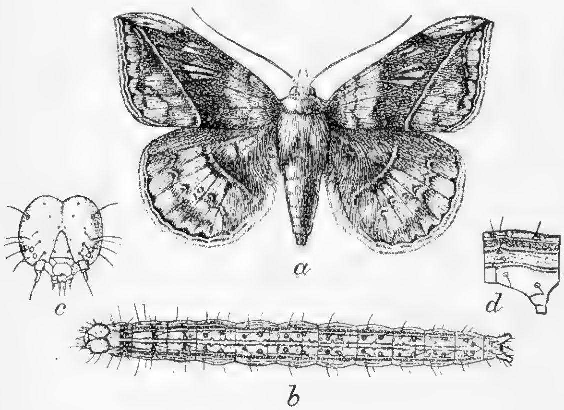


FIG. 20.—*Anticarsia gemmatilis: a*, moth; *b*, larva, dorsal view; *c*, head, seen from front; *d*, first abdominal segment, lateral view—*a*, *b*, enlarged; *c*, *d*, more enlarged (original).

The moth is also ornamental in spite of its somewhat somber colors—dull brownish gray with darker brown shades arranged as shown in the figure at *a*. The body is stout and narrowed to the apex. The expanse of the fore-wings is about one and one-half inches.

If the velvet bean should come into general use in Florida and neighboring States, the extermination of this caterpillar is apt to become a matter of considerable economic import. Doubtless the youngest caterpillars of the first generation could be readily reached by means of a spray of Paris green, arsenate of lead, or other arsenical, and this would have the effect of greatly reducing the insect for future generations, provided the work is carried on thoroughly. Or the arsenical could be distributed dry, as used against the cotton worm, by shaking it from bags fastened to each end of a board or pole and carried by a man mounted on a mule or horse. Later generations of the caterpillars will be apt to be more numerous and more difficult of treatment on account of the difficulty of placing the poison where all of the caterpillars will be reached.—F. H. C.

AN INSTANCE OF COMPLETE PARASITISM OF THE IMPORTED CABBAGE WORM.

A number of maturing caterpillars of *Pieris rapæ* were gathered at Washington, August 28, 1904, to ascertain what percentage might be parasitized at this time, as many were obviously injured. Sixty per cent of all that could be found in the last stages developed parasites of the imported Braconid *Apanteles glomeratus* Linn., all of which issued in masses of cocoons from their host within two days after the latter were taken under observation. The remaining caterpillars all transformed to pupæ and thereafter to perfect butterflies.

During the first week of September another lot of these cabbage "worms" was obtained from cabbage and other cruciferous plants from our experimental garden, all of the mature individuals that could be secured. These were counted and cared for in the same manner as before, and toward the end of the first week it was noticed that not a single larva had survived. No pupæ were formed, and therefore no butterflies issued, and since a mass of Apanteles cocoons was counted for each caterpillar that had been gathered, a case of complete parasitism was proven. As soon as it was noticed that the caterpillars had failed to pupate, both larvæ and pupæ were sought for on the grounds, but with negative results, showing that the same condition existed both in rearing jars and in the open.

The cocoons of *Apanteles glomeratus* were counted and found to vary from 30 to 35 to a mass; in other words, a full-grown caterpillar usually harbors about this number of parasites. A secondary parasite was observed issuing from a comparatively small proportion of the Apanteles cocoons. In one instance the Apanteles and the secondary parasite, a chalcidid, *Tetrastichus microgastri* Bouché, and an introduced form like the primary parasite and its host, were in equal numbers. In another case the proportions were 13 to 40. The usual number of secondary parasites was 2 to each primary parasite, but in some cases 3 of the secondary parasites must have issued from a single cocoon.—F. H. C.

SPREAD OF THE MEDITERRANEAN FLOUR MOTH IN PENNSYLVANIA.

March 15, 1905, we received specimens of the Mediterranean flour moth (*Ephestia kuehniella* Zell.) in different stages from a correspondent in Montgomery County, Pa. The insect was reported to have given no end of trouble since it arrived in some corn about a year before. The injury was of the characteristic form due to the construction of webs in the flour, in spouts, elevators, and reels, which prevented the stock from running. It was necessary to remove bolting cloths from reels, and to take out elevator belts and clean them. The fact was noted that the stock in the elevators and reels is kept so warm from grinding that the insects breed nearly as rapidly in winter as in summer. The insect was accompanied by the confused flour beetle (*Tribolium confusum* Duv.).

The recent very rapid increase of this flour moth has been already noted in the Yearbook of this Department for 1904, page 603.

TUSSOCK CATERPILLARS IN FLORIDA.

March 22, 1905, we received word from Mr. E. Neve, Tampa, Fla., that an army of caterpillars had made their appearance in that city and in several localities in the suburbs, stripping oak shade trees of every leaf, and spreading to other plants, even invading houses by entering the windows, crawling over porches, and climbing walls. Some persons claimed that the caterpillars stung them, causing ugly sores, and it was feared that the orange groves in the vicinity of the city would be infested. The insect concerned in this case is one of the tussock caterpillars, *Hemerocampa inornata* Beut., a near relative of the better known northern white-marked tussock caterpillar, *Hemerocampa leucostigma* S. & A. The soreness complained of was the result of the irritating action of the hairs of the caterpillars on the delicate surface of the skin, particularly on the neck and back of the hands.

A SQUEAKING SPHINX CATERPILLAR.

September 20, 1904, Mr. A. C. Wharton wrote us of a large caterpillar which he had taken at Port Gibson, Miss. It was described as over 2 inches in length, of a pale greenish blue color, and armed at the posterior extremity with a rather stout spine curving backward. On capturing it with his fingers he was surprised to hear it emit a distinct sound resembling the squealing of a very young mouse. The sound was faint but quite distinct at a distance of 2 feet. The species was identified by Dr. H. G. Dyar as *Cressonia juglandis* S. & A., who states that this species always "squeals" when seized, from which fact it is quite generally known as the squeaking sphinx.

The caterpillar of the death's-head moth of Europe, *Manduca atro-*

pos Linn. (better known in literature as *Sphinx atropos*), makes a hissing or, more correctly, crackling sound which seems to be produced by the rubbing together of the mandibles or jaws, each of these being provided on its outer surface with a row of prominences serving as a stridulating organ. The sound is not unlike that made by the discharge of an electric spark or the snapping of the finger nails together. Sometimes the sound is continuous and resembles that made by winding a watch. The death's-head moth itself also makes a sound, which has been compared to the squeak of a mouse. There has been wide difference of opinion as to the manner in which these sounds are produced, and the reader is referred to Tutt's British Lepidoptera, Vol. IV, pages 444–453, where the matter is treated in detail. The pupa, shortly before emergence, is capable of emitting a sound similar to that of the moth, although fainter.

A JUMPING GALL.

July 6, 1904, Dr. Morris Gibbs, Kalamazoo, Mich., sent a number of galls found underneath oak trees. When received nearly all of the specimens were jumping about in a very lively manner and to a considerable height for such small objects. Their motions are considerably different from those of the better-known jumping bean, which are caused by a lepidopterous larva similar to the codling moth, and known as *Carpocapsa saltitans*. These galls occur at the rate of a thousand to a single leaf, and are formed on the under surface of different species of oak. They have at first glance the appearance of a clover seed, having an average diameter of only 1 mm. Closely examined they are found to resemble a miniature acorn. The insect which produces this gall is a cynipid fly, *Neuroterus saltatorius* Hy. Edw., a common species, reported from Ohio to Michigan and Missouri and westward to California. It has been surmised that the peculiar bounding motion of this gall is caused by the larva within, whose motion is similar to the leaping of the cheese skipper (*Piophila casei* Linn.). A technical description of this gall was given by Riley in the Transactions of the Academy of Science of St. Louis (Vol. III, p. cxci). The same writer also mentioned this species on page 142 of the Annals and Magazine of Natural History, Vol. XII, fifth series, 1883.

THE GREAT ELM LEAF-BEETLE.

(*Monocesta coryli* Say.)

During the past two years injury by this species, which is ordinarily rare, has been observed in Virginia. September 21, 1903, Prof. William B. Alwood, Blacksburg, Va., wrote of damage by this

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beetle and its larva at Manassas Gap. It was feeding on red elm, and in one case utterly defoliated a tree 16 or 18 inches in diameter. July 25, 1904, Mr. W. C. Davis sent specimens in the egg, larval, and adult stages found on elms which were being injured at Rockbridge Baths, Va.

A good account of this species, with descriptions of its various stages, was published in the Report of the Entomologist for 1878 (Report of Commissioner of Agriculture, pp. 245–247, Pl. IV), which includes illustrations of the different stages, with a very brief account of the life cycle, the impression evidently being that the insect was single-brooded. It was stated that "toward the end of July and early in August the worms cease feeding and descend into the ground, burrowing therein and forming a simple oval cavity a few inches below the surface. They lie dormant therein through the fall, winter, and early spring months, assuming the pupa state but about a week before the beetles issue." The experience of the present year indicates a possibility of two generations or a long generation due to a long egg-laying period, as the eggs received July 25 hatched before the end of the month and the first week of August, larvæ attaining full growth during the latter half of August.

August 27, 1904, Mr. Otto M. Von Schrader, Charlestown, Jefferson County, W. Va., sent specimens of the larva, none of which had transformed to pupa when received on the 29th.

By request Mr. Davis kept this species under observation, and August 24 sent specimens of the nearly mature larva, with leaves almost completely skeletonized. In regard to the possible occurrence of a later generation he wrote substantially that July 12 the beetles were very abundant, but by the 25th they had left many of the trees entirely. In our rearing cages the beetles remained well into the first half of August. At Rockbridge Baths a considerable number of egg clusters remained, although the number observed seemed out of proportion to the numbers of beetles, fair evidence that the beetles do not deposit more than two egg masses. August 1 the eggs began to hatch. Although the larvæ were not more abundant in the latter part of August, the damage accomplished was ten times greater, as they destroyed the leaves more rapidly and more thoroughly by skeletonizing them. They prefer the under surface of the leaves, as do nearly all of their kind. Often, however, they are found feeding on the upper surface, presumably when this portion is in the shade. They sometimes eat through the leaf, but normally skeletonize it. Many leaves turn brown and drop without showing any signs of having been touched by the beetles.

THE MALODOROUS CARABID, NOMIUS PYGMÆUS DEJ., IN OREGON.

From time to time we have had occasion to mention this offensive little ground beetle and its occurrence in various portions of this country, from the Pacific coast to Michigan. August 20, 1904, Messrs. Woodard, Clarke & Co. called attention to an invasion in Portland, Oreg., where the insect was the occasion of unpleasant comment on the part of those who were so unfortunate as to be obliged to work in the vicinity of the bugs. Considerable expense was incurred in the payment of plumbers' bills for efforts to locate dead rats which failed to materialize, and employees of the firm feared typhoid fever, and were loath to remain at their post of duty. Our correspondents stated that there was no evidence that these beetles were dependent on extraneous influence or disturbance as a cause for their emitting the odor. They watched very carefully around a drain pipe on the lower roof, and the beetles seemed to emit the odor at all times. It was believed that their presence in numbers might be accounted for by dense forest fires which might have driven them from the woods and surrounding fields, the air being at times thick with smoke. This beetle is discussed more in detail in Bulletin No. 9, n. s., of this Bureau, pages 49–53.

REPORTED OCCURRENCE OF THE ASPARAGUS BEETLE IN CALIFORNIA.

During December, 1904, we received word from Mr. R. E. Smith, plant pathologist at the University of California Agricultural Experiment Station at Berkeley, Cal., reporting that the common asparagus beetle (*Crioceris asparagi* Linn.) now occurs quite commonly in that State in certain localities, and that it is becoming a serious pest. It was, he writes, observed incidentally in connection with asparagus rust, and growers were satisfied that they had seen the insect only within recent years, and that it seemed to have come at about the same time as the rust, which has been prevalent since 1901 or 1902. It is not as yet generally distributed over the State. No specimens of the species appear to have been seen by an entomologist, hence some doubt attaches to this report.

THE SCIENTIFIC NAME OF THE PLUM GOUGER—A CORRECTION.

There has been so much confusion in regard to the scientific name of the plum gouger, particularly since the appearance of our note on this subject in Vol. II of Insect Life (pp. 258, 259), that it seems desirable to bring the matter up again. As long ago as 1876 Le Conte wrote, in his Rhynchophora of North America (p. 194) that *Anthonomus prunicida* Walsh., which was originally described in the

Prairie Farmer for 1863, and redescribed in the Proceedings Boston Soc. Nat. Hist. (Vol. IX, p. 309), was a synonym of *A. scutellaris* Lec., the latter having been described in 1858 (Proc. Acad. Nat. Sci., Phila., p. 79), thus antedating Walsh's name. In Doctor Dietz's revision of the Anthonomini (Trans. Am. Ent. Soc., Vol. XVIII, 1891, p. 191) this point of synonymy is only briefly mentioned on the authority of Le Conte. Until the appearance of the note in Insect Life quoted above, Henshaw, in his Bibliography of Economic Entomology, corrected this synonymy in accordance with Le Conte's views; but in consideration of the facts that Dietz did not see specimens of *A. prunicida* Walsh, and that many are still in doubt concerning the right name to use, some further elucidation of the matter seems desirable. We have therefore asked the opinion of Mr. E. A. Schwarz, custodian of the coleoptera of the National Museum collection. He reports that there is in the museum a specimen in the handwriting of Walsh and from the old Riley collection, labeled *prunicida*, which agrees with the description and specimens of *scutellaris* of Le Conte as accepted by systematists.

Therefore the true name of the plum gouger is *Anthonomus scutellaris* Lec. As to *Coccotorus scutellaris* Lec., the name Coccotorus is treated as a subgenus by Dietz.

Mr. C. F. Baker mentions an *Anthonomus scutellaris* reared in great numbers from wild plums in Colorado (Entom. News, Vol. VI, 1895, p. 29), which may belong to this same species or to *A. hirsutus* Bruner, recorded, so far as we know, only from Nebraska (West Point) and on a single food plant, *Prunus pumilo.* Hence the note by Bruner in Vol. I, Insect Life, page 89, really refers to his new species, *hirsutus*, and the figure there used should be continued for *scutellaris* in preference to the two figured in Vol. III of the same publication, neither of which is quite correct.

UNUSUAL FOOD PLANTS FOR THE SQUASH LADYBIRD.

August 26, 1903, the writer found larvæ of *Epilachna borealis* Fab. about two-thirds grown feeding on leaves of muskmelon, beans, and *Ambrosia artemisiæfolia.* These larvæ were kept in separate breeding cages and reared to maturity. They fed freely on the plants on which they were found, pupated at about the same time, and the pupal period was practically the same—eight to ten days.

There was no squash or pumpkin growing in the fields where these larvæ were found and no cucurbit in the field where those on bean and Ambrosia were taken. The muskmelon field was separated by shrubbery from the bean field.

It is, however, extremely doubtful if this species could develop from egg to adult on any other than cucurbits.—E. S. G. T.

NOTES ON ORTHOPTERA COLLECTED ON SUGAR BEETS IN 1904.

During a trip through portions of the sugar-beet growing sections of the United States made in May and June and in September and October, 1904, a number of Orthoptera were collected, and these have recently been identified by Mr. A. N. Caudell, of this Bureau. Only those marked by a star (*) in the list have been previously reported on this crop.

Most of the Orthoptera taken the first trip were immature and could be identified at the most only to the genus. Nymphs identified by Mr. Caudell as belonging to "*Melanoplus atlanis* Riley or *M. femurrebrum* De G." were found at Longmont, Colo.; Montrose, Colo.; Paonia, Colo., and Lehi, Utah, doing considerable damage to young beets. At Echo, Oreg., several species were captured feeding on beets adjoining an alfalfa field that had recently been cut. They had entirely defoliated the beets along the borders and in some places had advanced well into the field. At no other points were grasshoppers seen doing serious injury, though several of the beet growers complain of severe injury in years past.

The following is a list of the species identified:

Stipator minutus Thom.: Olney, Colo. (4 Oct.), 4 ♂.

Ageneotettix scudderi Brun.: Lagrande, Oreg. (14 Sept.), 1 ♂; Spreckels, Cal. (20 Sept.), 2 ♀.

Circotettix occidentalis Brun.: Spreckels, Cal., 8 ♂, 3 ♀.

Gomphocerus clavatus Thom.: Longmont, Colo. (8 June).

Arphia pseudonitana Thom.: Fairfield, Wash. (10 Sept.), common.

Chortophaga viridifasciata De G.: Fort Collins, Colo. (1 Oct.); Longmont, Colo.

* *Dissosteira carolina* L.: Menominee, Mich. (5–6 Sept.); Daggett, Mich., (5 Sept.); Waverly, Wash. (10 Sept.); Fairfield, Wash. (10 Sept.); Lagrande, Oreg.; Echo, Oreg. (15 Sept.); Spreckels, Cal. (20 Sept.)—common at all places.

Dissosteira spurcata Sauss.: Waverly, Wash., rare.

Camnula pellucida Scudd.: Fairfield, Wash., common on high ground.

Sphragemon collare Scudd.: Menominee, Mich., rare in beet fields.

Trimerotropis juliana Scudd.: Lagrande, Oreg.

Trimerotropis n. sp.: Spreckels, Cal.; 2 specimens.

Trimerotropis vinculata Scudd.: Lagrande, Oreg., Echo, Oreg., Spreckels, Cal., Delta, Colo. (14 June), several.

Schistocerca venusta Scudd.: Echo, Oreg., rare.

**Melanoplus atlanis* Riley: Waverly, Wash., Fairfield, Wash., Lagrande, Oreg., Echo, Oreg., Spreckels, Cal., very common at all these places.

**Melanoplus bivittatus* Say: Menominee, Mich., Daggett, Mich., Fairfield, Wash., Waverly, Wash., Rocky Ford, Colo. (29 Sept.), Fort Collins, Colo., Olney, Colo. (4 Oct.), very common. At Olney was also taken 1 specimen of the brachypterous form.

Melanoplus devastator Scudd.: Spreckels, Cal., rare in beet fields.

**Melanoplus differentialis* Thom.: Menominee, Mich., Daggett, Mich., Olney, Colo., Rocky Ford, Colo., Manzanola, Colo. (3 Oct.), common.

Melanoplus femoratus Burm.: Fairfield, Wash.

**Melanoplus femur-rubrum* DeG.: Menominee, Mich., Daggett, Mich., Lagrande, Oreg., Echo, Oreg., Spreckels, Cal., Olney, Colo., common.

Melanoplus fordus Scudd.: Olney, Colo., 2 ♂, 2 ♀.

Melanoplus gracilipes Scudd.: Spreckels, Cal.

Melanoplus intermedia Scudd.: Spreckels, Cal.

Melanoplus lakinus Scudd.: Fort Collins, Colo., Olney, Colo., several.

Melanoplus marginatus var. *pauper* Scudd.: Spreckels, Cal.

Melanoplus tenuipennis Scudd.: Spreckels, Cal.

Melanoplus sp.: Fowler, Colo. (9 June), Longmont, Colo. (8 June), Fort Collins, Colo. (6 June), Montrose, Colo. (13 June), Delta, Colo. (15 June), Paonia and Hotchkiss, Colo. (14 June), Lehi, Utah (17 June), Byron and Durand, Mich. (29 June), all nymphs and very common.

Phœtaliotes nebrascensis Thom.: Lagrande, Oreg., Echo, Oreg.

Conozoa behrensi Sauss.: Echo, Oreg., Spreckels, Cal., common.

Xiphidium fasciatum (?) DeG.: Byron, Mich.

Cordillacris sp. (nymphs): Greeley, Colo. (2 June), Grand Junction, Colo. (12 June).—E. S. G. T.

A MEXICAN KISSING BUG.

Under date of September 12, 1904, Prof. A. L. Herrera, Comision de Parasitologia Agricola, Mexico, D. F., wrote that a large form of bug commonly known in that country as "chinche voladora," a specimen of which he furnished and which proves to be *Meccus pallidipennis*, Stål., is the cause of considerable apprehension of serious injury, especially to children which it attacks by puncturing the skin with the beak and sucking the blood.

The species is a reduviid, larger than our native so-called "kissing bugs," and is closely related to Conorhinus, the genus which includes the cone-noses, our most bloodthirsty species. It measures upward of 1¼ inches in length, and is five-eighths of an inch wide across the middle of the abdomen. It is black, with two triangular bands converging at the apex of the scutellum, while each segment of the connexivum or reflexed sides of the abdomen which border the tegmina is variegated with white, resembling the markings of certain of our common turtles. Its beak is a little longer than the elongate, pointed head. The insect is so large and of such formidable appearance that we would naturally expect it to be capable of a dangerous "bite."

HYDROCYANIC-ACID GAS AGAINST THE BEDBUG.

March 17, 1905, Rev. Ruter W. Springer, chaplain, U. S. Army, Fort Washington, Md., states that he has used the hydrocyanic-acid gas process for the extirpation of the bedbug in the barrack buildings of that fort with considerable success. He reports as follows:

> The experiment was first tried in a large barrack building, according to directions. Several receptacles were broken in mixing the acid, but the intended results were perfectly satisfactory. Since then my own residence was twice invaded, beyond the reach of ordinary remedies. In each case the effort at relief was perfectly successful. The last time a half a dozen insects were cap-

tured and placed in a glass. The glass was thoroughly wrapped up in a folded sheet, then in a pair of blankets, and then in a quilt. At the close of the experiment these insects were all found dead. As to pasting up cracks, I discovered that inch strips of newspaper, soaked for some time in water, and patted into place with the hand, would make an excellent gas check for any reasonable length of time, and afterwards would come off easily without requiring hours of labor

SINGULAR INCREASE OF "LERP" ON TREES OF THE "YELLOW BOX."

When traveling on the train between Melbourne and Macedon, I noticed a patch of probably some hundreds of acres of land on which the trees of *Eucalyptus melliodora* appeared to be covered with snow, but which on close inspection proved to be an enormous number of the lerp insect (*Lasiopsylla rotundipennis* Frogg.), covering the leaves so closely as to give the trees the aspect before alluded to. I can not account for this abnormal increase, as, although the lerp insects are common enough in the forests around Melbourne, never before in over fifty years of occasional bush life have I seen these singular waxy coverings in such great profusion. This season has been a hot one, and the lerp is by no means confined to the one species of Eucalyptus. It will be interesting to note how far the trees will be affected, and I hope to supplement this short note very soon.—CHARLES FRENCH, *Government Entomologist for Victoria, Australia.*

A RED SPIDER ON COTTON.

Under instructions from the Entomologist the writer proceeded, July 9 to 10, 1904, to Batesburg, S. C., in order to ascertain the primary cause of injury to cotton which had been reported in that section, whether red spider or some disease of the plant.

On the plantation of Mr. E. F. Strothers was found a small field of cotton in which a red spider was becoming common. The field was first attacked, according to Mr. Strothers, on the south side, or nearest the road, and was found infested for a distance of some 200 or 300 yards into the field. Some plants were already dead, while others had lost nearly all of their leaves. The leaves at first have the peculiar scarlet appearance due to the attack of this mite. This coloring occurs between the larger ribs, near the base of a leaf, and gradually spreads in all directions. As the injury becomes common over the leaf, the red color dies out, giving place to a dirty yellow, which later fades out, and the leaf shrivels and falls. Larger and older leaves are attacked first and soon commence to curl; younger leaves, when attacked, do not curl until injury has spread quite extensively over the leaf. The mites also attack the squares, flowers, bolls, and stems.

These mites were found on five plantations in and around Batesburg, and in every case north or northeast of water oak or elm trees that had been injured by red spiders earlier in the year—presumably this species.

On Mr. Cunningham's place violets and roses had been injured by this red spider, these plants being in a northerly direction from seriously affected water oaks. Across the road from this place is a small piece of cotton which was the most seriously affected of any seen. A field adjoining the yard and west of the house showed no injury. Earlier in the year this region was visited by strong southerly winds, and it is quite probable that the species living on the shade trees at that time were carried into the cotton fields.

On Mr. Mitchell's plantation, 2 miles out of town, injury was slight, but the red spiders could be found over a considerable portion of the field. Other cotton fields on this place and between here and Batesburg showed no injury, not a specimen being found. Cotton fields in all directions from Batesburg were visited and general conditions were the same in all cases.

Several insects (such as grasshoppers and smaller Hemiptera) were found on cotton leaves in infested fields with young red spiders attached to them.

From material collected by the writer Mr. Nathan Banks determined the species as *Tetranychus gloveri* Bks.—E. S. G. T.

SOME SUGAR-CANE INSECTS.

Anomala semilivida Lec. and *Myochrous denticollis* Say were found feeding on leaves of sugar cane and corn at Berwick, Morgan City, Broussard, Billeaud, and Olivier in April and May, 1904. At Broussard they occurred in all the fields visited; at other places they were rare. At Berwick small red ants were noticed carrying living adults of *M. denticollis* to their nests.

Larvæ of the bollworm (*Heliothis obsoleta* [*armiger*] Hbn.) were found very rarely, feeding on the upper unfolded cane leaves in early spring, working downward from above.

The sugar-cane borer (*Diatræa saccharalis* Fab.) was quite rare in young stalks in the spring, but in the fall some fields of "Trinidad" cane near Berwick were quite badly infested.—E. S. G. T.

SOME OBSERVATIONS ON KANSAS INSECTS.

We are in receipt of a communication from Mr. F. F. Crevecoeur, Onaga, Kans., in which he reports a few observations made during 1904.

During the fall he observed the twelve-spotted cucumber beetle (*Diabrotica 12-punctata* Ol.) feeding on apples that had been injured by birds or other insects.

The cotton worm (*Alabama argillacea* Hbn.) and a common wasp (*Vespa germanica* Fab.) were also quite abundant, feeding on apples. The wasp especially was observed to eat apples so that nothing was left but the skins.

October 2 a curculio, *Conotrachelus posticatus* Boh., was observed feeding on apple.

May 15 one of the willow weevils, *Dorytomus mucidus* Say, was observed in the pupal stage under stones by the water's edge along a creek. The adult issued two days later.

June 15 he observed a dipteron, *Ecthodopa pubera* Loew., feeding on a wild bee of the genus Halticus.

A moth, *Glaphyria* (*Homophysa*) *sesquistrialis* Hbn., was reared from larval cases in the nests of the ant, *Cremastogaster lineolata* Say.

July 23 a large robber fly of the family Asilidæ, *Promachus vertebratus* Say, was observed attacking a tachinid fly, *Jurinia aterrima* Desv. The Asilid mentioned is often seen attacking *Melanoplus atlanis* Riley and other grasshoppers.

One of the long-horned grasshoppers, a species of Orchelimum, doubtfully referred to *vulgare*, was seen September 19 eating an adult soldier beetle, *Chauliognathus pennsylvanicus* DeG.

SOME LOCAL NAMES FOR COMMON INSECTS.

During August, 1904, we received a number of insects from Hon. J. D. Mitchell for identification and as a donation to the National Museum, with notes on their habits and the local names applied to them. The most interesting species are as follows:

Pyrophorus physoderus Germ., from Jackson County, Tex., known as the "hominy beater," a name which it shares with *Alaus oculatus* Linn. and other "snap bugs" as far north as Washington, D. C. This species is luminous, having luminous spots on the thorax.

Monedula carolina Drury, the "cicada wasp;" digs holes in the sand and has been seen killing cicadas frequently, but no other insects.

Dasymutilla orca Blake, the "cow-killer ant;" a solitary species.

Arachnophroctonus ferrugineus Say, the "red spider hawk;" kills spiders and buries them. An individual was observed dragging along a large gray spider.

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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY—BULLETIN No. 55.

L. O. HOWARD, Entomologist.

THE REARING OF QUEEN BEES.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST

BY

E. F. PHILLIPS, Ph. D.,
Expert Apiculturist.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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E. R. SASSCER, *Student Assistant.*

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., October 14, 1905.

Sir: I have the honor to transmit the manuscript of a bulletin on the rearing of queen bees, by Dr. E. F. Phillips, Expert Apiculturist of this Bureau. It is hoped that the explicit directions given in this manuscript governing the production of queens will be of assistance to bee keepers throughout the country, and that it will prove the means of saving money for those who carry on apiculture except in the smallest way. I therefore recommend that this manuscript be published as Bulletin No. 55 of this Bureau.

Respectfully,

L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

Bee keeping is primarily a breeding problem, for the honey surplus of a colony depends so much on the queen. In order to make more public some of the best methods of queen rearing, this bulletin is issued. Much of the labor of manipulation can be avoided by the use of the systems herein described.

It is held by the best bee keepers that it is necessary to restock all colonies with new queens every year; but the practice is not as common as it should be. It is hoped that the simplicity of the methods hereafter described will serve as an inducement to those bee keepers who have not adopted the plan to pursue it in the future.

The rearing of queens has become a separate field, in that some men devote their entire apiaries to this purpose; and to these professional queen breeders must, to a large extent, be given the work of the improvement of stock; but it is far from wise for the ordinary honey producer to neglect this side of the industry.

E. F. P.

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NECESSITY OF REQUEENING.

In modern apiculture it is necessary for the bee keeper to be able to get queens at any time. Many bee keepers requeen all their colonies every year; others requeen every two years; it is necessary, then, that they have some method of rearing good queens to use in this way. Even where frequent requeening is not practiced, it is nevertheless often necessary to replace queens which do not come up to the standard in egg laying. Again, it often happens that a colony becomes queenless by the accidental death of the queen. Such a colony, if left to itself, will rear a queen, provided there are young larvæ in the combs, but few bee keepers are now willing to intrust so important a matter to the bees.

Frequent requeening is a very necessary thing if the best results are to be obtained. It is a well-established fact that queens lay more eggs during the first year than in any other, and that the number of eggs laid gradually diminishes until the queen is replaced, because of inability to keep up the colony. Every bee keeper knows, too, that, all other things being equal, the greatest amount of surplus honey is produced by the most populous colony. It is evident, then, that frequent requeening means the maximum honey production.

It has not yet been shown that requeening more than every second year pays for the extra labor, but the best bee keepers hold that queens should not be allowed to live longer than that time. There are, of course, exceptional cases in which the queen will keep up the population of a colony for two or even three years longer than the time given; but unless every colony can be watched constantly it will not pay to risk keeping queens more than two years old.[a]

It is also desirable to have extra queens on hand when the number of colonies in the apiary is to be increased by division or by any of the methods of artificial swarming. If a queen is provided as soon as

[a] An exception to this rule occurs in large queen-rearing apiaries where it is desirable to have large numbers of choice drones always on hand. Since old queens lay a much larger proportion of drone eggs, it is often desirable to keep one or two old queens of select stock on this account. There is no evidence that drones from old queens lack anything in vitality.

the increase is made, the new colony will gain about three weeks in brood production over a colony which has to produce its own queen.

The question which arises in the mind of every bee keeper is: Will it pay me to rear my own queens? Very good untested queens can now be purchased for $1, or even less, it is true; but where a large apiary is to be requeened, this amount, though small for one colony, reaches considerable size when multiplied by a few score; and if this amount can be saved, and the total net receipts of each colony correspondingly increased with comparatively little labor, it would seem folly for the bee keeper to persist in purchasing queens.

It will of course be necessary for the average bee keeper to buy some queens. The selection of fine strains of stock must be left to the professional queen breeder in most cases, and it will be well to buy the breeding stock from some such person. Where no particular improved strain of stock is desired, it may pay the extensive bee keeper to buy an imported queen to be used as a breeder. In the case of Italian bees this does not seem necessary, for very superior stock is reared in the United States, and queen bees of the Italian variety are actually shipped from this country to Italy to be used as breeders. In Carniolan, Cyprian, and other races not so much selection has been carried on in this country, and in consequence the desirability of importations is greater in order to insure purity of stock.

Few bee keepers are so situated that they can with profit rear their own breeding stock. It is the rule in some apiaries to choose the queen from the colony with the best honey record as the breeder for the following year, but this, while seemingly good policy, leads to curious errors. Unless it is certain that the queen is of pure stock or of a fixed cross she should not be used, for it is a well-known fact that when a first cross is used as a breeder the resulting offspring are most variable.

It is the purpose of this bulletin to outline a plan for breeding queens in the home apiary which it is believed can be used with the minimum of labor and expense, one with which good results have already been obtained. Queen rearing can not be carried on without careful attention, but the methods are not, as many believe, so complicated as to make it impossible for the honey producer to afford the time. The beginner in bee keeping can scarcely expect to rear good queens during the first year, and no one can hope to do so until he becomes well acquainted with the habits of bees. It is impossible to give directions minute enough to cover every phase of the subject, and so that every emergency will be foreseen: a great deal must necessarily be left to the common sense and experience of the apiarist. The outline herein given, however, ought to be sufficient for anyone who has had one year's careful work with bees.

NATURAL QUEEN REARING.

Before taking up any artificial methods of queen rearing, it is necessary to have well in mind the circumstances and conditions under which a colony of bees will undertake to rear a queen. It is well known to all bee keepers that workers are female bees, that, when a queen is to be reared, a larva which would under other circumstances become a worker is fed on a specially prepared food, and that thereby the reproductive organs are fully developed. All female larvæ when just hatched from the eggs are alike in development, whether they are destined to become queens or workers. If then any female larva is chosen and so placed that this special food is given it, the resulting bee is a queen; on the other hand if the ordinary larval food is given it, a worker is the result. This discovery is generally attributed to Schirach, although the assertion is frequently made that the fact was known before his time.

Since this change of food is exactly what is brought about in nature by the workers, in order to proceed intelligently, we must first know the conditions under which such a thing can be done; for, while bees are somewhat flexible in their instincts, too great a departure from their natural inclinations will result only in failure. The three conditions under which a colony will rear a queen in nature are (1) swarming, (2) supersedure, and (3) queenlessness.

(1) *Swarming.*—In the spring of the year, as a rule, but at any time when the quarters in which the colony is located are too small, bees acquire what is known as the "swarming impulse." In spite of all the work that has been done on the habits of these insects, just what brings this about and the exact physiological conditions leading up to it, are still unknown. Many weird and wild guesses have been made at various times, but it may be said, almost without fear of contradiction, that we are as far as ever from knowing the true cause of swarming. It does not always hold true that cramped quarters produce the phenomenon, nor that sufficient room will prevent it.

At any rate, when the swarming impulse is aroused the bees begin to build queen cells, and in these eggs are often laid by the queen. The queen cell is larger at its base than the worker cell and projects, when completed, beyond the outside line of the comb, hanging down in an acorn-shaped projection with irregularly pitted walls. The number of such cells which are produced depends on many things, among which may be mentioned temperature and the race of bees. In colonies of Italian bees the number is usually not great, but in Cyprians there are often from 30 to 60 queen cells, while in Tunisians there may be several times that number. About the time the queen cells are capped, the old queen and part of the colony leave to establish a new one.

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(2) *Supersedure.*—When a queen on account of age or other cause ceases to lay eggs enough to keep up the strength of the colony, the workers build queen cells and rear queens. When the first one of these emerges, an encounter ensues between the young queen and the old one, and almost invariably the latter is killed.

(3) *Queenlessness.*—It may happen that the queen in a colony is killed, and in that case, if there are young larvæ in the combs, the workers will rear queens, one of which later becomes the mother of the colony. While in nature this is probably a more rare condition than is either of the two preceding, it is a normal and natural circumstance under which queens are reared.

In the rearing of queens by the so-called artificial methods it is necessary to follow rather closely one of the three natural conditions. As will be shown later, queens can be reared in colonies with a laying queen, provided a perforated zinc sheet be used to prevent the latter from tearing down the cells, but in such cases we probably approach the swarming condition.

In practice the bee keeper can, if he wishes, take queens from normally constructed cells. By making a colony queenless a considerable number of these will be reared, and by very careful watching almost all of them can be captured and caged before they kill each other or destroy other queen cells. To do this, however, it is necessary to look over the entire colony several times a day for several days, and thus it is far from a time-saving method. The plan is not to be recommended except where it is impossible to use some of the better methods. In the same way queens emerging from cells built in swarming time or during supersedure may be captured. There are, however, better methods of queen rearing; for, by modern appliances, the work is not only made much more simple, but also gives better results. A description of these methods may seem rather complicated to one who has not tried them, but the manipulation is easily learned, and after a brief acquaintance with the appliances the whole subject of queen rearing becomes very simple.

ARTIFICIAL QUEEN REARING.

The methods to be described here are not those of any one system, but are the result of many investigations in this field. It is impossible to give credit to every one who has offered valuable suggestions on this subject, and no such attempt will be made; for it is often difficult to learn with certainty who first used and recommended any particular plan. The bee-keeping journals are full of valuable hints on this work, and methods long ago in use are repeatedly rediscovered and given as new. To prevent any injustice, then, it seems best to avoid giving credit in all cases, except where there is no doubt as to the origin of the plan. The author disclaims all credit of originality in this bulletin, but can say that all the methods described have been tried successfully by him, either in the apiary of the Bureau of Entomology or before entering the service of that Bureau. The object in writing such a bulletin is that the successful methods may become better known. In most cases the plans given are somewhat modified and are not exactly as used by the originators of the various systems. These modifications may not appear to everybody to be improvements, but they are such as have seemed desirable either in the work of the apiary of the Bureau, or in the experience of other queen breeders. In giving directions for each part of the work of queen rearing, several methods are described; for it is realized that not all bee keepers can conveniently use the same system. Where a particular appliance is known commercially under a certain name, that name is used; for in such cases no dispute as to originality can arise and no injustice can be done. The author disclaims any responsibility in giving these names, but employs those in current use in apicultural literature. None of the appliances which are mentioned in this bulletin are patented and any bee keeper is at liberty to make them, either in the style described or with any modifications which he sees fit to make.

The use of some terms which are rather current in bee-keeping literature has been avoided, since several of the more common terms are not only useless but misleading. If the writers on apiculture were to be more careful in the nomenclature of the science, it would do much toward making their descriptions clear, and at the same time apiculture would be regarded with more respect by beginners and outsiders.

An effort has also been made to exclude all discussion which does not have a direct bearing on queen rearing. It is assumed that the reader is familiar with the principles of bee keeping, and consequently it has not seemed necessary to discuss other phases of the work of the bee keeper.

STARTING QUEEN CELLS.

The queen cells used by various queen breeders vary greatly. Natural queen cells are sometimes used in queen rearing by cutting them from the comb and fastening them with wax to a bar the length of the top bar of the hive. These cells already stocked with royal jelly, the food of the queen larvæ, are ready to use by simply removing the larvæ already in them and replacing them with larvæ from the breeding queen. There are, however, several objections to such cells. They are far from uniform, and are not easily put into nursery cages when sealed; they are supplied with more royal jelly than is necessary; in most cases they are not easily obtained in sufficient number; and, finally, they can not be handled and removed, as can artificial cells. Where such cells are used it is often customary to allow the queens to emerge on the combs of the hive, but this necessitates the hunting for young queens, which is a waste of time.

DESCRIPTION OF CELL CUPS.

It is much better to use a cell base artificially produced. These cells can be made of wax, or on wooden bases with a depression which is filled with wax. They are just as readily accepted by the bees, and because of uniformity and ease of handling are much preferable.

The Doolittle cell, made by molding wax on a stick with rounded end of the exact diameter of a queen cell, is very good and was probably the first artificial cell used in commercial queen rearing. The molding stick is dipped in hot wax, and when one layer of wax is cool, the process is repeated, each time the stick being dipped a shorter distance. The result is a cup with thin edges and heavy base. Such cells are also made by pressing out the wax in a mold. The cells are then fastened to a bar with wax preparatory to introducing the larvæ (see fig. 1).

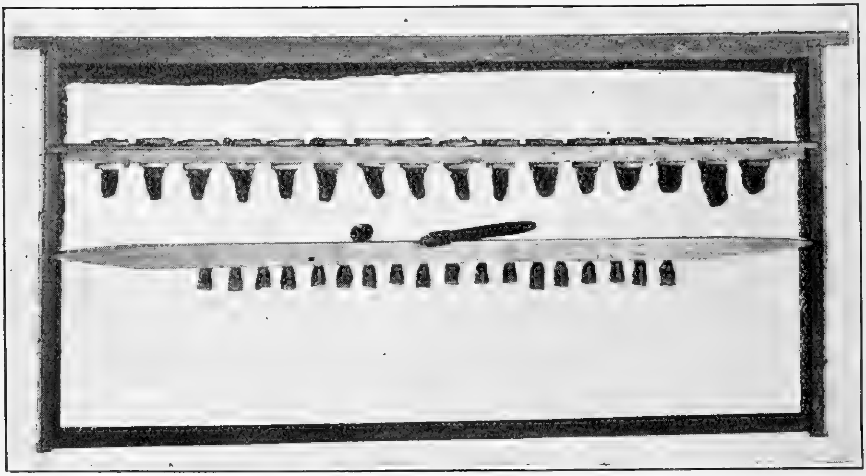

FIG. 1.—Standard frame with bar of completed cells on wooden flanged cups and bar of Doolittle wax cells (original).

Cups with wooden bases are now widely used and have many advantages over the wax cups, in that they can be transferred from one bar to another without danger of breaking and can more readily be used again after the queen has emerged. These cups are usually made of a cylindrical piece of wood with a concave depression in one end which is lined with wax. There is a nail point in one end which allows them to be fastened to a bar by pressure (see fig. 2), or, better, there is a flange at the upper end so that they can be put through holes bored in the bar (see figs. 1 and 2).

TRANSFERRING LARVÆ.

Having procured the cells to be used, with the requisite bars, the bee keeper is ready to transfer larvæ to these cells. Before being used for the first time, each cell should be thoroughly daubed on the inside with royal jelly. This seems to give to it the odor of a queen cell; at any rate the bees are much more ready to accept it. A small amount of royal jelly should then be put at the bottom of the concave

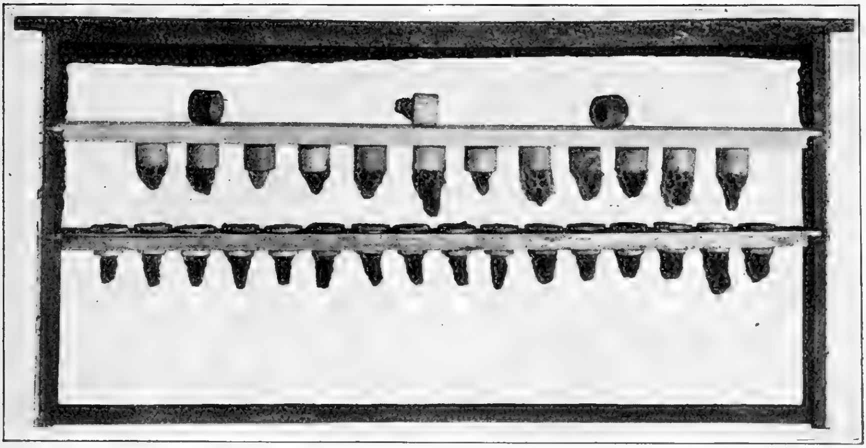

FIG. 2.—Standard frame with bars of queen cells on wooden bases. The top bar holds cells of the Root pattern (original).

depression, and a larva from the colony of the breeding queen placed on it. The larva must not be more than three days old, and it is far better to use one which has not been hatched from the egg for more than one day. This transfer from the worker cell to the artificial queen cell may be done with a match or toothpick which has been cut thin and bent on the end to an angle of about 45°. No special tool is necessary, although when this procedure is to be repeated frequently it may be desirable to use a steel rod or some similar instrument, shaped as above described. The bar is then placed in a queenless colony, and the bees will build down on the cells until they complete them, at the same time feeding the larvæ with royal jelly until the time comes for the cell to be sealed. As a rule not all the cells are accepted, but just as many will be accepted in the case of artificial cells as when natural cells are fastened to a bar, as previously described. If a two-story hive is

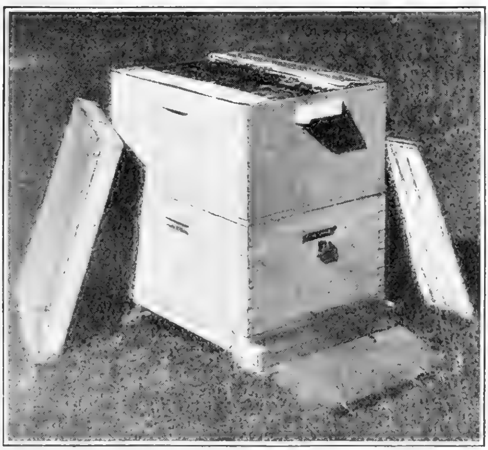

FIG. 3.—Two-story hive with perforated zinc honey board between stories, the top to be used for queen rearing (original).

to be used, the bar should be placed in the upper, and the queen confined in the lower, story. For the latter purpose a perforated zinc honey board (see fig. 3) should be used. In a one-story hive the bar should be surrounded by a perforated zinc incubator. A larger proportion of cells are usually accepted in a queenless colony. In case

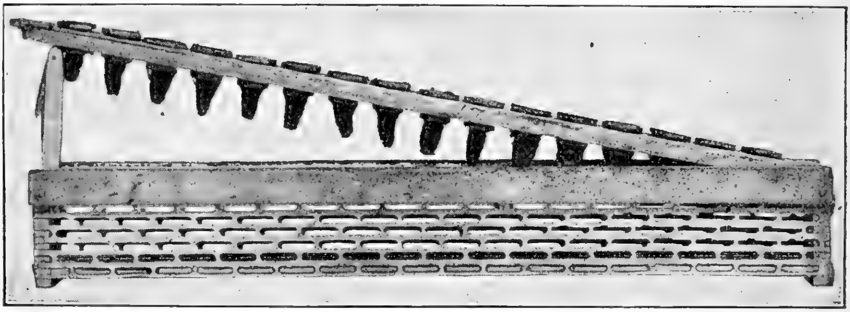

FIG. 4.—"Swarthmore" incubator holding sixteen cells on wooden bases (original).

there is a colony with an old queen which is about to be superseded, a large number of cells may be started, and this is also true in a colony preparing to swarm. Here, too, for safety the queen of the colony should be kept away from the cells by perforated zinc.

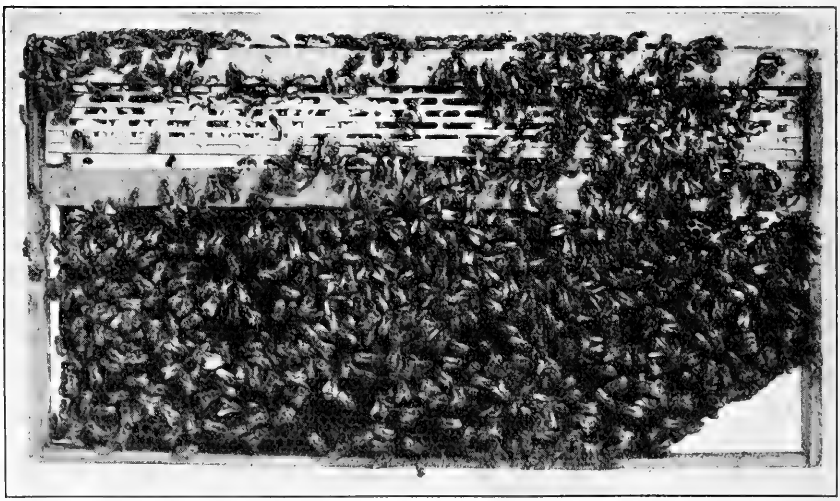

FIG. 5.—"Swarthmore" incubator in frame. The metal supports at the upper ends of the side pieces of the frame do not show (original)

The chief difficulty in rearing queens by this method is to get the cells accepted. Once started, they are usually completed, even if transferred to a colony which does not readily accept cells. In many cases it is customary to start cells in a queenless colony, and in twenty-four hours to transfer the bar to a hive with a queen, putting the cell in an incubating cage of zinc (see figs. 4 and 5). This gives the advantage of starting the cells under the most favorable conditions for their acceptance, and at the same time makes it unnecessary to have so many queenless colonies in an apiary, which is obviously not economical.

METHOD OF STARTING CELLS.

In starting cells it is desirable that the bar be placed at a level of about 3 inches from the top of the frames when standard-sized frames are used, since this puts the cells in the middle of the brood chamber where the heat is most uniform. This can be done by the method illustrated in figures 1 and 2. After cells are once started they may be kept at almost any level of the hive so long as they are fed and kept warm; and as many as three bars may be fastened in one frame where there are plenty of bees to cover all of them. It is possible to put three such frames of started cells in one story of a colony, but at least one frame of comb should be between each two cell frames, so that there may not be too large an opening in the hive. In this way a strong colony will readily complete and care for more than a hundred cells.

DIFFERENCE IN RACES.

Here, again, racial characteristics play a large part. Italians do not as readily accept and complete large numbers of queen cells as do either Cyprians or Carniolans. In yards in which Italian queens are reared, it may therefore be desirable to keep colonies of Cyprians or Carniolans. It need scarcely be said that in such cases drone traps should be used. No fear need be entertained by the queen breeder that races producing large numbers of queens necessarily produce poor ones. Anyone familiar with the prolificness of the queens of these races could not hold such an idea. There is no evidence that under these circumstances the larvæ are less well fed; indeed in such colonies, as in those with fewer queens to care for, the larvæ always leave some royal jelly in the cells when they enter the pupal stage, during which, of course, no food is eaten.

SWARM BOX.

Since the greatest difficulty with this part of queen rearing is in getting the cells started, it is fortunate that we have a method by which the matter may be made more certain. It is desirable to get bees into the condition in which they will start large numbers of cells; this can be done by the use of what is known as the "swarm box." We know that when bees are in too cramped quarters they acquire the swarming impulse, and that under this influence they begin to rear queens; hence if we confine bees in a hive or box the same condition is brought about, but ir a much shorter time. Whether the condition under confinement is the same as the swarming impulse, we do not know definitely; but, what is more to the purpose, we do know that they accept large numbers of queen cells.

DESCRIPTION OF BOX.

A style of swarm box which has proven very satisfactory in the Department apiary is made large enough to hold five frames of standard Langstroth size (see figs. 6 and 7). The bottom is covered with wire cloth, and small wooden strips, nailed on each end, raise the bottom from the table or floor on which the box rests and thus allow abundant ventilation. The top of the box is removable, and has cut in it two slots, into which are fitted two cell bars. Holes are bored in the latter to accommodate 16 flanged wooden cell bases. These slots, which run almost the entire length of the box, are so placed that if a frame of comb be put on each side of the box and another exactly in the middle, the slots are directly above the intervening spaces. This then places the cell cups directly over the two spaces left in the box.

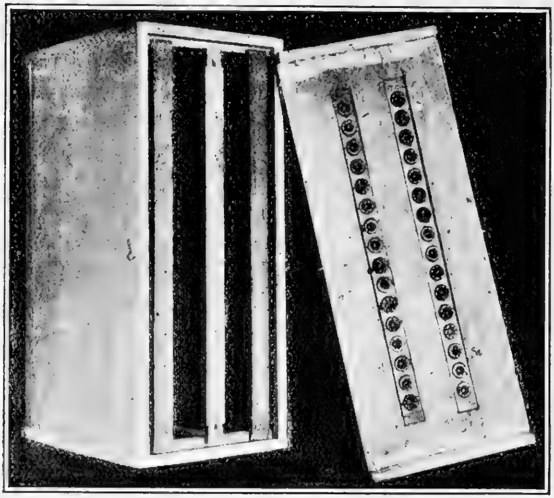

FIG. 6.—Swarm box, showing position of frames and inner side of lid, with wooden cells in place, ready for bees (original).

METHOD OF USE.

In practice, this box is placed on the ground in front of any hive from which a considerable number of bees can be taken. The two side frames are placed in the box, and bees from about six frames of the hive are shaken into it, the middle frame is inserted, and the box is closed. The slots should contain the cell bars and the wooden cells, which are, however, still empty. The frames used in the swarm box must contain honey, pollen, and water, but no brood, and the operator must be absolutely sure that the queen of the colony from which the bees are drawn is not in the swarm box. To allow easy manipulation, the lid of the box should be nailed down or otherwise secured and the box removed to a cellar or other cool place for about six hours. It has been found even better to use only one frame, properly provisioned, in place of three, placing it in the middle of the box; but for the beginner the use of three frames is recommended. When only one is used more bees should be shaken into the box.

At the end of about six hours the wooden cell bases are removed one at a time, using an extra base as a plug to prevent the escape of any of the bees, and into each base is placed a little royal jelly and a very young larva from the colony of the breeding queen. It is not absolutely necessary to use royal jelly at this time, for if enough of the larval food be transferred from the worker cell with the larva to

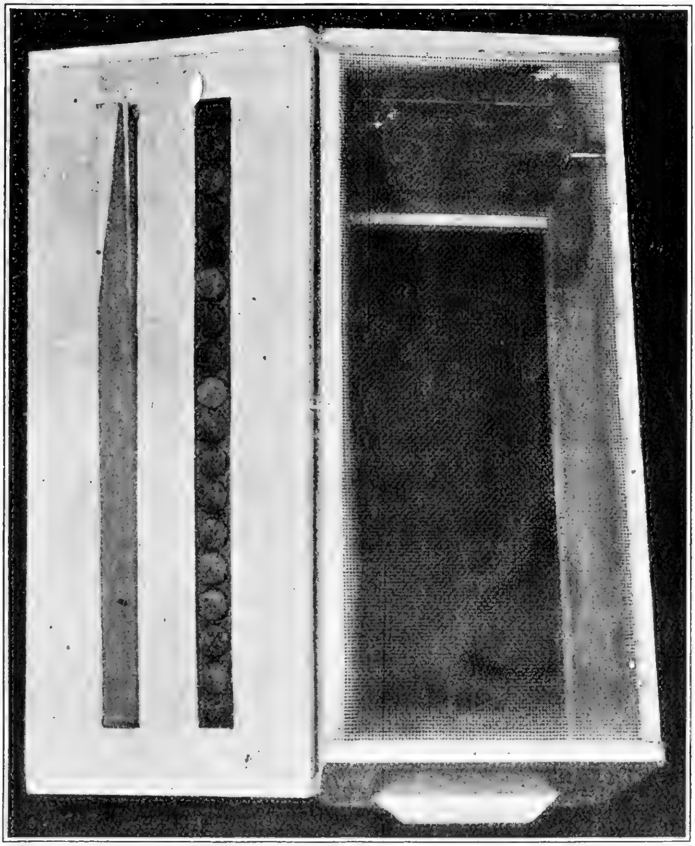

FIG. 7.—Swarm box from below, with top of lid. A blank bar is in place in one slot, as used when only sixteen cells are to be started (original).

keep it moist for a short time, the confined bees will secrete royal jelly so rapidly that the larvæ will neither dry up nor starve. However, in every-day manipulation it may be better to use a very little royal jelly, and the small amount of extra time required for this is, in the hands of most manipulators, generally repaid by the fact that more cells are accepted. The cell bases now containing larvæ having all been replaced, the swarm box is covered with a quilt to keep the cells warm and is put away until the next morning, at which time the box is opened, the bees shaken out in front of their old hive, and the cells on bars hung in any colony which will complete cells. By this method a much larger proportion of cells will be accepted, and the time required is very small. A schedule, which is in use in the Department apiary during the queen-rearing season, for the use of the swarm box, may not be out of place here to illustrate the small amount of time required for this manipulation, and to be used as a working plan:

9 a. m. Shake bees into swarm box. (About 5 minutes.)
3 p. m. Insert royal jelly and transfer larvæ to cell cups. (About 10–15 minutes.)
9 a. m. (next day). Shake out bees and place cells in colony to be completed. (About 5 minutes.)

While the construction of a special box and this manipulation may seem like an undue amount of labor, the schedule shows that such is not the case. In actual use in the apiary of the Department of Agriculture, it has been found not only to save time, but to be more satisfactory in every other way, particularly in the larger number and more uniform feeding of the cells accepted.

The swarm box has been criticised in various quarters as being opposed to the natural habits of the bees, and it is supposed that this is a valid reason for condemning it. It is a popular fallacy among some bee keepers that there must be absolutely no departure from the natural instincts of the bees, and a new or strange idea is frequently condemned on these false grounds. The same men will use movable frame hives and queen mailing cages, and will remove honey from the hives either by extracting or in the far more unnatural section. We must, as pointed out previously,[a] know the habits of the bees; but equally important in practical work is a knowledge of the amount of flexibility in the instinct. In fact, modern apiculture has come to be a study of the modification of conditions under which bees can thrive to bring about the best results for the bee keeper.

ALLEY SYSTEM OF CELL STARTING.

There is another method of starting queen cells which gives very good results. Mr. Henry Alley recommends that a strip of comb, with young larvæ from the breeding queen, be cut wide enough for one row of complete cells to remain intact. The outer portions of the cells on one side are cut away and every second larva is killed or removed. This strip is then fastened to the bottom of a comb with the open ends pointing downward, and the whole put in any colony used for cell building. The queen cells are built very regularly and a large proportion are accepted. In the apiary of the Bureau it has been found easier to use partly drawn out foundation in which are young larvæ, as shown in figure 8, thus avoiding the cutting away of

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[a] *See* "Natural queen rearing," p. 9.

the ends of cells. This method is very simple, since it does away with the necessity for transferring, and gives good results; but the cells must be cut apart to be put in nurseries, and in this manipulation they lack the firmness of cells with wooden bases. It has also been recommended that drone comb be used in the same way, and that a larva be transferred into every other cell. This plan, however, does not possess the one really good feature of the Alley method, and has therefore nothing to commend it.

THE USE OF "COCOONS."

Another plan, used by several queen breeders, is that of transferring the larva in the "cocoon" to an artificial cell cup. The comb is cut down until quite thin (about three-sixteenths inch), and then bent back and forth until the lining of larval skins and the excreta, gener-

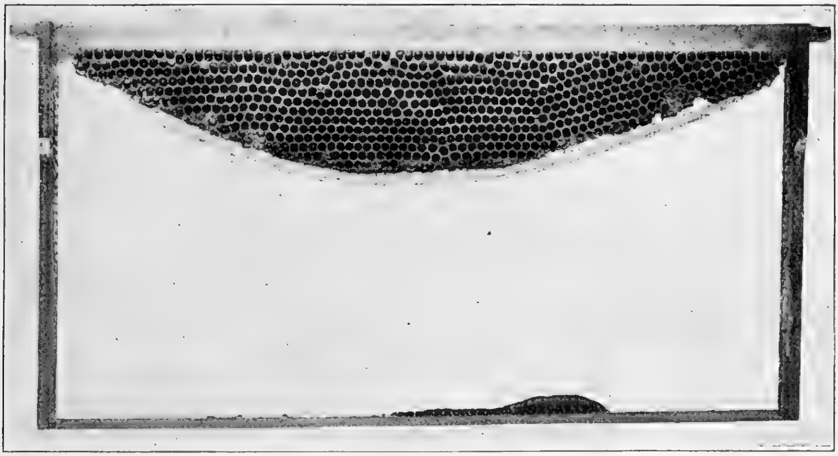

FIG. 8.—Frame with a strip of foundation only partly drawn out, with larvæ in cells, cut according to Alley plan of cell starting (original).

ally called the "cocoon" by bee keepers, is loosened. This is transferred by forceps, or on the end of a rounded stick with a depression in the end. This plan does not require the use of royal jelly; but it takes considerable practice to make the transfer successfully and seems to be no better than the method of transferring larvæ alone.

COMPLETING QUEEN CELLS.

INCUBATORS.

The carrying up of queen cells to the time when the adult virgin queen emerges is much easier than the starting of the cells. Cells once started may be hung in a queenless colony without any covering or protection, and it is an easy matter to have a large number cared for. In the practical work of the Department apiary it is customary to use cell bars holding sixteen cells each, and two or three of these bars are fastened in one Langstroth frame. Frequently two or even three such frames are put in one hive; but usually part of the cells are sealed or in nurseries, so that there are usually not more than fifty at a time which require feeding. These cells may also be put in any colony with a laying queen, provided an incubating cage of perforated zinc is placed around them (see figs. 4 and 5), or in the second story of a two-story colony, with the queen kept below by a perforated zinc honey board (see fig. 3).

STYLES OF NURSERY CAGES.

One day before the queens are due to emerge, each cell must be placed in an individual nursery, so that the young emerging queens can not attack each other. This nursery may be made of wire cloth

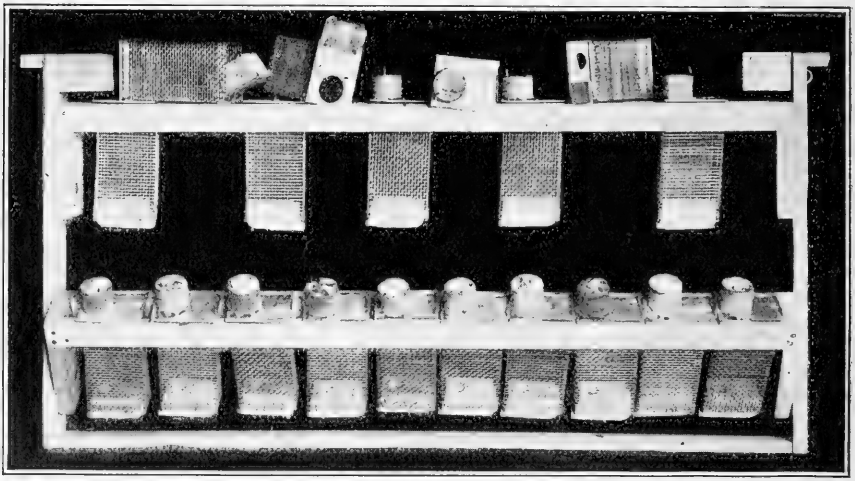

FIG. 9.—Titoff nurseries in frame holder, showing construction of nursery (original).

or of perforated zinc, but wire cloth is perhaps better, since in one or two cases in our apiary, during the past summer, young virgin queens managed to get through the perforated zinc and to do some damage before being discovered. The cell should not be put in a wire-cloth nursery more than one day before the queen is due to emerge, for the workers should be allowed to thin down the wall of the cell so that the queen will have no difficulty in gnawing her way out. Even when separated from the workers by wire cloth for one day, the queen usually takes a longer time in getting out, but no queen which has vitality enough to become a prolific layer will ever entirely fail to do so.

Many different kinds of nursery cages have been advocated, and really there is little choice between them, each queen breeder preferring the one he has used, the choice frequently being made without trying any other. Before making a choice, however, it would be wise for the prospective queen breeder to study the problem. The ideal nursery cage must at the same time be an introducing cage; so that from the time when the queen cell is put in until the queen is transferred to another hive to be mated, no attention is necessary except to uncover the candy plug to allow the workers to eat the queen out. The Stanley cage, consisting of a cylinder of perforated zinc, will do

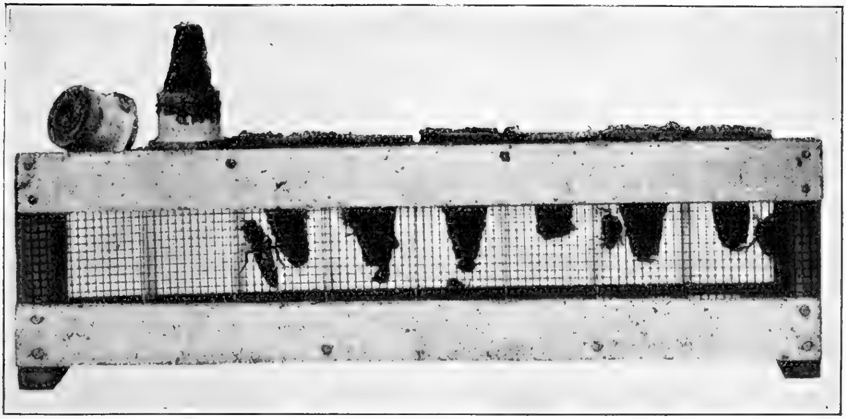

FIG. 10.—"Swarthmore" nursery, with queens. Two cells removed to show construction (original).

very well, provided it is modified so that it can be used as an introducing cage, but it is awkward and not easily handled in a hive. The long West cell protector is also good, except that it is not so convenient for introducing and does not fit into any bar, but must be stuck on a comb. It may also be added that any cell protector is worse than

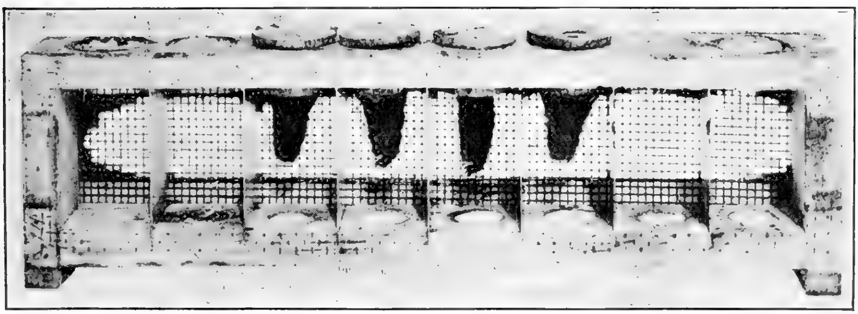

FIG. 11.—"Swarthmore" nursery dissected (original).

useless where artificial cells are used. Where the old method of cutting natural cells from colonies and transferring these cells to queenless colonies is practiced, a cell protector is desirable and almost necessary, since the workers in repairing the cut edges of comb often gnaw entirely into the cell and kill the queen. The author has never known this to happen on artificial cells. The Titoff cage (fig. 9) is also very good, but has the disadvantage of being awkward to handle in a frame and of being made for use without flanged cell cups. It is a convenient cage for introducing, however.

The Alley nursery, consisting of a block of wood with a large hole bored through it, is excellent. The openings are covered with wire

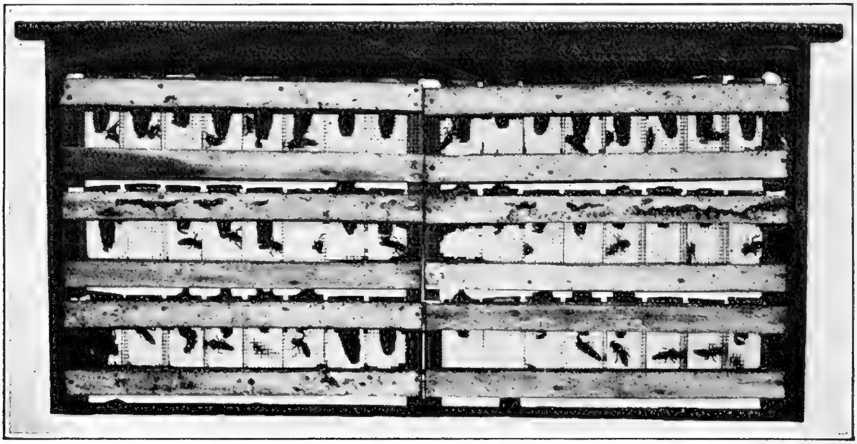

FIG. 12.—"Swarthmore" nurseries in frame, showing method of storing forty-eight queens (original).

cloth, and a hole for the queen cell and one for the candy plug are bored to meet the central hole. It will be found that a cage made with a wooden frame will be better than an all-metal cage, since it is

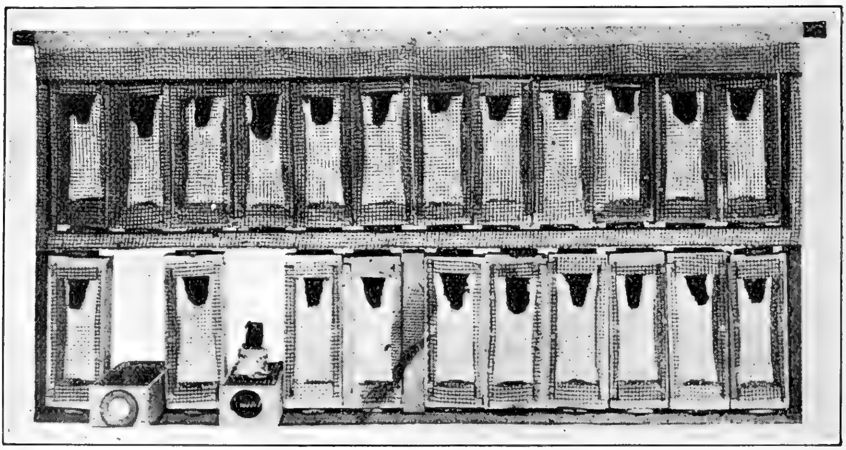

FIG. 13.—A style of cage which answers all the requirements for convenience and usefulness as nursery and introducing cage (original).

more easily placed in the hive in any desired location, and is held in place with propolis. These nurseries can be placed in an empty frame, and left until the frame is filled solid with them; and in this way a colony will keep a good many cells warm until the queens emerge.

The Swarthmore nursery, shown in figures 10, 11, and 12, is excellent also, but it is unfortunate that when this form is used the queens must be removed to introducing cages. This nursery is more valuable when used for keeping queens on hand for some time after mating. Queens can be removed from the mating colonies and stored in them for several weeks even, without any harm; and the mating colony can be used several times in that period for mating other queens. The size of this nursery is very convenient, and 48 queens may be kept in a frame, as shown in figure 12. In the illustration these queens were actually Caucasian virgins, and the nursery had been used for emerging queens. This is not the most convenient nursery for virgin queens, and the author understands that the originator, Mr. E. L. Pratt. does not so use it.

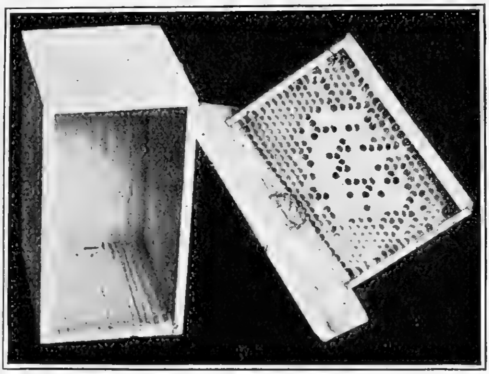

FIG. 14.—"Swarthmore" nucleus with one frame removed to show construction (original).

A nursery, then, should be so constructed that the queen will be separated from the workers by wire cloth; should be of such a form that any style of artificial queen cell may be placed in it; should contain a place for candy as food for the young queen; and should above all be useful as an introducing cage. The use of a special introducing cage of any type is not generally recommended. Even in introducing queens received by mail the shipping cage is as good as any "improved" introducing cage and saves time.

FIG. 15.—"Swarthmore" nucleus with introducing cage (as in fig. 13) in place between the frames (original).

INTRODUCING QUEEN CELLS.

But it may be asked, "Why not introduce queen cells directly to the colony where the queen is to stay until mated?" This method is all right where time is no object; but the queens might just as well be kept in a nursery until three to five days old, and thus they need not be in the mating colony more than four or five days. If a queen cell be placed in a mating colony it means that for a day or two before the queen emerges, and for at least five days before she mates, the colony is unproductive; and commercial queen breeders can not afford such a loss. Such a method of introduction is easier, it is true, but certainly is not economical. In introducing from a nursery it sometimes happens that queens are killed, but even this loss is not great enough to justify the method of introducing cells, especially since queens from cells are sometimes rejected also.

The practice of putting a little honey on the tip of the queen cell when in a nursery, so that the emerging queen may have something to eat while gnawing her way out is not necessary, and has, when practiced, sometimes led to the death of the queen by suffocation.

MATING QUEENS.

The best method of mating queens has perhaps been more discussed by bee keepers than any other phase of queen rearing, the bone of contention being the size of the colony which shall be used in mating.

Some bee keepers insist that queens should be mated only in full colonies, while others go to the opposite extreme and claim that only a handful of bees are necessary to care for a queen during this period of her life.

COMPARISON OF DIFFERENT SIZES OF BOXES.

A comparison of the cost of the two methods will help to solve the difficulty, for bee keeping is a business proposition, and bee keepers desire the most return for the least expenditure of either time or money. Mating in a colony means that that colony is without any new brood for about a week; and since during the summer season the life of the average worker is about six weeks, the loss resulting is about equal to one-sixth the cost of the colony used. This is to some extent made up by the increased activity in brood rearing after such a period of rest; but at any rate a colony can make no increase in size when queens are being mated, and there is almost always a loss. From this standpoint, then, the smaller the colony, the cheaper this part of the rearing will be; and if this were the only point to be considered there could be but one answer to the question.

The time spent in manipulation is an important item, especially where large numbers of queens are to be reared. It is more difficult to introduce a queen into a large colony than into a small one, and this is a factor to be considered, since the chances for occasional losses of queens which may result in considerable loss of time are much reduced by the use of small colonies. In looking over mating colonies to see whether the queen is laying, there is everything to be said in favor of the small colony or "nucleus." There is less comb area to be covered, and, if any eggs are present, it is easy to see them at a glance; but the chief gain is in the time spent in finding the queen to remove her from the colony. To go over 8 or 10 or even 3 or 4 full frames requires ten times as much time as to open up a small nucleus and pick off the queen almost at the first glance. This much is in favor of small colonies, certainly.

There are, on the other hand, certain disadvantages in the use of very small nuclei in the hands of the inexperienced. Queens can be mated from small boxes with a comb area not greater than that of a 1-pound section of honey, and with a mere handful of bees; but experienced bee keepers have failed to make these work successfully, merely through ignorance of the special manipulation necessary for the smaller colonies. The complaint is also sometimes made that these nuclei are robbed out because the small number of bees will not defend the hive against invaders and that the colony will "swarm out" or leave the box because it is too small. It is also claimed that the nucleus will not be a success unless there is unsealed brood in the comb to hold the bees. All of these general statements are too broad, for such colonies are not more easily robbed than large ones, do not swarm out if properly made, and brood is unnecessary under some circumstances. However, there is a foundation for these complaints, every one of which comes from experienced men.

The entrance to a nucleus of the smallest size should be very small, so that one bee can protect the hive from several robbers. If, by any chance, a small colony without brood becomes queenless, it will almost invariably swarm out, and to this must be attributed most of the cases so reported. Unsealed brood undoubtedly helps to hold the bees in the colony, and certainly should be used in most cases. After the first laying queen is removed from a nucleus, this brood will be present; and from that time on there is no difficulty. To prevent the bees from swarming out with the first queen, brood may be given to them. If, however, the bees are confined in the colony for some time (to which there is no valid objection), they will rarely swarm out, even without brood, and to remove them to an out yard lessens this difficulty still further.

Nuclei with not more than a few dozen bees will mate a queen, and this has been done, and is being done repeatedly. There is objection, however, to the use of the smallest nuclei in the hands of the inexperienced, for they will die out unless watched, and often require restocking. In a large queen-rearing yard, this frequently amounts to considerable labor, and to avoid that feature a somewhat larger nucleus is desirable. Bee keepers are not always adepts at handling small nuclei, and in actual practice a colony should be in such condition that it can be handled quickly, safely, and sometimes even rather roughly.

A size of nucleus which has proven to save both time and labor in the apiary of the Department of Agriculture is one having a comb area somewhat less than one standard Langstroth frame. The hive bodies were originally made large enough to hold five frames, as shown

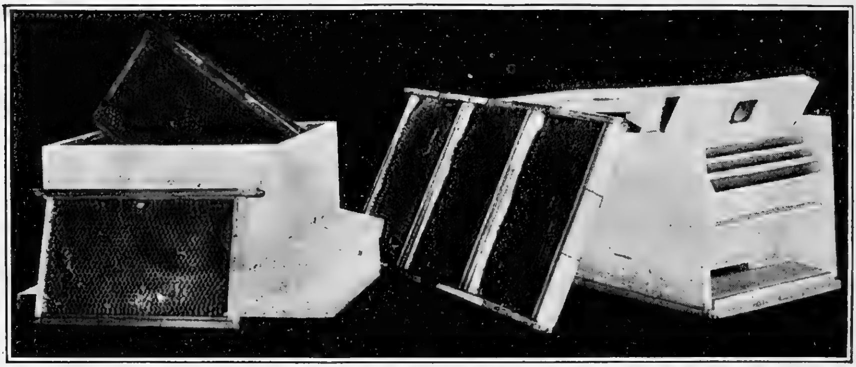

FIG. 16.—Benton mating boxes, showing method of combining frames to make a standard sized frame, and positions of feeders (original).

in figure 16; but, in practice, three or even two are used, and the extra room is an advantage in moving the frames quickly. The construction of the frames is shown better in the illustration than could be done by a written description. Any frame used in a nucleus should be so made that it can be used as part of a standard-sized frame, or so that a number of them fit into an empty frame; for otherwise it is difficult to get them filled with honey and brood before making up the nuclei. The frames of this particular nucleus box are one-third standard size, and two full ones and one only partly built out have given most satisfactory results. If the bees are ready to build, some place should be left for new comb; otherwise they will build small combs to the cover. A feeder is attached either to the back of the hive body, or in front over the entrance, and these can be filled very rapidly when feeding is necessary. A colony of this size requires much less attention in this regard than the smaller size, and is correspondingly better.

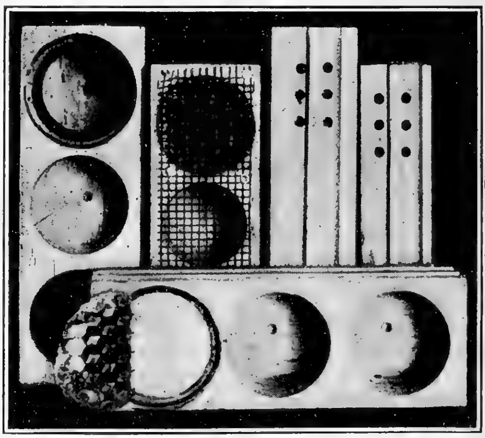

FIG. 17.—Benton mailing cages, showing construction. The larger size is for shipment to distant countries. The smaller cage may be used for shipments to Europe (original).

The comb area is small enough in this hive for the queen to be very quickly found, and, unless too many bees are put in, this part of the manipulation is very simple. The original cost of the hive is considerably more than that of the smallest sized nuclei, but the body is much more durable, and the cost as compared with that of the full-sized hive, which some breeders use, is small. This mating box was designed by Mr. Frank Benton, of the Bureau of Entomology. It is not intended that the inference shall be made that this nucleus box is the best in use. It is described merely as a guide to queen rearers, and any other style of box which combines the good features of this one will do equally well.

No one can deny that queens may be mated in hives smaller than a full colony, but a question sometimes arises as to whether the queens are as vigorous and prolific after being mated from small boxes. To this, it may be answered that the successful mating of a queen depends on the drones which fly in the air; and this is in no way influenced by the size of the hive. It takes very few workers to feed a queen—witness the mailing boxes—and this is the only function of the accompanying bees. If then a queen is herself strong and vigorous, and meets an equally vigorous drone, she will be successfully mated, will be just as prolific, and will lay just as long, when kept in a small colony to mate as in a full-sized one. From a practical standpoint it may be answered that queens mated in small nuclei when put to the test have actually proven as good as those mated under other circumstances. This is after all the true test to be used.

PHENOMENA IN MATING.

In from five to ten days after the emerging of the young queen from the queen cell, she leaves the colony for her mating flight. The first flights of a queen from the hive are very short, and, like young workers, she flies in circles near the entrance, as if fixing the location. Several such flights may be taken before she really takes a long one. Finally, however, she leaves the entrance and flies in ever-increasing circles upward, and, if there are drones in the apiary or near by, she is usually mated. The height to which she flies and the distance from the hive at which she meets the drone depend entirely on circumstances; it may be near at hand or even a couple of miles away. This is a matter very difficult of observation, naturally, but the mating has often been observed by chance. It is a very simple matter to see the first circles of the virgin on leaving the hive entrance, and if drones are plentiful it is not hard to see that many of them start after her. Anyone can verify so much; the rest depends on chance observations.

From dissections of virgins and fertile queens, it has been found that, in mating, the spermatheca or seminal receptacle is filled with spermatozoa or male sex cells. The spermatheca is a very minute sac opening into the oviduct down which the eggs must pass in going from the ovaries to the outside of the body. As each egg is laid, if it is to be fertilized, it receives one spermatozoon from this spermatheca, and the male cell is received into the egg and unites with it. More than one spermatozoon may adhere to the outside of the egg, but no normal egg will admit more than one through the micropyle or opening in the end of the egg covering.

In mating, the queen receives an enormous number of these spermatozoa, the number having been estimated at from two to twenty million. Since mating usually occurs but once, it is evident that these spermatozoa must be capable of independent existence for five years or more, for they are not capable of dividing or increasing in number in any way, and the queen is of course unable to produce new ones. Frequent cases have been reported of queens which have mated more than once, and this probably accounts for irregularity in the markings of the offspring of some queens. It is claimed by some that obviously the first mating must have been unsuccessful, but there seems to be no ground for that view, and there is no reason to believe that both matings were not complete. There is no reason whatever, so far as is known, why a queen can not receive a supply of spermatozoa from two drones, and some of the arguments to the contrary, with no basis of observation or knowledge of the anatomy, are not worthy of consideration. Cases have even been reported in which queens which have actually begun to lay have gone out for a second mating; but the evidence is as yet meager, and it will be well to wait for further observation before considering such a possibility. Usually, however, a queen takes but one mating flight, and thereafter never again leaves the hive except with a swarm. The ovaries develop to such an extent that flight is impossible, without a previous stoppage in egg laying.

TESTING QUEENS.

If the honey producer is rearing queens for his own use, they may be introduced into full colonies as soon as they begin to lay. A fair idea of the value of the queen may be formed from the number and regularity of the eggs laid in the nucleus box, and if later she is found to be mismated, or not up to the standard in egg laying in a full colony, she should be discarded. A queen may be tested as to the purity of mating by allowing her brood to emerge in a small nucleus, but no estimate can be made in this way concerning her prolificness. In testing for pure mating, however, the entrance should be covered with perforated zinc to prevent the colony from swarming out. If a queen is to be sold as "untested," she may be shipped as soon as she begins to lay after mating. Tested queens are those which have been kept until their progeny show the markings of pure mating.

Tested queens which have been kept in full colonies to observe purity of mating, and which after one season show that they possess ability to produce strong colonies, are sold as "select tested." However, it is to be feared that some queen breeders are not careful enough about this test and that queens are often sold under this guaranty which are simply tested queens one year old, which simply means that their life of usefulness is thereby shorter by one year. For breeding, nothing but the very best of "select tested" queens should be used. Great care should be exercised in choosing such queens by watching purity of mating, prolificness, honey production of workers, disposition of bees, tendency to keep a very large colony of bees at all seasons; and especially, care should be taken that brood rearing does not cease as soon as the honey flow slackens in midsummer. Some bees, otherwise good, will stop brood rearing with the first sign of a decrease in honey, with the result that the colony enters the fall flow with old bees, and that scarcely anything but old bees are in the colony at the beginning of winter. This is probably the essential cause of the excessive death of bees in early spring, known as "spring dwindling."

NECESSITY OF PURE STOCK.

The necessity of purely-mated queens for breeding can not be too emphatically urged. The so-called "hybrids," or mismated queens, produce young queens of so much variability in every character that it is very unwise to use them. There is one phase of queen breeding which would doubtless prove useful, but which has not yet been tried to any extent. The first crosses of various races have proven very useful; as, for example, the cross between Cyprians and Carniolans, but no breeder to the writer's knowledge has ever undertaken to fix the type. That this could be done seems very probable, reasoning from what we know of crosses in other animals, and by careful selection of prolific queens whose workers showed all the characteristics of the first cross, these crosses would doubtless prove valuable as breeders. Under no other circumstances, however, should mismated queens be used.

SELECTION OF DRONES.

The selection of drones is one of the things in which the vast majority of bee keepers are notoriously careless. Queen breeders will select a breeding queen with great care and allow her progeny to mate with drones from any hive in the apiary, and just as long as this is done there can be no advance in the types. Drones should not be allowed to fly except from colonies where the queens are prolific and the bees good workers, and just as much care should be exercised in the choice of colonies for the production of drones as for breeding queens. The mere fact that mating takes place in the air, out of the control of the bee keeper, is no reason why care should not be taken in the selection of drones which are allowed to fly in the yard. When breeding any race, Italians for example, it is not enough that all the drones be Italians; they should be selected as to honey production of the workers, prolificness of the queen, or any other quality which is considered in choosing a breeding queen.

Selection of drones may be accomplished by the use of drone traps or by cutting out drone comb. For absolute safety the drone trap is preferable, since some drone brood may escape observation. When most colonies are requeened every season, only queens of breeding value should be kept, since old queens produce larger numbers of drones.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ENTOMOLOGY—BULLETIN No. 56.

L. O. HOWARD, Entomologist.

THE BLACK HILLS BEETLE,

WITH

FURTHER NOTES ON ITS DISTRIBUTION, LIFE HISTORY, AND METHODS OF CONTROL.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST.

BY

A. D. HOPKINS, Ph. D.,

In Charge of Forest Insect Investigations.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., November 14, 1905.

Sir: I transmit herewith the manuscript of the report of Dr. A. D. Hopkins, of this Bureau, on an investigation of the Black Hills beetle, with especial reference to its occurrence in the Pikes Peak Forest Reserve and in the vicinity of Colorado Springs and Palmer Lake. This investigation was made at the request of the Bureau of Forestry, and I recommend the publication of the report, which brings the information concerning this species up to date, as Bulletin 56 of this Bureau. The figures and plates are necessary for the illustration of the text.

Respectfully,

L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE BLACK HILLS BEETLE.

(*Dendroctonus ponderosæ*[a] **Hopk.**)

INTRODUCTORY.

The object of this bulletin is to give additional information on the distribution, life history, habits, and methods for the control of the Black Hills beetle, based on further investigations by the writer and his field assistants, and information through correspondence with forest officials and others.

It is now known that this beetle occurs in the eastern sections of the Rocky Mountain region from the Black Hills of South Dakota to northern New Mexico; and there is evidence that its distribution extends westward into Utah and northern Arizona.

It attacks and kills the western yellow or bull pine (*Pinus ponderosa*) and the white spruce (*Picea canadensis*) in the Black Hills of South Dakota; and the western yellow or bull pine, the limber pine (*Pinus flexilis*), and the Engelmann spruce (*Picea engelmanni*) in the Pikes Peak region.

Wherever this insect is found in abnormal numbers its depredations on living timber are more or less extensive. It has killed between 700,000,000 and 1,000,000,000 feet of timber in the Black Hills Forest Reserve, and is also demonstrating its destructive powers in central Colorado and New Mexico.

The method for its control recommended by the writer and adopted in the Black Hills and Pikes Peak region has been sufficiently tested to show that it is both practicable and effective, and that, under proper management, a forest can be protected at a moderate expenditure, or almost without cost where there is a market for the timber.

HISTORICAL REFERENCES.

Probably the earliest published information on the destructive work of this insect is that by Prof. H. S. Graves,[b] in which he refers to the dying pine timber in the Black Hills of South Dakota. He stated that the patches of dying and dead timber are usually rectangular in shape, following the tops of the divide or ridges and running lengthwise up and down the slope, and that this injury was probably caused by bark-boring insects of a species of Scolytidæ.

[a] Family Scolytidæ. [b] Ninth Rept. U. S. Geol. Surv., Pt. V, p. 87, 1897–98.

Specimens of the bark-boring insects found attacking the living trees in the area mentioned by Professor Graves were sent to the Department of Agriculture in August, 1898, by Mr. William M. Pratt, from Piedmont, S. Dak., and by Mr. H. E. Dewey, from Lead, S. Dak., and more specimens were sent in by Mr. Dewey in August, 1899. These were at first identified as *Dendroctonus rufipennis* Kirby, and as *D. terebrans* Oliv.; but in 1900 they were examined by the writer and were found to represent an undescribed species of Dendroctonus. Specimens of the same insect were also found in the collections of the American Entomological Society, at Philadelphia, and in the United States National Museum, labeled South Dakota, Utah, and Colorado, the latter from Pikes Peak, July 10, 1900.

In September, 1901, upon the request of Mr. Gifford Pinchot, Chief of the Bureau of Forestry, and under the direction of Dr. L. O. Howard, Chief of the Division of Entomology, an investigation of the trouble affecting the timber in the Black Hills Forest Reserve was made by the writer; and on October 23, 1901, a typewritten report was submitted to Doctor Howard and Mr. Pinchot which, with additional data and illustrations, was transmitted for publication in January, 1902, and was issued in that year as Bulletin No. 32, new series, of the Division of Entomology. In this bulletin the new species found to be the primary cause of the death of the timber was described under the name of *Dendroctonus ponderosæ*, and certain facts in its habits and life history were presented, together with *recommendations based thereon, for felling and barking the infested trees at a time of the year when the mere removal of the bark from the main trunk, without burning, would be sufficient to kill the broods.*

In July, 1902, Mr. John P. Brown, secretary of the International Society of Arboriculture, issued a "Special Rocky Mountain Bulletin on the Destructive Beetles of *Pinus ponderosa*," in which reference is made to the destruction of pine timber in the Black Hills of South Dakota and in Colorado by two beetles, which he designates as the "large destructive barkbeetle" and the "small destructive barkbeetle," but he omitted their scientific or technical names. Therefore it is not known to what particular species he referred, or whether or not he had two or more species confused. It is evident, however, that the depredations in the Black Hills were caused by *D. ponderosæ*, previously described.

Mr. Brown recommended the remedy of felling and barking the trees and burning the bark with the tops; but his main argument was for the protection of insectivorous birds.

In 1902 Mr. J. L. Webb, special field agent in forest insect investigations, assigned from the Bureau of Forestry, and working under instructions from the writer, spent five months (May 28–October 30) in the Black Hills Reserve, studying the life history and habits of the beetle. He also conducted extensive trap-tree experiments, in which over two hundred matured healthy trees were girdled or felled to determine their attractive influence on the Black Hills beetle and other forest-tree insects. In August, 1902, and June, 1903, the writer visited the reserve and made special studies of the beetle and of the trap-tree experiments. In October and November, 1902, and November, 1904, Field Assistant H. E. Burke visited the reserve for the same purpose, and Forest Ranger W. G. Courtney made records of observations on the trap trees from June to October, 1903.

August 12, 1902, Prof. C. P. Gillette sent specimens of a barkbeetle from Bailey, Colo., with a statement that he had found it in dying pine trees. This proved to be the Black Hills beetle, *D. ponderosæ*, and was the first authentic record of its work in Colorado.

During a special investigation in May, 1903, the writer found the same species in northwestern New Mexico, in the vicinity of Vermejo, where it was attacking and killing the matured pine timber over a large area. Here the method of cutting and barking the infested trees was recommended.

In December, 1904, specimens of the beetle were sent by Mr. P. P. Blass, with a statement that a large amount of timber was dying in the vicinity of Palmer Lake. In reply, Mr. Blass's attention was called to the dangerous character of this enemy of pine trees, and published data on the subject, supplemented by written instructions for the cutting and barking of infested trees, were sent him. Upon the suggestion of Mr. Blass, on February 15, 1905, a set of bulletins and written instructions were also sent to the town board of Palmer Lake. This resulted in the cutting and barking of a large number of infested trees by different people in that vicinity. Upon information from the clerk of the town board of Palmer Lake that the timber was dying in the forest reserve, adjoining the town property, information was conveyed by the writer to the Forest Service, together with copies of recommendations for the cutting and barking of infested timber; also stating that upon receipt of information from the supervisor as to the character and extent of the trouble in the reserve, the Bureau of Entomology would take the matter up with them and, if necessary, send a man into the field to make special investigations. Later a report of May 11, 1905, addressed to the Forest Service by Supervisor Clarke, was referred to the writer on May 17. In reply to this, more detailed instructions were sent to Supervisor Clarke, for the identification of the trees which should be cut, with the statement that it would be more desirable for the Bureau to make an investigation in the fall.

In a letter dated July 14, 1905, Prof. C. P. Gillette, State entomologist of Colorado, stated that during a visit to Palmer Lake he noted that a large amount of timber was dying in that vicinity. The specimens sent to the Bureau of Entomology with his letter proved to be the Black Hills species, thus leaving no doubt regarding the primary enemy and the great danger of an invasion which might soon extend beyond control unless active measures were adopted.

In the meantime, General Palmer, certain members of the faculty of the Colorado College, and others interested in the protection of the forests in the vicinity of Colorado Springs had inaugurated an active campaign to control the ravages of the beetle, in which the services of Prof. Lawrence Bruner, of the University of Nebraska, were secured to make investigations and give instructions in felling and barking the timber. Two reports were submitted by Professor Bruner to General Palmer, one dated August 2, the other September 19. These reports, together with correspondence and other data, were published in Arboriculture for October, 1905, pages 205–212.

Under Professor Bruner's direction between 600 and 800 trees on private lands in the vicinity of Glen Eyrie, Colorado Springs, and adjoining the reserve were felled during August, September, and October, and the bark removed and burned with the tops, to kill the insects with which they were infested.

On September 16 a full report of the results of explorations by the forest rangers in the Pikes Peak Forest Reserve was submitted to the Chief of the Forest Service by Supervisor Clarke. This included specified descriptions of ranges and sections containing infested timber which General Palmer had requested permission to cut and bark at his own expense, for the further protection of the surrounding public and private forests. Copies of these typewritten reports and statements were submitted by the Acting Forester for consideration, and upon consultation with Mr. Gifford Pinchot, Forester, and Mr. Overton W. Price, Associate Forester, it was decided that the writer should proceed at once to make the necessary investigation on which to base recommendations for the consideration of forest officials and others, in further efforts to control the destructive insects in and around the Pikes Peak Reserve.

This investigation was made October 5 to 13, 1905, and the following report submitted:

REPORT ON FOREST INSECT INVESTIGATIONS IN THE PIKES PEAK FOREST RESERVE.

OBJECTS.

The object of this special trip was to investigate the character and extent of depredations by the pine-destroying beetle of the Black Hills (*Dendroctonus ponderosæ* Hopk.) in the pine forests of the Pikes Peak Forest Reserve, in the vicinity of Colorado Springs and Palmer

Lake and at such other points as might be deemed necessary; to give instructions to the forest officials and others in carrying out our recommendations for the control of this and other insects directly associated with the dying timber, and to determine for the Forest Service the approximate extent of necessary cutting of timber on the reserve to protect the remaining living timber in the vicinity of Colorado Springs and adjoining private estates, as proposed by Gen. William J. Palmer.

EXPLORATIONS.

Beginning on the morning of October 5 explorations were made as follows: Glen Eyrie trail on mountain northward, returning via Douglass Canyon; October 6, from Glen Eyrie by way of Colorado City, Bear Creek Canyon, High Line road, to Bruin Inn, returning by way of North Cheyenne Canyon, Colorado Springs, and Palmer Park; October 7, from Glen Eyrie by way of Manitou, over Crystal Park trail to Crystal Park, returning by the Bear Creek trail, Bear Creek Canyon, and Colorado Springs; October 8, from Glen Eyrie, by way of Blair Athol, Pike View, Pope Ranch, and Palmer Park; October 9, from Colorado Springs by way of Colorado Springs and Cripple Creek Railway to Clyde, thence by wagon to an altitude of about 10,000 feet, returning by same route to Colorado Springs; October 10, from Colorado Springs by way of the Colorado Midland Railroad to Woodland Park, thence by wagon to Manitou Park; October 11, by saddle from Manitou Park east to Palmer Lake, thence by wagon southeast by way of Husted to Woodland Ranch; October 12, in the Colorado pinery on the Arkansas and Platte divide; October 13, in the Colorado pinery, returning by way of Colorado Springs to Glen Eyrie.

Additional explorations were made on the 12th and 13th by Mr. Edmonston, under my instructions, in the vicinity of Palmer Lake.

During all but one of these trips I was accompanied by Mr. W. D. Edmonston, head ranger of the Pikes Peak Forest Reserve, who was designated by Forest Supervisor Clarke as the proper official to receive instructions in the identification of the infested trees to be felled and barked to kill the principal insect enemies. I was also accompanied on a number of the trips by General Palmer's foreman, who received similar instructions. Supervisor Clarke accompanied us on two trips, General Palmer on three, and Forest Assistant Clement on two.

SUMMARY OF RESULTS, CONCLUSIONS AND RECOMMENDATIONS.

(1) The depredations by the Black Hills beetle (*Dendroctonus ponderosæ* Hopk.) within the area examined are by no means as extensive as we were led to believe from the reports and correspondence.

(2) The principal areas of recent damage by this beetle in the reserve and on private lands are in the vicinity of Cascade and Palmer Lake; but evidence of old and new work was observed to be more or less frequent in all sections visited.

(3) The evidence found on old, dead, standing, and felled trees of the work of the Black Hills beetle on pine, the spruce-destroying beetle (*Dendroctonus piceaperda* Hopk.) on Engelmann spruce, and the Douglas spruce Dendroctonus (*D. pseudotsugæ* Hopk. MSS.) on Douglas spruce indicate that all of these species have been present and destructive to living timber in this region for at least fifty years. The number and distribution of such old beetle-marked trees indicate that very extensive depredations have been wrought by them in the Pikes Peak region within the past century; and present conditions also indicate that a large per cent of the vast destruction of timber, heretofore attributed to fire, was primarily due to the work of these insects.

(4) The three species of bark beetles above mentioned are without doubt the most important insect enemies of conifer forests in the central Rocky Mountain region; hence they are a constant menace to the remaining living timber in and around the reserves of central Colorado.

While at present the spruce-destroying beetle appears to be rare, and the Douglas spruce and Black Hills beetles are not common enough to cause extensive depredations, it is plain, from what is known of the destructive powers of these insects, that if neglected and if specially favorable conditions for their multiplication should prevail for two or more years in succession they could easily destroy all of the timber of commercial size and a large per cent of the reproduction.

THE BLACK HILLS BEETLE.

The Black Hills beetle (*D. ponderosæ*) is at present the most common and destructive enemy of the living pine timber in and around the Pikes Peak Reserve; therefore it should receive primary consideration.

The best success in any efforts by forest officials or private owners of forests to control this beetle will depend on a sufficient knowledge of the species, its habits, life history, and the influences which are favorable or unfavorable for its increase and destructive invasions.

Insufficient knowledge on these points results in the confusion of the primary and secondary enemies of the tree, unnecessary expenditure of time and money, by felling and barking trees at the wrong time of the year, or after the broods of the primary enemy have emerged, the felling of living trees which would have recovered, and the unnecessary destruction of beneficial insects and insect diseases by burning the bark.

The following description of distinctive characters of the beetle, its work, habits, life history, etc., is based on the results of our studies of the species in the field and laboratory, brought up to date, regardless of what has been previously published or given out in correspondence.

CHARACTERS OF THE BEETLE (FIG. 1).

The distinctive characters of the Black Hills beetle are its length, which is from one-sixth to one-fourth of an inch; its stout form, with broad head and prothorax; its black color, and the rounded or convex rear end of the body (declivity of the elytra), which is without conspicuous long hairs. The allied species, which may be mistaken for it, are distinguished as follows: The large red turpentine beetle (*Dendroctonus valens* Lec.) is much larger, is dark reddish in color, never black, and forms large masses of pitch at or toward the base of living and dying pine trees and stumps. The Colorado Dendroctonus (*D. approximatus* Dietz) is black, with broad head, but the body is more elongate, the front of the head is grooved, and the declivity of the elytra has long, stiff hairs; it lives in the bark of pine, but makes a winding, sometimes branched, gallery. The spruce-destroying beetle (*Dendroctonus piceaperda* Hopk.) is reddish brown to black, but with much narrower head, with long hairs on the declivity of the elytra, and is always found in spruce. The Douglas spruce beetle (*Dendroctonus pseudotsugæ* n. sp.) is dark red or brown, and always breeds in Douglas spruce and western larch. The species which most closely resembles the Black Hills beetle is the mountain-pine beetle (*Dendroctonus monticola* Hopk.), which is only distinguished in the adult stage by the smaller size, slightly less stout form, less distinctly roughened elytra, and more obscured rows of punctures on the sides of the elytra, the latter being the most important character for its distinction.

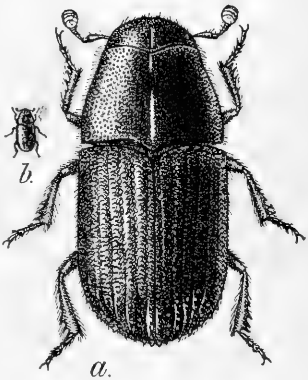

FIG. 1.—The Black Hills beetle: *a*, adult, enlarged; *b*, same, natural size. (Author's illustration.)

CHARACTERS OF THE GALLERY (FIGS. 2 AND 3 AND PL. I).

The primary gallery excavated in the bark by the Black Hills beetle is distinguished from that of any other species as yet known to live in the pine of the Black Hills or Colorado by the slight curve at the entrance end and the almost straight course with the grain through the inner layers of bark, and grooving the surface of the wood. There is only one pine-infesting species with which this form of gallery can be confused, namely, the mountain pine beetle, which has not as yet been found in the same region. If it should occur, however, the galleries may be distinguished by the smaller size, more

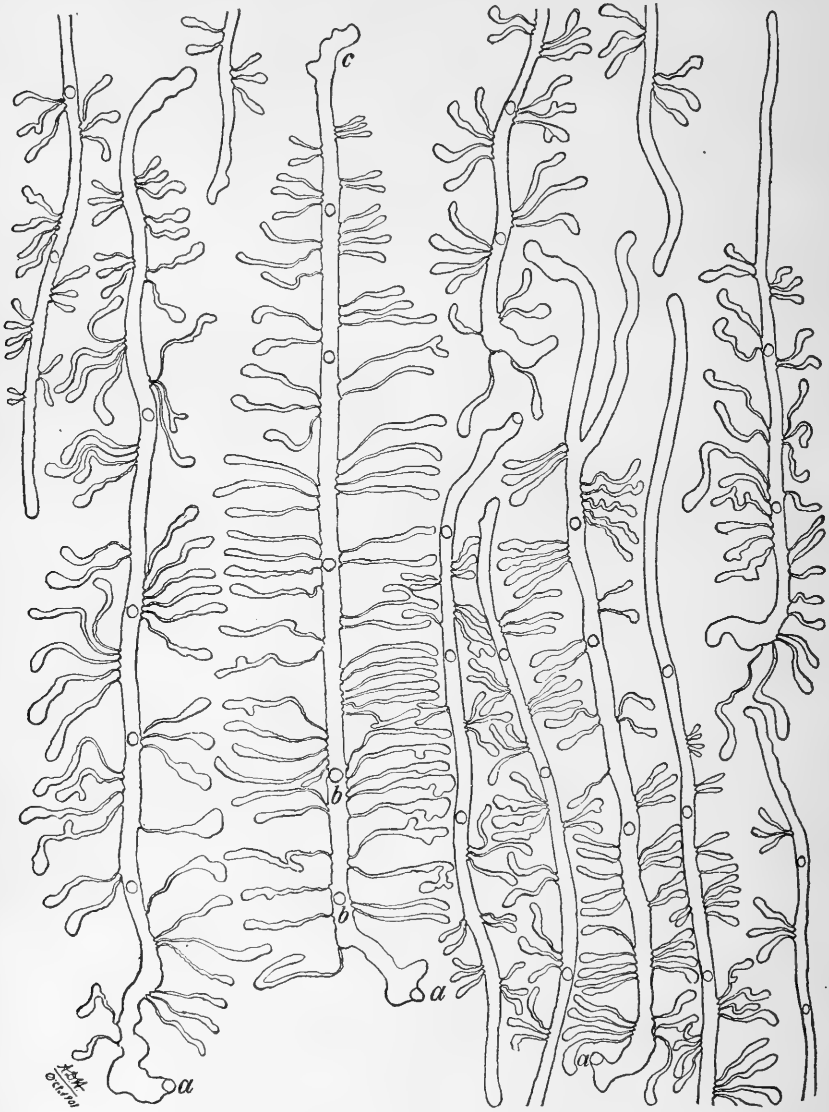

FIG. 2.—Work of the Black Hills beetle (*Dendroctonus ponderosæ* Hopk.). Primary galleries and larval mines in inner surface of living bark: *a*, entrance and basal chamber; *b*, ventilating holes in roof of gallery; *c*, termination. The larval mines radiate from the primary galleries. About one-half natural size. (Author's illustration.)

crooked and slightly winding course, and by the fact that they are more commonly met with in the silver pine, limber pine, and lodgepole pine. Whenever the Black Hills species is found in spruce the

FIG. 1.—PRIMARY GALLERIES AND LARVAL MINES IN INNER BARK. ABOUT ONE-THIRD NATURAL SIZE. (AUTHOR'S ILLUSTRATION.)

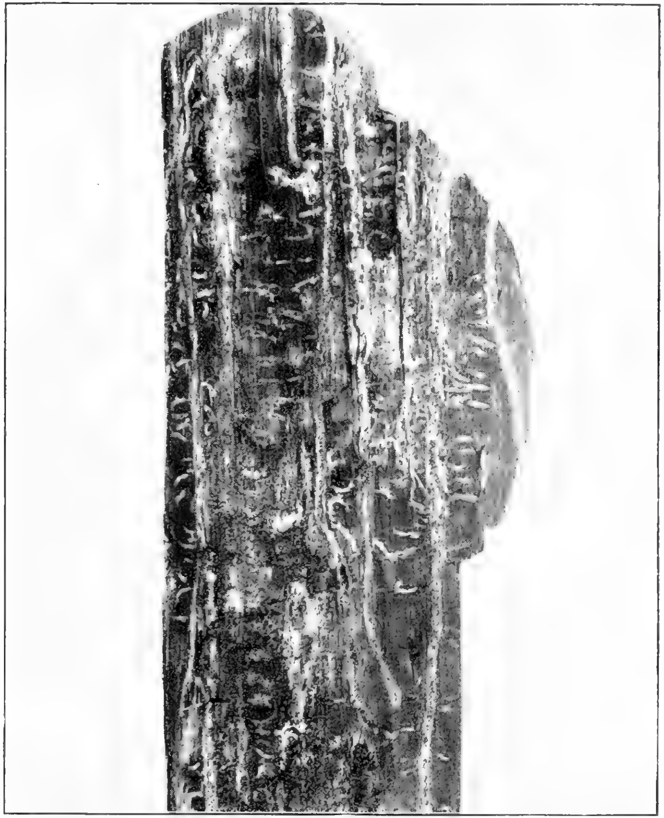

FIG. 2.—MARKS OF PRIMARY GALLERIES ON SURFACE OF SCORING CHIP. ABOUT ONE-THIRD NATURAL SIZE. (AUTHOR'S ILLUSTRATION.)

WORK OF THE BLACK HILLS BEETLE.

gallery is distinguished from that of the spruce-destroying beetle by its slender form and more evenly distributed side or brood mines.

CHARACTERS OF THE INFESTED TREES (FIG. 4 AND PL. II).

Trees attacked by the Black Hills beetle between July and October will be indicated by the presence of pitch tubes, or sawdust borings, and upon removal of the bark the young broods will be found mining through the inner living layers, or the bark will be entirely killed on the main trunk; but the foliage will remain green, or will be but faintly faded until May and June of the following year, when the leaves on the lower branches will turn yellow and die. This condition will rapidly extend to the topmost leaves, so that by the time the broods of maturing beetles are ready to emerge the foliage is yellowish red to light reddish brown in color. This is the stage of death called "sorrel tops." Later in the summer and during the following winter, after all living examples of the beetle have emerged, the foliage is dark reddish brown, called "red tops." This condition prevails during the second summer after attack; but by the third summer all, or nearly all, of the leaves have fallen, which gives the tops of the dead trees a blackish appearance, called "black tops."

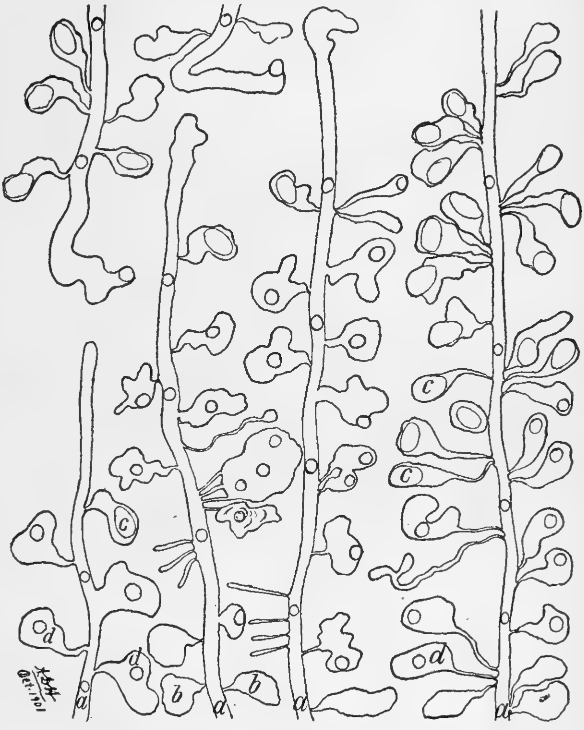

FIG. 3.—Work of the Black Hills beetle, in inner bark of dead tree: *a*, primary galleries; *b*, larval mines; *c*, pupal chambers; *d*, exit holes. Reduced about one-half. (Author's illustration.)

Beginning with freshly attacked trees during the first summer, they are distinguished by the exudation of fresh whitish or reddish pitch forming small masses or tubes on the bark of the main trunk or by the presence of fresh reddish sawdust-like borings lodged in the loose bark and around the base of the tree.

Trees infested with partially to fully developed broods from the latter part of August to the first of November, and during the period of inactivity, are distinguished by numerous pitch tubes over and entirely around the middle portion of the trunk and extending more or less toward the base and top. The age of the pitch tubes is indicated by their relatively moist or dry condition. A successful or vital infestation will be shown by the large number of pitch tubes surrounding the entire trunk, and also by their reddish color and general appearance. An unsuccessful attack—from which the tree will recover—is indicated after the first of November by a small number of smooth whitish pitch masses scattered about over the trunk, confined to or toward the base; their absence on the middle to upper portion of the trunk or, if present there, their failure to completely surround it.

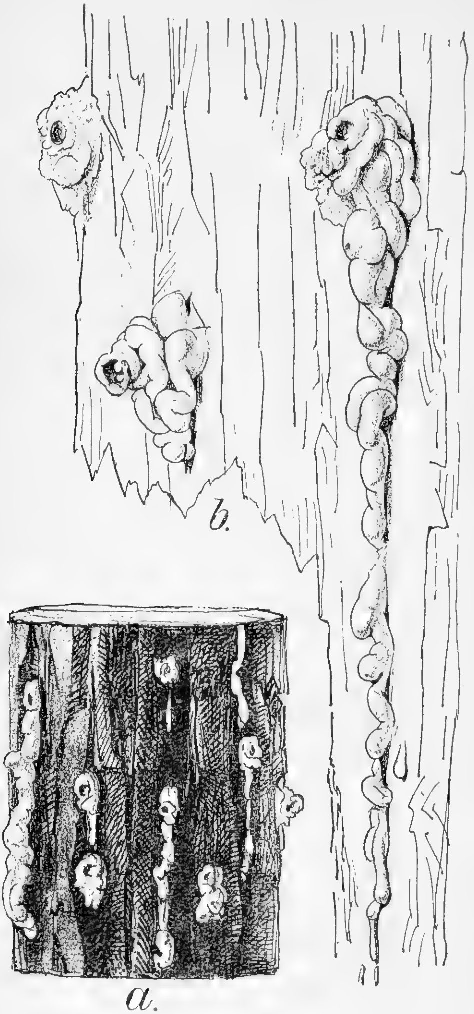

FIG. 4.—Work of the Black Hills beetle: *a*, pitch tubes on surface of bark, much reduced; *b*, same, two-thirds natural size. (Author's illustration.)

Positive evidence as to whether or not a green-topped, pitch-marked tree is infested by living broods is determined only by cutting into the bark at different places, 4 to 8 feet from the base. This test should be made during the inactive period, when trees are being marked for cutting.

Soon after activity begins in the spring, infested trees are distinguished by a pale appearance of the foliage, followed by a yellow or reddish brown color, as if killed by fire.

Dead trees which have been killed by the Black Hills beetle but are no longer infested by living broods are distinguished during the summer, fall, and winter by the old dry pitch tubes on the bark and the dark reddish brown or "black-topped" condition. The only

FIG. 1.—MARKS OF PRIMARY GALLERIES ON SURFACE OF WOOD WHEN BARK IS REMOVED. (AUTHOR'S ILLUSTRATION.)

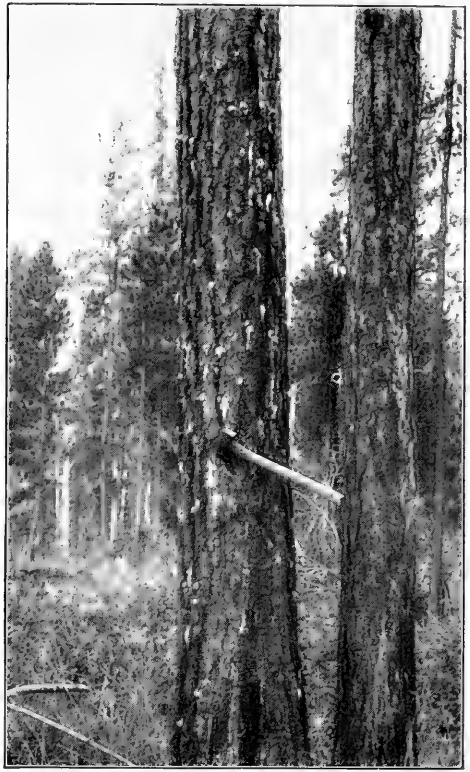

FIG. 2.—FRESHLY ATTACKED TREE, SHOWING PITCH TUBES. ADJOINING TREE NOT ATTACKED. (AUTHOR'S ILLUSTRATION.)

WORK OF THE BLACK HILLS BEETLE.

exception to this is when the top portion of the tree or one side of the trunk is killed the first year and a brood develops in the remaining living bark the next year. This sometimes occurs, but is never common enough to require special notice. Its occasional occurrence, however, explains why broods of the beetle are sometimes found in trees which appear to have been dead for two or three years.

LIFE HISTORY.

The insect passes the winter, or inactive period, in all stages—as larvæ, pupæ, and adults—beneath the bark of trees attacked by the parent beetles during the previous summer and fall. Activity begins in the spring as soon as sufficient warm weather prevails, when the broods continue to develop and mature, but remain in the bark until about the middle of July (Black Hills, latitude 44°, altitude 7,000 feet), probably later northward and at higher altitudes, and earlier southward and at lower altitudes. When the adults (fig. 1) begin to emerge from the bark of the trees in which they had developed from eggs deposited the previous year, they usually fly in swarms, and attack the living trees, in which they excavate galleries through the inner layer of bark and groove the surface of the wood. Along the sides of these primary galleries excavated by the beetle, eggs are deposited for the next generation, which, as before, hatch into grubs or larvæ (fig. 5), which mine at right angles to the primary galleries through the inner bark, on which they feed. This feeding and growing stage continues during the first summer, some of the individuals completing their development before fall, so that all stages, including the pupæ (fig. 6), may be found during the fall in the trees attacked in July. These with the younger broods remain dormant during the winter and complete their development the following spring in time to emerge in their regular course during the following summer.

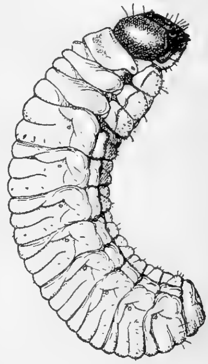

FIG. 5.—Larva of the Black Hills beetle. (Author's illustration.)

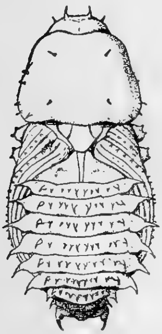

FIG. 6.—Pupa of the Black Hills beetle. (Author's illustration.)

The period of flight of the beetles and of their attack on living trees, as well as the egg-depositing period, is about seventy-five days, beginning about the middle of July and ending about the first of October. The exact time of the beginning and ending of this period in a given locality depends upon the latitude, altitude, and local conditions. The normal period of development of a brood from the time the living tree is attacked and the eggs deposited until the adults emerge from the dying or dead trees is about three hundred and forty days. The period of activity—the feeding, growing, and maturing stages—of all broods of a single generation during the first summer is about ninety days—July 15 to October 15—and about one hundred and fifty days from the time activity begins the following spring—early in May—until the last individual has developed and emerged—early in October. Thus there is a total active period of about two hundred and forty days. The period of inactivity—from about October 15 to early in May—is about one hundred and ninety-five days, making the total period of infestation of all broods of a single generation about four hundred and thirty-five days. This, of course, provides for an overlapping of the last broods of one generation and the first broods of the next, during July, August, and September.

NATURAL AND ARTIFICIAL INFLUENCES.

DROUGHT AND COLD.

It has been a common belief that the dying of the timber is caused by drought, but it is now clearly demonstrated that wherever the Black Hills beetle is abundant it kills the healthiest trees under all conditions of dry and wet seasons, moist or dry soils, north or south slopes, ridges, etc. It has also been demonstrated that it can withstand a temperature of 30° to 40° F., or more, below zero.

LIGHTNING.

It has been found that trees struck by lightning, or at least those struck in summer, are usually attacked by this beetle, and that such trees serve to perpetuate the species at times when it does not occur in sufficient numbers to kill trees on its own account. Such trees also serve to support the natural enemies of the beetle, including insects, diseases, and birds.

STORMS.

Storm-felled living trees also serve as emergency breeding places, and if the storm occurs at the proper time in the year to make the conditions especially attractive to the beetles when they are flying, they may be attracted for long distances. This concentration of scattering forces breeding in felled timber may form the nucleus for a destructive invasion. This has been demonstrated from time to time in Europe, where even secondary enemies of the genus Tomicus have been thus enabled to multiply in such great numbers as to attack and kill living forests.

FIRE.

Our observations so far have failed to reveal much evidence that this species will breed in trees injured or killed by fire in sufficient numbers to materially aid their increase. Indeed, newly fire-scorched trees observed near a sawmill in the Manitou Park section showed no trace of the presence or work of this beetle, although the trees were being attacked by several species of secondary enemies, including the true turpentine beetle (*Dendroctonus valens* Lec.). On the other hand, an extensive forest fire may contribute to the destruction of the Black Hills beetle by burning the dead bark from the living and dying infested trees, which may explain the evident sudden endings of old invasions.

COMMERCIAL CUTTING.

The cutting of living trees for commercial purposes has apparently little or no influence on the multiplication of the beetle. While it will breed in freshly cut logs from living trees, our experiments show that it prefers to attack standing timber. Then, again, any operations which involve the removal of the bark from the logs for ties, mining timbers, etc., will destroy any broods which may be therein. If cut into cord wood, the bark will soon become too dry for the insect to live in. Slabs from freshly cut logs may favor its development in small numbers, but usually the conditions in such material are not favorable. Neither do the green stumps, so far as we have observed, offer sufficiently attractive breeding places for this beetle to warrant the barking of such stumps. Nothing in the slash will offer favorable breeding places, except the tops of the main trunk, and this is seldom sufficient to warrant any special treatment.

SUMMER CUTTING IN PATCHES.

The cutting of living infested trees and of healthy trees in local commercial cuttings is objectionable from the fact that we have found that when a few living trees are felled in the midst of a forest where this beetle is present in numbers it will be attracted by the odor and will attack the surrounding standing timber. Therefore such local summer cuttings should be avoided.

TRAP TREES.

This is a method of combating bark beetles in which trees are girdled or felled to attract the insects to them, after which the broods are destroyed by stripping off the bark or burning the entire tree.

Trap-tree experiments were conducted by Mr. J. L. Webb, under the writer's instructions, in the Black Hills Reserve in 1902, in which trees were felled, hack girdled, girdled to the heartwood, belt girdled, and hacked and peeled at intervals of five or six days between June 2 and October 30. The result of this experiment showed conclusively that no method of preparing the trap trees was of sufficient value in its attractive influence on the Black Hills beetle to warrant its adoption in efforts to control this insect. While many of the trap trees were attacked, the percentage and density of the infestation were no greater than in near-by or distant healthy trees. On the other hand, it was shown conclusively that the felled trap trees were especially attractive to one of the most important secondary enemies, namely, the Oregon Tomicus (*Tomicus oregoni* Eichh.).

NATURAL ENEMIES.

INSECTS.

While a number of insect enemies of the Black Hills beetle have been found during our investigations, they appear to have little effect when the timber is dying over large areas, but under normal conditions of scattering infested trees they seem to render valuable service in preventing the rapid multiplication of the destructive beetle.

BIRDS.

The work of woodpeckers is frequently seen on infested trees, but, like the beneficial insects, they do their greatest service, perhaps, in helping to preserve the normal balance in the struggle of the trees against insects and of the insects against their own enemies.

DISEASES OF INSECTS.

Evidence was frequently found of the destruction of part or all of the broods in an infested tree by fungous diseases, but to what extent this factor affects the decrease of the beetle has not been determined.

SECONDARY ENEMIES OF THE TREES, AND NEUTRAL INSECTS.

Insects which attack only weakened, dying, or dead trees, and those associated with a destructive or primary enemy are called secondary enemies. Insects which simply live under the bark or feed on fungi, dead wood, and bark are in no manner responsible for injury to the tree. Thus they are either neutral insects, scavengers, or guests.

There are so many of all of these classes of insects associated with the Black Hills beetle in trees killed by it that it would require too much space to discuss them in this connection; but it seems necessary to say that the greatest care should be taken to avoid confusing some of the species of secondary enemies with the primary one, and that when there is the slightest doubt specimens should be sent to this Bureau for identification.

METHODS OF CONTROL.

The results of our investigations to date suggest but slight changes in our recommendations in 1901 and 1902, published in Bulletin 32 (pp. 21, 22), as follows:

It appears that the pine-destroying beetle of the Black Hills, like its eastern relatives, depends on the trees killed by it for the augmentation of its numbers and the perpetuation of its power of killing more trees. Therefore it is only necessary that the attacking force be reduced to a point where it can no longer overcome the vital resistance of the trees on which it concentrates its attack in order to successfully defeat it.

The fact that the attacking force of the enemy is already weakened from natural agencies suggests that they can be reduced by artificial means below their power of killing more trees next season, and thus bring the trouble to an end. Therefore the following are suggested and recommended as probably the best methods of accomplishing this result:

(1) Determine the location and extent of areas in which trees were attacked during the summer and fall (of 1901) and the number of trees now infested with living broods of the pine-destroying beetle.

(2) Select those areas in which there are the largest number of infested trees and mark the same for cutting.

(3) Secure, by sale contracts or otherwise, the cutting of these trees and the removal of the bark from the infested parts of the main trunks and stumps prior to May 1 (1902). The drying of the removed infested bark and surface of the wood will effectually destroy the insects. In addition the logs so treated will be protected next spring and summer from the attack of wood-boring insects, and thus be almost or quite as valuable for all commercial purposes as if cut from living trees.

It is not necessary that all infested trees in the reserve or those of all other infested areas should be thus cut and barked, but it is important that a large percentage should be so treated in order to insure a sufficient reduction of the beetles to check their destructive ravages.

Experience has shown quite conclusively that the above recommendations are entirely practicable, and it has also been demonstrated that whenever the felled trees are accessible for lumber, ties, mining timbers, or cord wood it can usually be sold for more than the cost of cutting and barking.

APPLICATION OF THE METHOD IN THE BLACK HILLS.

There has been a continued effort to control this destructive beetle in the Black Hills Reserve since 1901, but the adoption of the necessary radical measures was prevented by certain regulations governing the management of the reserve, which required the advertising and sale of the old dead and dying timber, for which there was not a sufficient demand in the State of South Dakota; and since a special provision of the law prohibited the shipment of timber out of the State, it was practically impossible to accomplish anything of importance.

We are informed, however, that the evident benefit in certain sections resulting from cutting and barking the infested timber is such as to indicate that if more radical measures had been adopted under a more liberal policy of timber sales, and under a temporary amendment of the laws relating to its shipment out of the State, the destructive beetle could have been brought under complete control and millions of feet of valuable timber saved without cost to the Government.

APPLICATION OF THE METHOD IN COLORADO.

Pursuant to our recommendations, a large number of trees were felled during the past summer (1905) on private lands in and around Palmer Lake, Colorado, where between 500 and 1,000 trees had been killed within recent years over a comparatively small area. Observations by the writer in October, and explorations by Ranger Edmonston in that vicinity, indicated a very slight new infestation this year. It is evident, therefore, that the efforts of the town board and of the citizens in cutting and barking the infested trees has had the desired effect in partially, if not completely, checking the destructive work of the beetle. If this good work is supplemented with a like effort on the part of forest officials during the coming winter, there is every reason to believe that the trouble in this vicinity will be brought under complete control, and that with a little well-directed effort each succeeding year it can be kept within normal bounds.

The same method was adopted by General Palmer and others,under the direction of Professor Bruner, in the vicinity of Colorado Springs and the Colorado pinery on the Platte and Arkansas Divide. The operation of barking and felling the affected dead and dying trees extended over an area of probably 150,000 acres, and between 600 and 800 trees were felled and barked, and the bark burned with the tops.

A thorough examination of this area by the writer indicates quite conclusively that the forces of the enemy have thus been sufficiently weakened to make their complete subjugation a comparatively easy matter, especially if the principal areas of present infestation in the reserve receive the proper treatment between now and the first of May.

It is evident to the writer that in both localities considerable unnecessary expense was involved in the cutting of old dead trees from which the enemy may have escaped and of those which might have recovered, as well as in burning the bark and tops, peeling the stumps, etc.; but it is plain that the losses from such unnecessary expenditures are of little consequence as compared with the great good accomplished.

FURTHER RECOMMENDATIONS RELATING TO THE CONTROL OF THE BEETLE.

(1) Explorations should be made, preferably during August, September, and October, to locate the principal areas of new infestation.

(2) Mark for cutting all clumps or patches of infested trees and some of the more accessible scattering ones in the worst-infested sections.

(3) The best time to fell and bark infested trees is between the middle of October and the first of May.

(4) If there is no demand for the timber, and more can be accomplished by piling the trunks and tops and burning them, or sufficiently scorching the bark to kill the insects, this method may be followed; but barking the infested portion of the trunks, without burning the bark or tops, is preferable, since it will avoid the destruction of many beneficial insects, and the exposed broods of the destructive beetle furnish food for birds.

(5) In some localities, and under certain conditions, it may be advisable to burn the tops, but if this is done to kill the insects it should be delayed until after the first of May and completed before the middle of June.

(6) If for any reason the work of felling and barking the trees can not be undertaken or completed before the first of May, it may be done during May and June. The necessity for burning the bark and tops at such time will depend upon local conditions and requirements.

(7) Summer operations should be avoided. There is nothing to be gained in felling freshly attacked trees which can just as well be cut in the fall and winter. In addition, there is danger of the freshly felled and barked trees exerting an attractive influence on the swarms of beetles which will cause them to attack the surrounding living timber. Then, again, any burning operations during the summer involves the danger of starting forest fires.

(8) If it is especially desirable, on account of timber sale and logging contracts, to cut the old dead as well as the newly infested living trees during the active period of the insect—May to October—a thorough exploration should be made by a forest entomologist or a trained forester, who should be responsible for the marking of the infested living trees. It is also important that all cutting of infested timber be concentrated in the worst affected localities.

(9) The burning of summer slash and the barking of stumps of trees which are healthy when felled is not necessary as a preventive measure against the Black Hills beetle, and the necessity for doing so against any other insect depends entirely on the species involved and local conditions.

(10) The result of experiments and observations indicate that the trap-tree method can not be successfully adopted for this insect.

(11) If a large amount of pine timber is blown down at any time, but especially in June and July, it should be carefully watched during the first year or two to determine whether or not it is attacked by the Black Hills beetle, and, if so, the bark should be removed during the fall after the attack is made.

NOTE.

The statements in this bulletin under the headings of "Life History," "Natural and Artificial Influences," and "Methods of Control" relate to the Black Hills beetle alone and are not applicable to any other species of barkbeetle.

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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY—BULLETIN No. 57.

L. O. HOWARD, Entomologist.

REPORT

ON

MISCELLANEOUS COTTON INSECTS IN TEXAS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST

BY

E. DWIGHT SANDERSON,

Special Agent, Bureau of Entomology, in Cooperation with the Entomological Department, Agricultural and Mechanical College of Texas.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1906.

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1906.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., December 5, 1905.

Sir: I have the honor to transmit herewith the manuscript of a report on miscellaneous cotton insects in Texas, prepared by Prof. E. Dwight Sanderson, entomologist of the New Hampshire College Agricultural Experiment Station, formerly State entomologist of Texas and a special agent of this Bureau cooperating in the work on insects injurious to cotton in Texas. This report gives the detailed results of a year's work on the minor insect enemies of cotton by Professor Sanderson and assistants, and is supplementary to investigations which have been conducted by other field agents of the Bureau on the more important subjects of the cotton boll weevil and bollworm. It contains definite records of observations on the life histories of numbers of species, as also data on their natural enemies. It has been prepared with the valuable assistance of Mr. A. C. Lewis at Terrell, and Mr. C. E. Sanborn at College Station, Texas, many of the records of life histories having been made by the gentlemen named. I recommend the publication of this matter as Bulletin No. 57 of the Bureau of Entomology.

Respectfully,

L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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REPORT ON MISCELLANEOUS COTTON INSECTS IN TEXAS.

INTRODUCTION.

Economic entomology has heretofore been concerned with but a few of the many species of insects affecting the cotton plant. The leaf caterpillar and bollworm, and recently the boll weevil, have been exhaustively studied as being the most important insect enemies of the cotton crop, but very little attention has been given to numerous others which frequently cause more or less injury.

The reason for this is found in the manner of the growth of cotton, the methods of its culture, and the nature of the injury done by these miscellaneous insects. Cotton is one of the most rank growing of all our staple crops, is cultivated over large areas, and matures its fruit normally for over a month. Consequently, any insect which does only local injury, which does not entirely destroy the young plant, and which does not defoliate the older plants nor destroy the most of their fruit, has been hardly worth combating; for the planter could better afford to stand the loss than to attempt fighting these pests by artificial means.

But with the advent of the boll weevil, and the consequent necessity for early cotton and intensive culture with reduced acreage, conditions have somewhat changed, and injuries which before were unheeded are now decried as further reducing the small margin of profit in the weevil district. Any insect which destroys the young plants, necessitating replanting, or which checks their growth while young, prevents an early maturity and consequently exposes the crop more to the attacks of the weevil; and later in the season when the weevil has levied its heavy tax upon the crop, any additional injury by insect pests seems a most onerous loss to the planter.

These considerations led to the investigation of the cotton insects of Texas reported below. A single season is far too short a time in which to thoroughly cover so large a subject over a State with such varied conditions, and the writer fully appreciates the incompleteness of this report. However, he has endeavored to collect or refer to all the available information concerning the economic aspect of the species treated, so that these notes may form the basis for a further and more exhaustive treatise upon cotton insects in the future.

It may not be out of place here to briefly refer to previous articles on cotton insects. Having briefly mentioned a few species during the preceding year, in 1855 Townend Glover included an article on cotton insects in his report to the Commissioner of Patents for that year, illustrated with numerous figures of the more common species.[a] Later he engraved better figures of many of these species, with which he published a few notes.[b]

In 1892 F. W. Mally, at that time an assistant in the Division of Entomology, in his report on the bollworm,[c] mentioned several cotton insects whose injuries might be mistaken for those of the bollworm. Some portions of this report were republished in Insect Life. As a result of an investigation of the insects frequenting cotton fields in Mississippi, Dr. William H. Ashmead published several papers[d] in which he gives brief notes on the habits of the insects found. In 1896 Dr. L. O. Howard gave the first general account of cotton insects published since that of Glover.[e] Since the publication of this paper no general study has been made of cotton insects other than the boll weevil and bollworm, except that excellent work of Prof. H. A. Morgan upon the differential locust, which is noted in the account of that insect in the following pages.

From his study of the life histories of the minor cotton insects and the methods of cotton culture, the writer believes that for but few of them will artificial remedies, such as poisoning, be found generally practicable. Like most of the insects affecting our staple crops, they must be largely controlled by general methods of culture and farm management, such as the destruction of their native food plants, rotation of crops, and winter or early spring plowing. More intensive cultivation of cotton will undoubtedly result in a material lessening of the injury by many of these pests, and, under such conditions, those which may be profitably combated by remedial treatments will be more successfully and generally treated.

Most of the work upon the life histories described below was done by Mr. A. C. Lewis, who was in charge of a temporary laboratory upon the demonstration farm of Mr. E. H. R. Green, at Terrell, Tex., and by Mr. C. E. Sanborn at the laboratory at College Station. Mr. A. F. Conradi, at that time assistant entomologist of Texas, also helped in the work. The writer is indebted to Doctor Ashmead, of

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[a] Report of U. S. Comm. Patents f. 1855, Agriculture, 1856, pp. 64–115, pls. 6–10.

[b] Manuscript notes from my journal.—Cotton and the principal insects, etc., frequenting or injuring the plant in the United States. Washington, D. C., 1878, 2 pp., 22 plates.

[c] 1893: Bul. 29, o. s., Div. of Ent., U. S. Dept. Agric., pp. 29–33.

[d] 1894–95: Insect Life, Vol. VII, pp. 25–29, 240–247, 320–326.

[e] 1896: "The Cotton Plant." Bul. 33, Off. Exp. Sta., U. S. Dept. Agric., pp. 316–350, figs. 9–29, Pl. IV; and 1897: Farmers' Bul. 47, U. S. Dept. Agric., pp. 31, 18 figs., 1 pl.

the U. S. National Museum, for the determination of the parasitic Hymenoptera, to Prof. E. D. Ball, Logan, Utah, for the descriptions, and to Mrs. Ball for the drawings, of the Jassid nymphs.

INSECTS AFFECTING THE YOUNG PLANTS.

CUTWORMS.

Observations were made upon three of the most common species of cutworms, and although the facts ascertained are not complete in any instance, so little has been written concerning the life histories of cutworms in the South that it seems well to record the facts observed.

Reports from numerous voluntary observers in different sections of Texas indicate that injury by cutworms to garden crops commences during the first half of March and ceases from the middle of April until early May, the exact dates depending upon the latitude. Thus in 1904 Mr. G. E. Miles reported that at Friendswood, Galveston County, cutworms commenced work on corn and potato about February 20, were still at work March 30, and ceased injury about April 13. In Cherokee County injury commenced about March 1. In Anderson County the injury was most serious about March 15, subsiding about April 16, and cutworms were reported as being found in gardens during the entire winter. Little injury was reported to cotton in 1904, but correspondents state that in many previous seasons they were obliged to replant very largely, on account of cutworms. Planters state that the injury is much more serious if during the previous fall there has been an abundant rainfall, so that there is a rank growth of grass and weeds about October 1, and that in the spring the worms are found in greatest numbers at the sides and along the ends of the fields, where there has been more vegetation.

After studying the following rearing records in Texas and other available data concerning these and other species in the South, the conclusion has been reached that the three species discussed below probably have much the same life history. It is probable that the insects may pass the winter in either the adult, pupal, or larval state; but the latter is by far the most common method, and wintering larvæ of all stages of growth have been found. The moths of this brood are seen about May 1. A second generation of moths appears during the first half of July, the larvæ being found about the middle of June. During September considerable injury was observed in 1904 in fall gardens, the larvæ, doubtless, being the progeny of the July moths. The adults of this third brood probably deposit eggs during early October, the larvæ from which pass the winter. It is very evident, however, that there is great variation in the life history, in Texas even greater than elsewhere, for, with the open winters and with but little if any frost in the southern half of the State, there is, doubtless, very little true hibernation, and the different broods must overlap one another at all seasons.

Doctor Riley states that the granulated cutworm, *Feltia annexa* Treitschke, probably has three generations in Georgia, and that it is the most common cotton cutworm in the South. From the writings of Doctor Riley and others, we believe that *Agrotis ypsilon* Rott. has one generation in the most northern States and two in the latitude of St. Louis, Mo.

THE GREASY CUTWORM.

(*Agrotis ypsilon* Rott. Fig. 1.)

Our records concerning this species are as follows:

TABLE I.—*Transformation records of the greasy cutworm, 1904.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex	May 2	May 21		
	March 28	April 26		
	June 15	June 18	15	July 3
College Station, Tex	March 15	April 28		
	March 16	March 26–29		
	March 28	April 28	20	May 18
	April 4	April 22[a]		

[a] Two specimens.

The average date of pupation of the hibernated larvæ was, therefore, about April 25, and thus the moths would emerge about the middle of May. Very evidently the moth emerging July 3 is of a second brood.

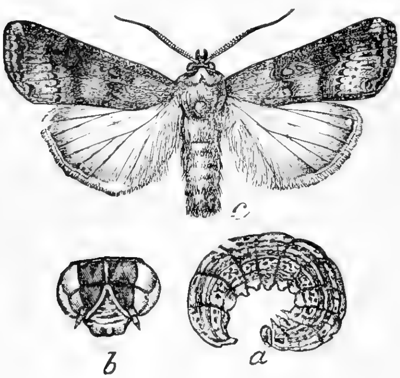

FIG. 1.—*Agrotis ypsilon*: *a*, larva; *b*, head of same, *c*, adult—natural size (after Riley & Howard).

The worms were observed feeding upon onions, cabbage, potatoes, and cotton. A moth was taken at College Station, May 11, 1903.

Several pupæ were parasitized by the tachinid fly (*Gonia capitata* DeG.), the first specimens of which emerged May 7.

Previous records.—This species first received careful consideration in this country by Riley,[a] who summarizes the knowledge of the species at the time of his writing, and describes the larvæ and eggs. He states that there is either a dual method of hibernation or it is double brooded. He records pupæ received from a cotton field at Americus, Ga., April 22, from which moths emerged April 24, 1879, and a pupa from Virginia Point, Tex., received December 3, from

[a] 1869: First Rept. St. Ent. Mo., pp. 80–81, fig. 28; and 1885: Ann. Rept. U. S. Comm. Agr. f. 1884, pp. 294–295.

which the moth emerged December 6. In Missouri full-grown larvæ were found as early as May 1, but in no case did the moths from them emerge until July. In his eighth report Lintner has discussed this species as an onion pest.[a] The first larva pupated June 16 and the moth emerged July 12, while other larvæ pupated July 2 and 6. Concerning the time of appearance of the moths he states:

I have taken it as early as May 30, and in collections made by me "at sugar," have observed it every night through the months of June, July, and August, on over half the nights of September, and until the last week in October.

The species was reported as injurious to cotton in Mississippi in 1888.[b] Garman[c] states that the larvæ are injurious from May to June 21; that adults have been taken from June 25 to September 23, and that newly emerged moths occur from June 29 to July 12. Quaintance, in his account of the tobacco insects of Florida,[d] states that the larvæ may be found in all stages of growth throughout the winter. In Maryland Johnson observed the species as a tobacco pest in late May and June, the first moths emerging July 19.[e] In his Twenty-first Report of the Insects of Illinois,[f] reporting the species as an enemy of sugar beets, Dr. S. A. Forbes writes as follows:

There is apparently but one brood each year, with many occasional irregularities in the stage of hibernation and periods of development. It seems usually to hibernate as a larva, pupating about June 1, and yielding the moth late in June and in July. The hibernating larvæ are seldom found after July 15. Pupæ have, however, been found in winter, and adults, probably emerging from these, early in spring.

It would seem, therefore, that not infrequently they winter as pupæ, the moths from which lay eggs in early spring, and from these develop caterpillars, which do not transform until midsummer or August. Normally, however, the insect winters as a larva, and the moths emerge early in July. In Texas, at least in the southern part of the State, where this species is most injurious, there are probably three generations. It must be remembered that the difference in latitude between St. Louis, Mo., and south-central Texas is equal to or greater than that between the former point and the northern boundary of the United States. Taking the length of seasons into account, it is only reasonable to suppose that the number of generations annually would increase in arithmetical progression as we go south.

An exhaustive study of this and other species of cutworms, both in the South and North, would clear up many uncertain points relative to their life history.

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[a] 1893: Eighth Report N. Y. State Ent. f. 1891, pp. 188–191.
[b] 1889: Insect Life, Vol. I, p. 217.
[c] 1895: Bul. 58, Kentucky Agric. Exp. Sta., p. 97.
[d] 1898: Bul. 48, Fla. Agric. Exp. Sta., pp. 181–183.
[e] 1898: Bul. 55, Md. Agric. Exp. Sta., p. 143.
[f] 1900, p. 104, 2 figs.

THE SHAGREENED CUTWORM.

(*Feltia malefida* Guen. Fig. 2.)

The summary of our observations on the life history of this species is as follows:

TABLE II.—*Transformation records of the shagreened cutworm, 1904.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex	March 29	May 6		
	April 23	May 4	27	May 31
	June 14	June 18	15	July 3
College Station, Tex	March 30			May 19
	do	April 29	23	May 22
	do	April 10		
	April 4	April 30	20	May 20

Larvæ were taken feeding on potato, cotton, and cabbage. Moths were captured at College Station September 15, 1902, and August 23, 1903.

Previous records.—The larva was first described by Riley,[a] who states that it "appears to be confined to the South Atlantic States, from the District of Columbia to Alabama." Since then the only published record occurs in Insect Life,[b] where the larva is reported as feeding on young cotton plants in Mississippi in 1889. The records of the Bureau of Entomology show that larvæ were received from Warrentown, Ga., where they had damaged cabbage, on May 3, 1879, and from Alabama, where they were injuring cotton, on June 23 of the same year. No other records of the species have been found. It is very common in Texas and evidently is a southern species.

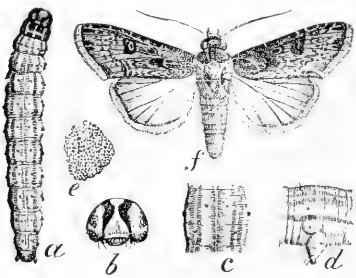

FIG. 2.—*Feltia malefida*: *a*, larva; *f*, moth—natural size (after Riley).

The caterpillars of this species are parasitized by *Glyptapanteles militaris* Walsh and *Meteorus vulgaris* Cress.

THE VARIEGATED CUTWORM.

(*Peridroma saucia* Hbn. Fig. 3.)

This species prefers garden vegetables for food, but it has been taken upon corn and doubtless occasionally attacks cotton. It has been fully discussed by Doctor Chittenden,[c] and the following brief sum-

[a] 1884: Rept. Comm. of Agric. f. 1884, pp. 292–293.

[b] 1890: Insect Life, Vol. II, p. 283.

[c] 1901: Bul. 29, n. s., Div. Ent., U. S. Dept. Agric., pp. 46–64, figs. 9–11.

mary of our observations on the life history in Texas merely supplements his account.

TABLE III.—*Transformation records of the variegated cutworm, 1904.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex.	March 31	April 5		
	April 18	April 25		
College Station, Tex.	March 16	March 24	18	April 11
	March 29, on corn.			

Judging from the above records, the life histories of the three species of cutworms discussed are evidently much the same.

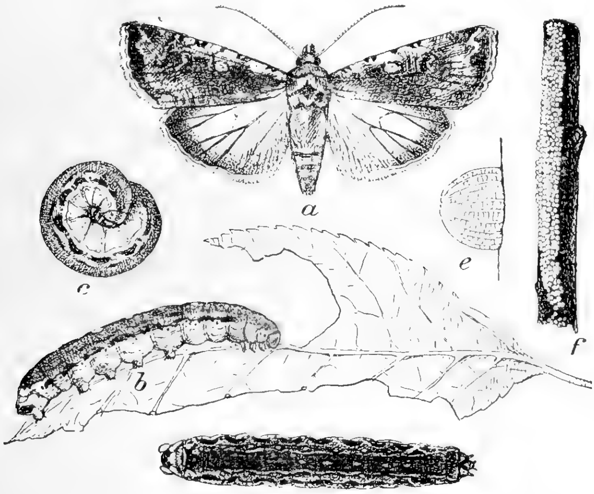

FIG. 3.—*Peridroma saucia: a*, moth; *b*, normal form of larva, lateral view; *c*, same in curved position; *d*, dark form, dorsal view; *e*, egg from side; *f*, egg mass on twig (after Howard).

THE GARDEN WEBWORM.

(*Loxostege similalis* Guen. Fig. 4.)

In Texas and the Southwest, the common name which has been given this insect seems hardly suitable, for there it is primarily a pest of corn and cotton and only incidentally a garden insect. In 1903 very serious and widespread damage in north Texas and Oklahoma, as well as in other parts of Texas, to young cotton and corn, necessitated replanting after the plants were well started. This injury occurred most generally during the first two weeks of June.

In 1904 the first moths were taken at trap light at College Station, April 10, 21, and 24. At Terrell the first was taken at light on May 24, and during the season there were more specimens of this moth caught at light than of any other affecting cotton; not a sufficient number, however, to warrant the use of light as a remedy at any time.

April 20, 1904, we received a report from Mr. S. J. Berryman, Montalba, Anderson County, that there was "some complaint of budworm (*Heliothis obsoleta* Fab.) and webworm in corn." No specimens of the webworm were received, but as we know of no similar insect commonly attacking corn in Texas, and as this pest is commonly known as the webworm and would injure corn about the time that injury by the "budworm" would commence, there seems no good reason for doubting the identity of the insect.

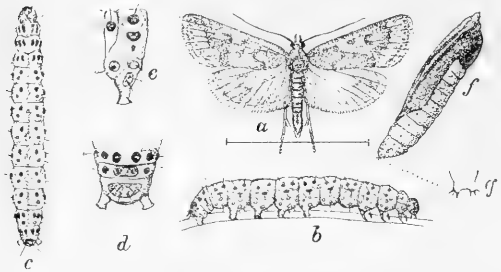

FIG. 4.—*Loxostege similalis*: *a*, male moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, anal segment; *e*, abdominal segment, lateral view; *f*, pupa; *g*, cremaster—*a*, *b*, *c*, *f*, somewhat enlarged; *d*, *e*, *g*, more enlarged (reengraved after Riley, except *c*, from Chittenden).

A nearly full-grown larva was taken at Terrell about May 17, 1904. Moths taken May 24 oviposited on the 26th. The eggs are deposited on either surface of the leaves in bunches of from 8 to 20 and hatch in three days. One female laid 48 and another 54 eggs. From these eggs three generations were reared up to September 29, as shown in the following table:

TABLE IV.—*Transformation records of the garden webworm.*

Egg laid.	Days egg.	Hatched.	Days larva.	Pupated.	Days pupa.	Moth.	Days before oviposition.	Total days.
May 26	3	May 29 ...	17	June 14	9	June 23	3	31
June 26..........	3	June 29...	25	July 24	7–8	August 1......	6	42
August 8	4	August 11.	22	September 1 ..	8	September 9 ..	6	38
September 15....	......	....	......	....	......	....	......	......
Average...	3.3	....	21.3	....	8	....	5	37

In the case of the second generation, one larva which had hatched June 29 was observed to molt July 7, 19, and 24, at which latter date it pupated.

The eggs laid September 15 had not hatched on October 1 and were probably infertile. It has not been observed in what stage the winter is passed, but from the observations of Professor Gillette[a] on the nearly related species *Loxostege sticticalis* Linn. it seems probable that the larvæ hibernate in the ground in a silken tube. It is entirely possible, however, that in Texas the pupa or adult moth may pass the winter. In any event the hibernating brood first becomes mature by

[a] Bul. 98, Colo. Agric. Exp. Sta., p. 6.

the middle of April in central Texas and larvæ of the first brood are found nearly full grown by the middle of May. The moths of this brood oviposit late in May, of the second in late June or early July, of the third about August 8, and of the fourth about September 15. There would still be ample time for a fifth brood in the fall, especially in the southern part of the State. Without rearing one series through an entire season it would doubtless be impossible to determine the probable number of generations, for the moths appear almost continuously in July, as is seen by the following record, which shows the number of moths taken at trap light at Terrell on the dates given—July 3, 3; 7, 4; 8, 5; 9, 4; 10, 5; 14, 6; 26, 4.

Young cotton and corn are usually affected when about 8 inches high, so that replanting makes a very late crop. Alfalfa is also often seriously damaged, the injury occurring somewhat earlier in the spring than that to corn and cotton, and again in August or September. Undoubtedly the larvæ working on the alfalfa in the fall remain in the fields over winter. In the spring they work upon the alfalfa, and, when that is cut, they move out into the cotton and corn adjoining in such numbers that this migration has often been observed and reported to us. About the middle of July, 1903, alfalfa was thus injured in Oklahoma. On August 24, 1904, Mr. Lewis found that the alfalfa near Scurry, Kaufman County, Tex., had been somewhat injured, and learned that the insect had done similar damage about the same time in 1903. On September 1 the same injury was found at Wolfe City. The larvæ had migrated to the adjoining rows of cotton, which had been partly defoliated, and had then disappeared, evidently being in the pupal stage, as were those being reared in the laboratory at that time. September 12, 1899, Mr. W. D. Hunter sent to the Division of Entomology two moths of this species, stating that it had been exceedingly destructive to alfalfa in southeastern Nebraska during that year.

As has been previously recorded, the favorite food of the insect is the common pigweed or "careless weed" (Amaranthus), from which the insect received its local name of "careless worm." It is common throughout the arable portion of the State, as is evidenced by reports of its occurrence from near San Antonio, from Victoria, and from east Texas (Anderson County), but it seems particularly injurious in the northern part of the State. Many of the larvæ captured were parasitized by *Apanteles laphygmæ* Ashm. and *Cardiochiles explorator* Say. One specimen was parasitized by a larva which emerged and formed its cocoon July 29, the adult, which proves to be *Mesochorus electilis* Cress, emerging August 4.

The species has also been found to be parasitized by *Exorista hypenæ* Coq. and *Phorocera parva* Bigot, specimens of which have been bred by Mr. Pergande.

Past history.—The first account of this insect was published by Doctor Riley,[a] who gives its past history, an account of its depredations, its food plants, and life history, and a partial description of the larva. Doctor Chittenden has published notes upon the species,[b] and Dr. S. A. Forbes has also given an excellent account of the insect.[c]

Remedial measures.—Dusting or spraying the affected crops with an arsenical will, of course, quickly check the depredations of the pest; but as some delay is usually involved in such an operation over a large area, considerable injury will have been done before it is completed. Preventive measures are more important. Of these the destruction of those native weeds upon which the larva feeds is of great importance, especially where land is left uncultivated. The thorough cultivation of the land in fall or winter will also probably be of great benefit, if the larva passes the winter in the soil, as seems probable. On this point, Mr. S. J. Berryman, of Montalba, a careful observer, writes:

> I think the reason that I am not bothered by them is because I have had all of my land broken in the winter and harrowed it several times. The blackbirds followed my plow all the time, and I think they got most of them. At least, I am not bothered with the insects, and I hear no complaints from those who did the same way.

In the case of alfalfa a thorough cultivation in late fall or early spring would doubtless be of value for the same reason.

THE WHITE-LINED SPHINX.

(*Deilephila lineata* Fab. Fig. 5.)

The well-known and exceedingly variable larvæ of this sphinx moth are common inhabitants of the cotton field about the time the young plants are being chopped. Usually their injury to the foliage of the young plants is noticed by the hands, who can destroy most of the caterpillars at this time. Occasionally, however, they become over-abundant and swarm over all the vegetation much as does the army worm, destroying every low-growing plant in their path. Such was the case near San Antonio in 1903, when garden crops and cotton were seriously injured by immense numbers of these caterpillars.

On May 30, 1903, caterpillars in almost all stages of growth were common on cotton at College Station, and several were kept under observation. The first was ready to pupate June 1, and three entered the earth to pupate June 11. June 25 about twenty flies of *Winthemia quadripustulata* Fab. emerged from these. Three moths emerged on July 3, 4, and 14, respectively. The caterpillars were not subse-

[a] 1885: Rept. Comm. Agric. f. 1885, pp. 265–270.

[b] 1902: Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 46, 47; and 1903: Bul. 43, l. c., pp. 39–40, figs. 36 and 37.

[c] 1900: 21st Rept. State Ent. Ill., pp. 108–109, fig. 33.

quently observed that season, and only rarely in 1904, so that it seems probable that the insect was checked by the parasitic fly mentioned.

May 18, 1904, a number of larvæ were taken at Terrell, Tex. The first pupated June 3, another June 7, and a third June 14. The moths from the two last mentioned emerged June 24 and July 2, respectively. On June 14 a pair of moths were taken *in coitu*. On the 16th, 96 nearly globular green eggs were laid by the female on the leaves, from one to eight eggs being deposited in a place. These

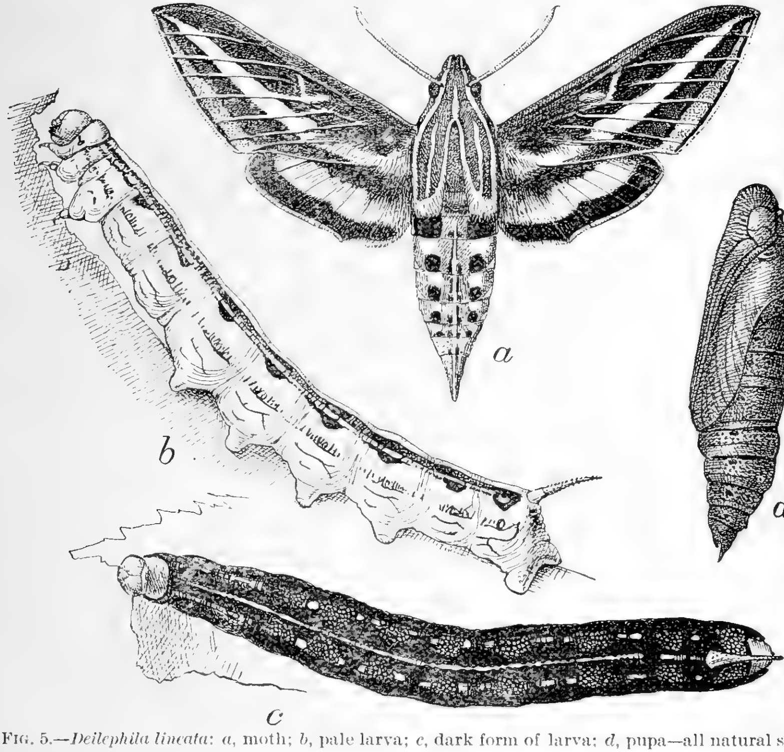

FIG. 5.—*Deilephila lineata*: *a*, moth; *b*, pale larva; *c*, dark form of larva; *d*, pupa—all natural size (from Chittenden).

hatched June 20, but, unluckily for the continuation of the experiment, the young larvæ died.

It would seem evident that there is another and possibly a third generation during the season in Texas, although no observations were made later in the year than those above reported. Riley states that there is but one generation in a year[a], but Forbes[b] records two broods, the larvæ of the first appearing in July and August, and those of the

[a]1871: 3d Rept. State Ent. Mo., pp. 140–142, figs. 60–62; and 1884: Rept. Comm. Agr. f. 1884, p. 412.

[b]1900: 21st Rept. State Ent. Ill., p. 155.

second from the middle of September through October. The winter is undoubtedly passed in the pupal stage, as has been observed farther north. Although so common, no thorough study of the life history of the species seems to be recorded in entomological literature.

Food plants.—A long list of food plants has been attributed to this species. Of these, purslane and chickweed are undoubtedly the favorites. Chittenden[a] states that they feed on sugar beets, tomatoes, and apple and prune trees. Dr. Herman Behr[b] states that the species is nowhere as common as on the Pacific slope, and that in California the larvæ prefer plants of the family Onagraceæ, including Epilobium, Boisduvalia, Clarkia, Eucharidium, Godetia, Œnothera, and the introduced Fuchsia. He says also that there the insect rarely suffers from parasites, and that it easily adapts itself to other food plants, such as Rumex and Portulaca, but is not common on grape. Walsh and Riley give as food plants purslane, turnip, buckwheat, watermelons, and apple,[c] and state that the species is commonly attacked by tachina flies.[d] Saunders[e] mentions the larva as occurring also on plantain. There is no previous mention of the species as a cotton pest, though planters state that they have frequently noticed the larvæ. It is commonly found on grapevines and may be considered as feeding on almost all low-growing vegetation.

Of the methods of control, the most important is that of preventing the growth of the weeds upon which the larvæ normally feed. Only where these have been abundant does the species become injurious. When serious injury is threatened, the caterpillars may be readily controlled by dusting or spraying with arsenicals. To destroy the pupæ, land grown up in weeds on which the caterpillars were known to have been feeding in the fall should be plowed and harrowed thoroughly in winter.

MAY BEETLES.

LACHNOSTERNA CRIBROSA Lec. (Fig. 6.)

Injury by this species to cotton was first reported by Mr. J. H. Burton, of Valleyview, Cooke County, about the middle of March, 1904. On March 25 the work of the beetles on Mr. Burton's plantation was observed by the writer. The beetles, which are about an inch long and shining black in color, remain in the soil during the day, emerging about an hour before sundown, or on a cloudy day at about 4 p. m. They feed for an hour or two and then reenter the soil.

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[a] 1903: Bul. 43, n. s., Div. Ent., U. S. Dept. Agric., p. 41.

[b] 1882: Papilio, Vol. II, p. 2.

[c] 1869: Am. Entomologist, Vol. I, p. 206.

[d] 1870: l. c., Vol. II, p. 257.

[e] 1877: Can. Ent., Vol. IX, p. 66.

If near the old hole, a beetle will use it again; otherwise a new one is quickly made, and in a few minutes the beetle will have disappeared. The beetles were usually found about 3 inches deep in the soil, but Mr. Burton stated that he had found them in burrows running horizontally to a vertical burrow some 4 or 5 inches deep. A hundred of the beetles were picked up around the edge of a cotton field in a few minutes. Some of them emerged from ground which had been covered with water, but seemed none the worse for it. They are exceedingly awkward, and when disturbed feign death, remaining in any conceivable position for several minutes. For the past two years they had destroyed peanuts and had injured strawberries, grape cuttings, and cowpeas in this locality. Young cotton was attacked in preference to anything but ragweed, which is the favorite food plant. When observed they were feeding on the ragweed along the fences around cotton. This is the usual place for them to appear. Subsequently they spread into the cotton, doing injury along the edges. One beetle is said to destroy a cotton plant 6 or 8 inches high during its evening meal. A number of beetles were observed to emerge in young corn. They did not feed, however, and many of those found were dead. They were not found in meadow land. During the previous year cotton had been planted on land where grain had been grown the year before. After the grain was cut the land had been left for the remainder of the season to grow up to weeds, and it was not plowed until late the next spring, just before planting cotton. In this field the extent of injury to cotton was unprecedented. The cotton planted in 1904 was on land which had been well plowed and kept free from weeds during the previous fall and winter, and in this case the injury was not serious. The beetles do not seem to be injurious on land following corn. It seems probable that the females oviposit in cotton land and that if this is well cultivated and winter plowed the larvæ are killed. Larvæ feeding on the roots of weeds along the fences where plowing is impossible will, of course, survive this treatment, but the number of adults emerging in the spring will be comparatively very small.

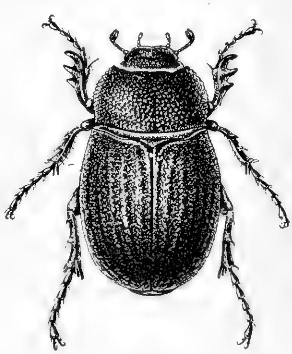

Fig. 6.—*Lachnosterna cribrosa:* female—enlarged (author's illustration).

On July 14, 1904, injury by this insect was observed along one end of a small piece of cotton at Wichita Falls, the land having been in wheat during the previous season. At this time the beetles had practically all disappeared, although they were present in great numbers a few days previously.

The species was also reported from Fife, McCulloch County, where damage to garden crops commenced about March 15; from Wawaka, Ochiltree County, where they were injurious in gardens May 10, and from Canyon, Randall County, in the central part of the Panhandle, where some damage was done to cotton about July 20. In the last case the beetles had almost disappeared on August 25.

Beetles confined under a cage over cotton in the field laid a few eggs July 1, but unfortunately the eggs were destroyed by ants and no larvæ were secured.

It was found that when Paris green was dusted upon the foliage the beetles readily succumbed to the treatment, so that there should be no difficulty in controlling them by dusting the weeds around the edges of fields.

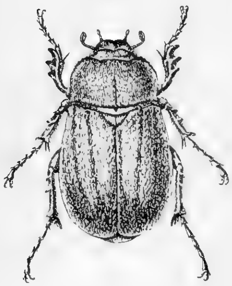

FIG. 7.—*Lachnosterna lanceolata:* female—somewhat enlarged (author's illustration).

This species was originally described from the Rio Grande Valley, and no other type locality was given. The only previously published record of injury is that in Insect Life, Volume VII, page 360, where the insect is reported to have destroyed several crops of wheat in Baylor County, Tex., the beetles having increased in numbers for several years previous to 1895. It is evidently most abundant in northwest Texas, and has not been observed east of Cooke County.

LACHNOSTERNA LANCEOLATA Say. (Fig. 7.)

This species, somewhat smaller than the preceding, is of a brown color and is well clothed with gray hairs. Specimens were received July 5, 1903, from D'Hanis, Tex., where, occurring in large numbers, they had done considerable damage to cotton. Beetles were found common, though not abundant, on cotton and sunflower leaves at Terrell. From specimens confined June 4 eggs were secured June 18. The white, globular eggs, about 2 mm. in diameter, were laid singly about 2 inches beneath the surface. They hatched June 25, and the larvæ fed on cotton and grass roots during the summer and fall.

July 15, 1902, the Division of Entomology received specimens from S. E. Russell, Duncan, Ind. T., stating that they were damaging young cotton. The species has also been reported from China Spring, McLennan County, Tex.,[a] where it was injuring collards. It had been noticed commonly since 1890, and its favorite food plants were stated to be several species of Amaranthus common around corn fields.

[a] 1900: Bul. 22, n. s., Div. Ent., U. S. Dept. Agric., p. 107.

LACHNOSTERNA FARCTA Lec.

This species has been reported as injuring cotton in southwest Texas by planters in Uvalde County, where it is occasionally quite abundant on young plants. According to previous accounts,[a] the feeding habits of the beetles seem to be much the same as those of *Lachnosterna cribrosa* Lec. November 3, 1895, Mr. E. A. Schwarz sent from Beeville, Tex., a larva of this species taken in a cotton field. Another larva, received from him from San Diego on December 14, was placed upon grass roots and was still active the following April. It was then given fresh sod and remained alive until September. In the Report of the Commissioner of Agriculture for 1879 Professor Comstock mentions an outbreak of this species on beans in Bexar County, Tex. The feeding habits of the beetles as described by him are similar to those of *L. cribrosa*.

It should be noted that the larvæ of none of these species of "May beetles" have been observed in injurious numbers and that very little is known of their habits.

THE DIFFERENTIAL LOCUST.

(*Melanoplus differentialis* Thos. Figs. 8, 9, 10, and 11.)

More or less injury is done by this locust every year in some locality in Texas. In the spring of 1904 an exceptional outbreak occurred in

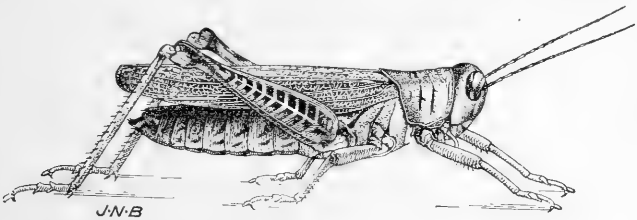

FIG. 8.—*Melanoplus differentialis:* adult—enlarged (author's illustration).

the south-central part of the State, along the Brazos River and its tributaries, being especially injurious in Grimes, Waller, Washington, Lee, Brazos, and Burleson counties.

Owing to the very careful studies of the habits of this species made by Prof. H. A. Morgan in Mississippi in 1899 and 1900,[b] it did not seem necessary to devote much attention to that subject. Therefore, although a few observations on the life history are noted below, we were chiefly concerned in finding the most feasible means of combating the young hoppers over large areas.

The eggs commenced hatching about the middle of March, 1904, and young nymphs continued to appear for about three weeks, the majority

[a] L. c., p. 107; and 1880: Rept. Comm. Agric. f. 1879, p. 247.

[b] 1901: Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., pp. 7–27, 12 figs.

before April 1, the season being an exceptionally early one. The eggs had been laid in the hard ground on the edges of fields and in fields uncultivated during the present season. Young of the first instar taken to the laboratory on April 23 molted April 25, May 10, May 23, and May 30 and became adult on June 8. The habit of ascending a stalk of corn or weed during the last molts is illustrated in figure 9. It was found exceedingly difficult to distinguish the different instars by any markings or by the general size of individuals, for in both these respects different individuals vary very greatly. It was found by measuring reared specimens, however, that the length of the hind tibiæ was fairly constant for a given instar, and this proved true of a series subsequently measured. The length of the metatibia is as follows: First instar, 3–4 mm.; second instar, 5–6 mm.; third instar, 8–9 mm.; fourth instar, 11–12 mm.; fifth instar, 15–16 mm. These are the measurements of the cast skins, the measurements in the case of live or mounted specimens being slightly less in each instar. The time of molting varied for different individuals and was governed by the amount of food available, so that no fixed dates can be given. In 1903, in a local outbreak, the first three stages, mostly the second and third, were found to occur on June 1. The development during these two seasons probably illustrates the extreme dates of early and late development for this latitude.

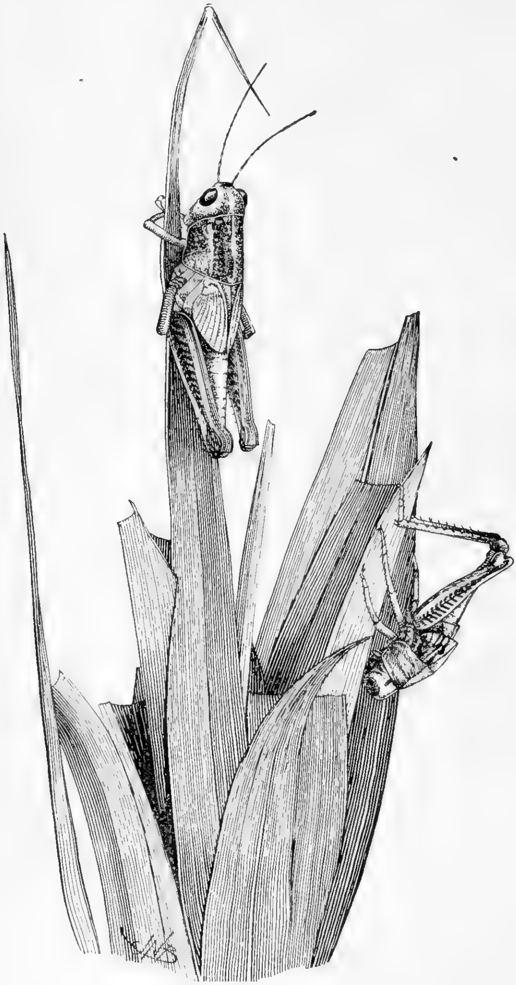

FIG. 9.—*Melanoplus differentialis* on corn leaves: adult in natural position, upper figure; pupa skin below on right—natural size (author's illustration).

Attention was first called to the 1904 outbreak by Mr. W. H. Brown, of Navasota, whose plantation lying along the Brazos River was visited by the writer April 1. At this time the young hoppers had been at work for about ten days, and were still hatching. They occurred in countless numbers around the edges of cultivated fields and on uncultivated ground among the weeds, from which they were migrating to the young crops as the food supply became scarce. In

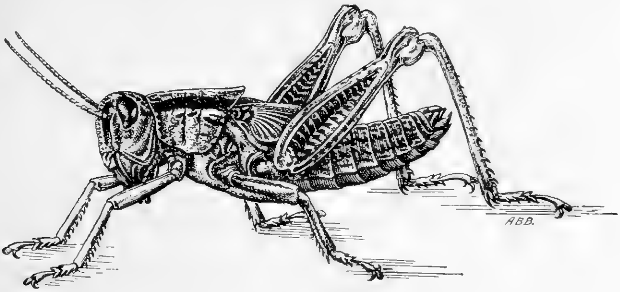

FIG. 10.—*Melanoplus differentialis:* young nymph—enlarged (author's illustration).

such situations old logs were so covered with the young as to be completely blackened by them. The "stand" of young corn and cotton had already been destroyed over several acres. In one field, where they first appeared, Mr. Brown had used dry Paris green and had largely checked the injury. It was found that by plowing fields where the stand had been badly injured or was poor, large numbers of the young hoppers were destroyed by burying, and the remainder migrated to the weeds at the edges of the fields. While still young they can not be readily driven as is possible when they are half or more nearly grown. All of the vegetation around the edges of the fields was therefore poisoned with Paris green or green arsenoid. In some cases the poison was mixed with flour, which made it more adhesive. Over the fields, both those which had been plowed and those wherein the hoppers were feeding, poisoned bran mash was distributed, 1 pound of Paris green being mixed with 25 pounds of bran. This treatment proved exceedingly effective. Five days later, when again visited, the great majority of the hoppers were found dead among the weeds which had been thoroughly poisoned. The effect of bran mash is not so apparent, as the hoppers after eating it crawl beneath small clods of earth and there die, but by examining the ground around a small pile of the mash from 12 to 20 dead hoppers were found, and many more had doubtless died farther away. To moisten the mash, water is found as effective as molasses. Around the edges of the fields, and in patches of weeds on uncultivated land, a spray of pure kerosene or of strong

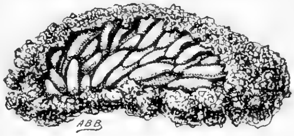

FIG. 11.—Egg mass of *Melanoplus differentialis*—enlarged (author's illustration).

kerosene emulsion was used with marked success. The planters preferred using the pure oil, its effect being more quickly apparent. Paris green was used both as a dust and as a spray. The dust seemed to be much the better form of application and more effective, although more material is required. Several types of portable powder guns were used by various planters under our direction, and were found to apply the poison much more effectively and economically than is done by the use of a sack. Where these methods were thoroughly practiced, the young hoppers were much reduced in numbers by the third week in April and their injury checked. An unfortunate feature of these methods of treatment lay in the fact that, after a field had been almost entirely rid of the pest, migration would take place from adjoining uncultivated land, possibly owned by a nonresident, or on a part of a neighboring plantation where no harm could be done the crops of the owner and where, therefore, nothing had been done toward checking it. This necessitated continued work by certain individuals, much later than would have been necessary had the whole community pursued the same methods; and in several instances caused vexatious losses after it was thought that a field had been entirely freed from the hoppers.

Natural enemies.—Just after the young had hatched large numbers of a small conopid fly, *Stylogaster biannulata* Say, were observed darting about and hovering over the young hoppers. It was impossible to observe their oviposition or to rear them from the hoppers subsequently, but, owing to the previously observed habits of this species, there is little doubt that it was parasitic upon the young.

During the last week of April large flocks of blackbirds and reedbirds or bobolinks appeared in the fields for a few days, and undoubtedly did more than any other natural agency to check the pest. They consumed immense numbers of the hoppers, so that, with the methods previously employed, but little damage was done later in the season.

Trapping in holes.—June 1, 1903, a small outbreak occurred a few miles from College station. At that time the locusts were slightly less than half grown. The eggs had been deposited in a small strip of grass and weeds along a ditch running through the center of the field, and from there the young hoppers had migrated for some little distance on all sides and had destroyed considerable cotton, then about six inches high. In this case it was essential to prevent further injury as soon as possible, and although poisoning would undoubtedly have killed them in a few days much damage would have been done before they succumbed. A number of post holes were therefore dug in a double row, the holes alternating, near the center of the affected area, and several men and boys drove the hoppers toward them. Very large numbers were thus caught in the holes and were then easily destroyed. It was demonstrated that for such conditions this is one of the most satisfactory methods for quickly checking the injury over a small area.

Cause of 1904 outbreak.—In the summer of 1902 the Brazos River overflowed in a most unusual manner, and again in February, 1903, a smaller overflow occurred. This resulted in large areas throughout the lower Brazos valley remaining uncultivated in 1903. This hard-packed soil gave ideal conditions for oviposition, and the weeds which came in furnished the favorite food of the hoppers, thus making their rapid multiplication certain. That an unusual outbreak should occur in the spring of 1904 was therefore to be expected. Throughout the bottom lands of central Texas this species is always common, and does more or less damage along the edges of the corn and cotton fields; but ordinarily the planters disregard the injury and allow the pest to multiply. Then, when such conditions as those above outlined occur, the pest increases very rapidly and serious injury is widespread. Were the weeds around the edges of the fields dusted with an arsenical whenever grasshoppers are observed to be common, and were uncultivated areas plowed during the winter when possible, the numbers would be so reduced that such outbreaks would not frequently occur. These conditions were exactly similar to those mentioned by Professor Morgan[a] concerning the outbreak of this species along the Mississippi, after a crevasse had been formed in the levee and a consequent overflowing of the adjacent land had resulted.

Use of fungous diseases.—Cultures of the fungous diseases with which experiments have been made in recent years as a means of combating locusts were secured from several sources. The tubes received from Prof. Lawrence Bruner, of Nebraska, mentioned below, were stated to contain what was probably a species of Mucor. Those received from Prof. C. P. Gillette, of Colorado, had been sent him by Doctor Edington, of the Bacteriological Institute, Grahamstown, Cape of Good Hope. Those from the Bureau of Entomology were marked "Culture C," and were also of South African origin, although prepared by the Department of Agriculture. These cultures were handled according to the directions sent with them,[b] and locusts dipped in the prepared solution were freed where they were most abundant in the field. Corn meal moistened with the solution was also scattered in these localities. These distributions were made on April 19, at four points, several miles apart. Examinations on April 29 and May 9 failed to reveal any grasshoppers dead from disease, nor did the planters see any later in the season. After May 1 the locusts had been so depleted

[a] 1901: Bul. 30, n. s., Div. Ent., U. S. Dept. Agric., p. 31.

[b] See Howard, Yearbook U. S. Dept. Agric. f. 1901, p. 464; and Bruner, Bul. 38, Div. Ent., U. S. Dept. Agric., p. 50.

in numbers by the remedial measures taken and by birds that they were not excessively abundant; but had the cultures been effective some diseased individuals would surely have been found three weeks after the first distribution, when the insects were still plentiful. Furthermore, at College Station, on April 4, a dozen locusts were dipped in the culture received from Professor Bruner and introduced into a field cage where several dozen live hoppers were given favorable conditions. These were supplied with food and the cage kept in good condition until June 4, during which time much rain fell, but no diseased specimens were observed.

Early in June cultures of the South African fungus were received direct, through the courtesy of Dr. Alexander Edington. Upon learning of an outbreak of *M. differentialis* in north Texas, and upon the request of planters there, several of these tubes were sent them and were prepared and disseminated by them as directed. They were, however, unable to notice any diseased locusts as a result.

These accounts of failures to secure any benefit from grasshopper cultures can not be regarded as at all conclusive concerning their lack of efficacy, but they at least add to the weighty evidence already reported against the value of such cultures for the control of grasshoppers.

THE CLUMSY LOCUST.

(*Brachystola magna* Gir. Fig. 12.)

Throughout the counties of west-central Texas, as far east as Bexar and Comal, this species replaces the common southern lubber grasshopper (*Dictyophorus reticulatus* Thunb.), shown in figure 13. Unlike

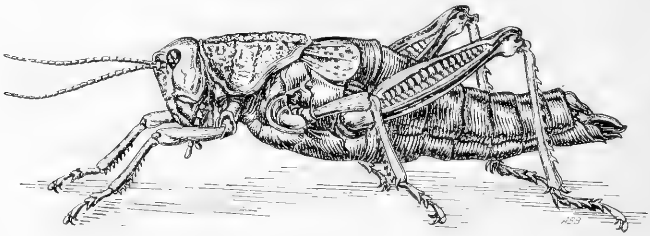

FIG. 12.—*Brachystola magna*, adult—natural size (author's illustration).

the latter species, however, the "clumsy locust" occurs in large numbers and often does serious damage. In 1904 it was much less injurious than usual, and no observations upon it in the field were possible. Our information concerning its habits is, therefore, derived mostly from correspondence with Mr. L. B. Smith, of Rescue, Lampasas County, a prominent bee keeper and careful observer, whose accounts have been largely confirmed by others in neighboring counties. May 22, 1903, Mr. Smith wrote as follows:

We are being bothered again by the wingless locusts. They are destroying the cotton crops by the wholesale, and, unlike most other insects, these come early and remain until frost comes in fall, and do not seem to have any natural enemy or disease. This insect has destroyed cotton in isolated districts of this section for several years past, but has appeared earlier and in greater numbers this year than ever. They are usually worse in June and July than at any other time. Some of us saved the larger part of our crops last year by unceasing fight against them with sticks, but we had to keep that up for about six or eight weeks, and it is very tedious work. They ate thousands of dollars' worth of cotton last year. We think the principal cause of their increase is the destruction of the wild birds and the hog law. In neighborhoods near here where there is no hog law and hogs run at large the grasshoppers do not get numerous. We have seen hogs eating them.

Mr. Smith requested that if possible some more efficient remedy be suggested, and in our reply the use of poisoned bran mash and the

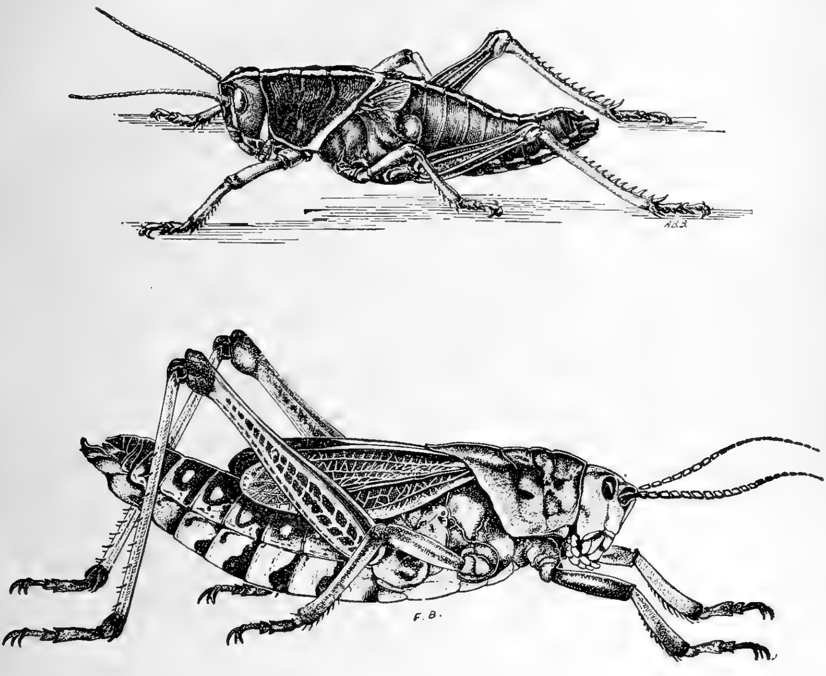

FIG. 13.—*Dictyophorus reticulatus:* nymph above, adult below—somewhat enlarged (original).

thorough poisoning of all weeds and grass was advised. In reply to questions concerning the habits of the locusts, Mr. Smith wrote on June 9, 1903:

I shall answer your questions in regard to the cotton-eating grasshoppers as best I can. First, "When do they appear first in the spring?" They usually appear in the latter part of May and first of June, but usually not in sufficient numbers to seriously affect cotton until about June 15. This year they were numerous by May 1 and have now become very destructive to cotton. Second, "How late do they work in the fall?" They remain until freezing weather comes on, though they do not seem so vigorous in August and September and do not eat cotton so much then. Third, "At what time do they become full grown in summer?" Usually in July they begin mating and depositing eggs, though many of them are grown [now], as the large pair I am mailing to-day. Fourth, "In what places are they most numerous and destructive?" In cotton fields. They have never seriously injured any other crop than cotton, though they are found in pasture far from any farm. They are destructive in Coleman, Runnells, Burnet, and Llano counties and as far west as Concho County, and I know not how much farther west.

These grasshoppers are numerous in nearly all districts in these western counties in which the hog law has been enforced for the past few years. We can not use the poisoned bran mash here on account of the great honey dearth, as it would poison my neighbors' bees as well as my own.

However, the mash was tried, as Mr. Smith's next letter, dated July 6, indicates.

The hoppers are still giving me trouble, but we have them somewhat checked now by using the poison on them as suggested by you. I am using the wheat bran sweetened with a cheap grade of molasses and arsenic mixed with it, and I believe it would have been a perfect success if I had commenced in time. I saw the first pair mating June 10. They get their full growth by the last of May. As to when and where they deposit their eggs, I have never been able to ascertain.

Mr. Smith sent numerous specimens, which were kept in cages in the laboratory for some time, but all failed to oviposit.

Undoubtedly the poisoned bran mash will prove perfectly effective for the control of these insects if employed plentifully early in the season. It is possible that the eggs are laid in grass land, and that they or the young hoppers may be eaten to a considerable extent by hogs where the latter are not restricted. Probably with larger areas of land under cultivation in these western counties the species will become less abundant, for, although it occurs as far north as Kansas and western Missouri, it is reported by Doctor Riley to be not very injurious there.

The species has been well named the clumsy locust, for it is exceedingly awkward. The wings are shorter than those of the other lubber grasshoppers, and, unlike those of Dictyophorus, are not raised from the back when disturbed. The coloration is somewhat variable, being mostly a tawny brown, with markings of greenish or yellowish, the latter often being quite pinkish.

THE BUR CLOVER APHIS.

(*Aphis medicaginis* Koch.)

Associated with the common cotton or melon aphis, *Aphis gossypii* Glover (fig. 14), there was found another species concerning which no previous economic mention has come to our notice, although the *Aphis* sp. mentioned by Mally [a] may be the same thing.

The two species occur together on the young cotton plants just as the first leaves are forming. *A. medicaginis* may be found abundantly at this time, and for a week or two earlier, on the common bur

[a] 1891: Bul. 24, o. s., Div. Ent., U. S. Dept. Agric., p. 30.

clover and a species of Oxalis. Mr. Sanborn has also noted it as occurring on clover (*Trifolium bajariensis*), cowpea, alfalfa, and coffee bean (*Cassia occidentalis*). Late in April it often becomes so abundant on bur clover as to cause the plant to wither, large swarms of flies buzzing around the infested plants attracting attention to them. Like the cotton aphis, the species is often so severely parasitized by *Lysiphlebus testaceipes* Cress. that it is killed out in a very few days.

The young stages and the apterous females are not at first easy to distinguish from *A. gossypii*, but the apterous females are darker and have a shining reddish or brownish-black appearance, while those of *gossypii* are deep greenish in color and have the cauda very much

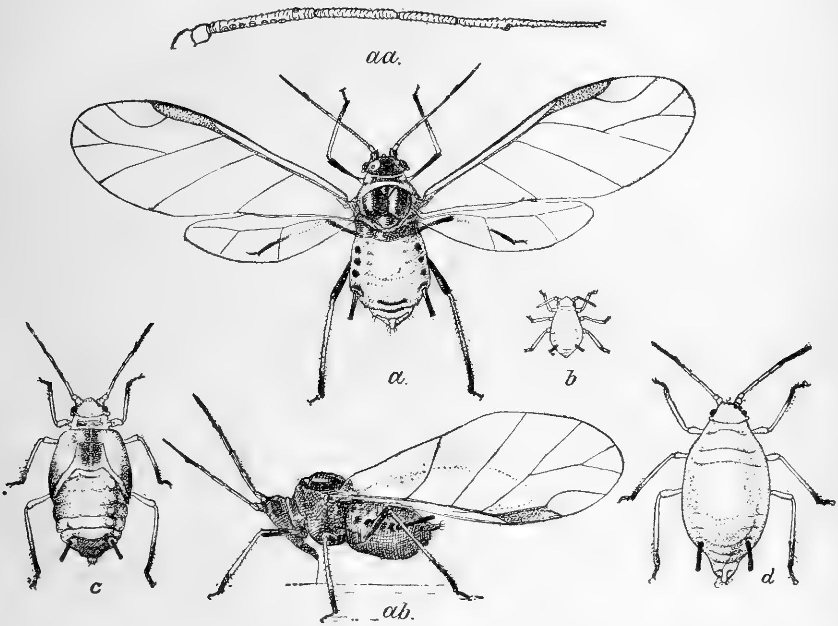

FIG. 14.—*Aphis gossypii: a*, winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female—all greatly enlarged (after Chittenden).

longer. The winged forms are readily distinguished by the dark markings on the abdominal segments of *medicaginis* which are lacking on *gossypii*. These markings, however, are only noticeable when the specimens are mounted in balsam.

Specimens were determined as probably *medicaginis* Koch by Mr. Th. Pergande, who, however, seemed to share our own doubt as to their identity with that species. After a careful examination of Koch's description and figures, though there are some noticeable discrepancies, it nevertheless seems probable that our species is that described by him, especially as some of its host plants have come from Europe. Koch states that the species is hardly distinguishable from

"*Aphis cichorii*" (*Aphis intybi* Koch), and his descriptions hardly distinguish the two species, the main differences being the smaller size of *medicaginis* and the coloration of the antennæ and legs. In coloration of the legs the apterous females of our specimens resemble *medicaginis*, but the coloration of the antennæ is like that of *cichorii*. The size is difficult to determine from Koch's figure. It appears probable that *Aphis medicaginis* Koch is synonymous with *A. cichorii* Koch (*A. intybi*), but as it is practically impossible to determine this without the types, and as the name *medicaginis* has heretofore been used in American literature, it seems best to retain it.

For those who are unable to refer to Koch's description it is here given:

Head, neck, and body black, legs yellowish white, the points of the femora, tibiæ, and tarsi, black. Honey tubes somewhat long and black. The middle joints of the antennæ yellowish. This form is very closely related to and hardly distinguishable from *A. cichorii*. It is smaller, and is the smallest of the species which have yet come to my notice. The winged insect has the same colorings as *A. cichorii*, except that the two middle segments, namely the fourth and fifth [*evidently of the antennæ*—E. D. S.], are yellowish, and the stigma of the front wing is smoky brown, darker on the margin, approaching yellow toward the base.

The wingless mother is hardly larger than the winged, though a little broader, not as broad, however, as the same form of *A. cichorii*. She is dark brown above and below, on the back somewhat blackened. Honey tubes and style black. Antennæ and legs yellowish white. The two end joints and the three shorter basal joints of the antennæ, as well as the points of the femora of the third pair of legs, and the points of the tibiæ and tarsi of all the legs, black. The points of the femora of the second pair grade into brown at the tips. The coxæ grade into smoky brown. The whole insect has very little glossy appearance. Only the back part of the abdomen shows itself somewhat flattened, and with a short brilliant gloss.

The host plant is *Medicago fulcata;* the aphis appears on this in very large numbers, congregating in millions. They colonize on the twigs, and more seldom down on the leaves. The winged forms readily make their escape when they notice danger.—(Translation of C. E. Sanborn.)

The species was first noticed in this country at St. Louis, Mo., in July by Monell,[a] who gives its food plants as *Caragana arborescens*, *Robinia viscosa*, and *Melilotus italica*. Monell notes the shining black dorsum, which agrees better with our description than that made by Koch, who states that it is glossy only for a short distance on the abdomen. This character is noted also by Thomas.[b] The species is also mentioned by Œstlund in his Aphididæ of Minnesota (p. 69), and by Osborn in his Catalogue of the Hemiptera of Iowa.[c] In a paper on the Hemiptera of Colorado[d] Cohen notes it on *Astragalus bisulcatus*, principally in the racemes of the flowers, and on *Glycyrrhiza lepidota*.

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[a] 1879: Bul. U. S. Geol. Survey, Vol. V, No. 1, p. 24.
[b] 1895: 8th Rep. State Ent. Ill., pp. 100–192.
[c] 1892: Proc. Iowa Acad. Sci., Vol. 1, p. 129.
[d] 1895: Bul. 31, Colo. Agric. Exp. Sta., p. 120.

DESCRIPTION.

Winged viviparous female.—Length, 1.99 mm.; width, 0.58 mm.; antennæ, 1.33 mm.; segment III, 0.33 mm.; IV, 0.27 mm.; V, 0.22 mm.; VI, 0.10 mm.; VII, 0.27 mm.; wing expanse, 6.64 mm.; cauda, 0.11 mm.; cornicles, 0.34 mm.; metatibiæ, 0.91 mm.

Head, thorax, antennæ, cornicles, and cauda black; abdomen slightly lighter or more grayish-black; legs yellowish, except distal half of femora and distal fifth of tibia and tarsus, which are dark; stigma and insertion of wings yellowish; three lateral blackish spots on margin of abdominal segments in front of cornicles, and fainter dark-brown markings forming broken bands on abdominal segments. Cornicles straight, tapering. Antennæ with a row of about five sensoria on segment III.

Apterous viviparous female.—Length, 1.66 mm.; antennæ, 1.19 mm.; segment III, 0.25 mm.; IV, 0.15 mm.; V, 0.17 mm.; VI, 0.11 mm.; VII, 0.22 mm.; cauda, 0.13 mm.; cornicles, 0.33 mm.; metatibiæ, 0.86 mm.

Reddish or brownish black when seen under lens, but otherwise apparently shining black; cornicles and cauda black; sutures of caudal segments whitish, pulverulent; antennæ yellowish, except black distal segments; legs yellowish, except tarsi, tips of tibiæ, and tips of metafemora; cornicles slightly constricted at base, extending to or beyond tip of cauda.

First and second instars.—Light yellowish brown, a light stripe bounded on either side by a darker brownish stripe along the dorsomeson; cornicles black and connected by a dark rusty band; head darker, rather greenish; legs and antennæ similar to adult.

Third instar (which will form pupa).—Deep pinkish, dorsal lines on abdomen as in previous instar; shoulders whitish, otherwise same as before.

Pupa.—Deep pinkish.

Fourth instar, apterous.—Deep reddish or maroon covered with whitish pulverulence; head rather greenish; at first the body is greenish or brownish, but gradually becomes uniform dark reddish as seen under lens, and finally blackish.

In either this last or the adult stage the insects commence to turn blackish on the caudal portion, the change in color gradually extending forward. At the same time the pruinosity is lost, and finally the adults become shining blackish. The color of the immature stages is exceedingly variable.

THE FALSE CHINCH BUG.

(*Nysius angustatus* Uhl. Fig. 15.)

During the spring of 1904 the false chinch bug occurred in unusual numbers over widely separated localities in Texas and Louisiana, damaging all sorts of crops, many of them not heretofore known to be injured by it, and among them cotton.

Attention was first called to its occurrence by the citizens of Sabinal, Uvalde County, Tex., late in April; and on May 2 Mr. Sanborn visited the locality. The insect had been known there for several years, but until that spring had never done serious damage. The young bugs occurred at that time in countless numbers, having caused the mesquite trees to turn yellow, and destroyed the young cotton so as to necessitate replanting over large areas, more or less injury occurring over the territory within a radius of 10 miles from Sabinal. The migration of the bugs was much like that of the true chinch bug (*Blissus leucopterus* Say); they would remain in one place until the vegetation there was destroyed and then move on. At this time hardly any adult bugs were seen. Late in May the writer visited the same fields, and hardly a specimen could be secured, although a few adults were found in corn. In this case the damage was done entirely by the nymphs; and the swarms disappeared after their devastation of the cotton as suddenly as they had appeared. Of the nymphs taken to the laboratory all died before maturing, so that their identity can not be definitely established; but there seems to be no doubt, from a comparison with determined specimens, that they are *Nysius angustatus*.

Early in May the same species appeared in immense numbers in wheat fields in one or two localities in north Texas, greatly to the alarm of the owners, but no material injury was done. Later in the month specimens were received from several points in central Texas, where, occurring in immense numbers, they were doing serious damage to various garden crops. In Brazos County they appeared sporadically in April, May, and early June, seriously injuring gardens. They were also observed in the field working on prickly lettuce and other weeds. In most cases they appear suddenly, practically destroy the vegetation within a certain area, then move on, and nothing more is seen of them in that locality. In habits they are much like the true chinch bugs, many of them remaining in the soil at the base of the plant and quickly running into it when disturbed, so that it is exceedingly difficult to combat them successfully. This was observed at Sabinal, where the nymphs attacked the young cotton before it was fairly out of the ground.

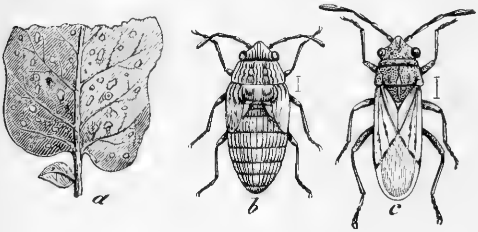

FIG. 15.—*Nysius angustatus*: *b*, last stage of nymph; *c*, adult—much enlarged (after Riley).

Late in May Prof. H. A. Morgan, State entomologist of Louisiana, forwarded specimens of this species collected by Mr. E. W. Dayton, who reported them as seriously injuring cotton at Jonesville, La. On June 15 Mr. Dayton wrote further:

> Just after receiving your first letter we had a hard rain, and that with the hot sun caused most of the insects to disappear, but there are spots of about one-fourth an acre scattered over the fields yet, and they are doing some damage. They damaged about 75 acres, reducing the stand to about one-half on this. I noticed a spot of about one-fourth an acre yesterday covered with them, and they seemed to be doing the usual damage.

It would seem, therefore, that this pest feeds on nearly all low-growing vegetation. Its favorite food seems to be plants of the family Cruciferæ, such as shepherd's purse and pepper grass, under which the nymphs are frequently found in large numbers.

All efforts to rear the insect or to determine its life history proved futile, as appears to have been the case in the past, for no definite observations seem to have been made concerning its life history. Professor Forbes[a] states that Professor Osborn has taken the eggs in Amaranthus blossoms, but this would not necessarily indicate that to be the usual place of oviposition. Undoubtedly the winter is passed in the adult stage, and there is probably more than one brood in a season. The species is a difficult one for the entomologist to study, either from the economic or from the systematic standpoint. After the examination of a large series taken in various localities in Texas and on various plants, Mr. Heidemann considers all the specimens to be of this species, but he states that the genus is so poorly known that it is impossible to satisfactorily separate the species at present.

The nymphs may be readily combated by spraying with kerosene emulsion, but the adults are difficult to handle. On garden crops we have found that by beating along the infested plants with a small screen covered with a sticky substance, such as is used for "fly paper," large numbers may be caught. Tobacco water applied copiously on the soil around the plants is also of value in the garden. A better knowledge of the life history would undoubtedly aid in devising means for controlling the insect on field crops, which fortunately, however, are not often attacked.

THE COWPEA-POD WEEVIL.

(*Chalcodermus æneus* Boh. Figs. 16 and 17.)

This weevil was frequently sent to us, being mistaken for the boll weevil. In several instances, however, it was stated that it was doing noticeable damage to young cotton, as has already been reported by Doctor Chittenden.[b] Subsequent to his report, in May, 1904, serious injury was done by the species in Georgia. As it was impossible to investigate the cases in Texas, the following account of the injury in Georgia and the habits of the weevils has been kindly furnished by Prof. Wilmon Newell, recently State entomologist of Georgia:

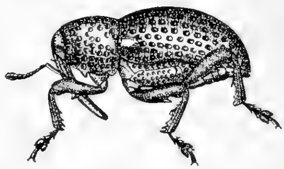

FIG. 16.—*Chalcodermus æneus:* lateral view, much enlarged (from Chittenden).

Injury by this species was personally investigated at Herod, near Dawson, Ga., May 27, 1904. Beetles were found upon about 15 acres of cotton, from 4 to 10 beetles on each plant. The plants were about 4 inches high. The beetles feed for the most

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[a] 1900: 21st Rept. State Ent. Ill., p. 95.

[b] 1904: Bul. 44, Div. Ent., U. S. Dept. Agric., p. 39.

part in the afternoon or early morning, and upon cloudy days, although a few may be found on the plants at noon on bright days. The beetle punctures the tender

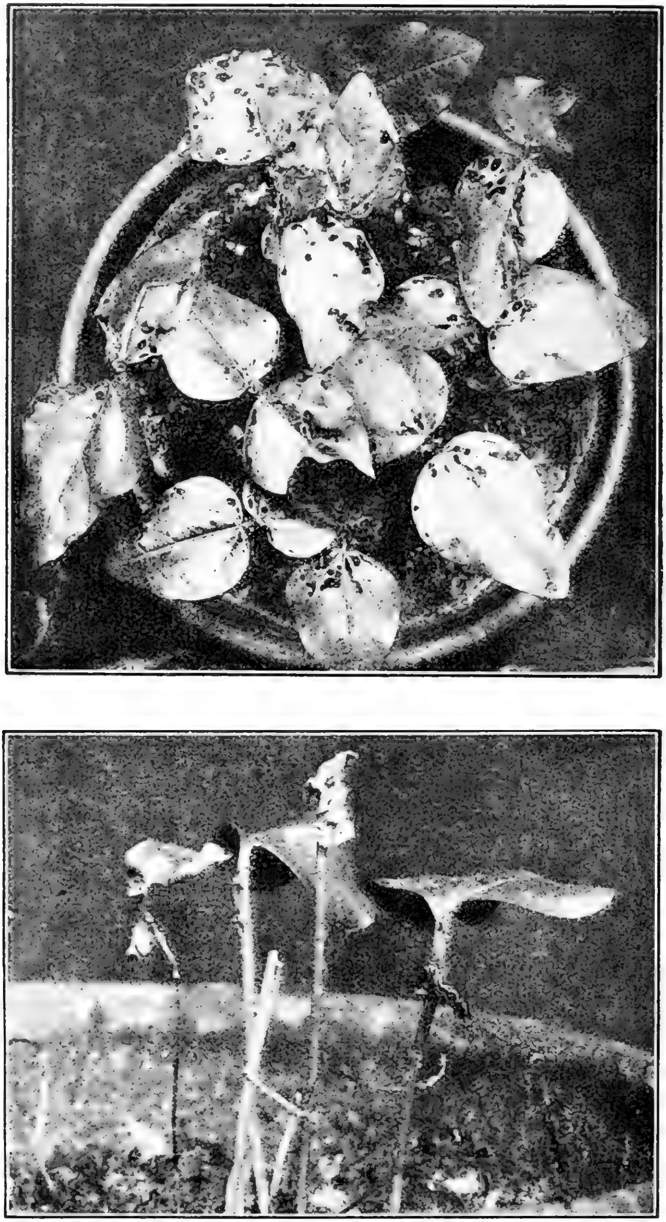

FIG. 17.—Work of *Chalcodermus æneus:* above, on young cowpeas; below, on young cotton. (Photograph by Wilmon Newell.)

stem, often just below a leaf, and this puncture reaches to the very center of the stem or occasionally to the epidermis of the opposite side. Punctures occur upon leaf stems and the upper tender part of the main stem, often just below a leaf, but rarely upon the base of the stem near the ground. The punctures upon leaf stems are so close as to practically sever the stem; the leaf soon withers and dies and drops. In some cases the beetles seem to stay over the puncture after it is made and suck up the sap which accumulates. In several cases we found a beetle upon the shady side of a stem, remaining over or close to several punctures, indicating that a single individual may make several punctures and take the sap that accumulates in all of them. Punctures in a case of this kind are not over one-sixteenth to one-eighth of an inch apart, and from two to four are found in each group. We are inclined to think that the punctures are made purposely for securing the sap and not for devouring the tissue. Eight punctures were counted on a plant not over 2 inches high, and in this field were found an average of from 5 to as many as 16 beetles on and about each plant. In this 15-acre field fully 25 per cent of the cotton stalks had been killed by the attacks of this beetle, and in some small areas as much as half had been killed.

During the day the weevils hide for the most part in the loose dirt about the plants at a depth of from one-half an inch to 2 inches. They occurred also on neighboring farms, but in no other case in such injurious numbers. In all cases the owners of infested fields reported that the first appearance of these insects in the cotton was in those portions of the fields that had been in cowpeas the year previous. About three weeks later—May 27—the injury became less, owing to the more rapid growth of the plants, and perhaps also to the greater dissemination of the beetles.

The use of arsenicals is not likely to result satisfactorily unless the treatment is exceptionally thorough. If cotton is not planted after cowpeas the pest will be disposed of, but the latter crop is very necessary in the rotation plans of the Georgia farmer. Where these beetles appear in the cotton fields in early spring we suggest merely that chopping be as long delayed as possible or until the amount of damage can be accurately forecasted. The injury will probably not result in more than a severe thinning, and if care is exercised in chopping a good stand may be secured in nearly all parts of the infested fields. In the laboratory adult beetles placed upon young cotton plants readily left them and migrated to young cowpea plants near at hand. A decided preference for cowpeas is indicated, and trap rows of cowpeas through the cotton fields might be efficient.

LEAF-EATING CATERPILLARS.

SALT-MARSH CATERPILLAR.

(*Estigmene acræa* Dru. Fig. 18.)

This caterpillar is a common pest in cotton fields and often does considerable damage locally. A very satisfactory description of the different stages of the insect has been given by Doctor Hinds[a] in his account of an outbreak in cotton at Victoria, Tex., so that the following notes will merely furnish further data toward a more complete knowledge of the life history.

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[a] 1904: Bul. 44, Div. Ent., U. S. Dept. Agric., p. 80.

TABLE V.—*Transformation records of the salt-marsh caterpillar.*

Place.	Larva taken.	Pupated.	Days pupa.	Moth emerged.
Terrell, Tex	June 18	June 20, 27	25	August 22, unhealthy.
Do	June 29	July 2	14	July 16, 1904.
Do	August 20	August 29	14	September 12, 1904.
Do	October 8	October 18		——, 1904.
Do	June 27	July 11	14	July 26, 1904.
College Station, Tex	September 5, 1902.	October 14-22	24	November 8 to January.
Paris, Tex.[a]		Cocoons, May 29, 1885.		
Ercildoun, Pa.[a]	July 17, 1893			July 29.
Hartford, Conn.[a]	Eggs laid August 3, 1893.			
San Jose, Cal.[a]		Cocoons, March 9, 1883.		

[a] From the records of the Bureau of Entomology.

The notes concerning the cocoons from Paris, Tex., state that they were found by the million on cotton, and that the caterpillars were destroying it and other green plants. As hibernated caterpillars of

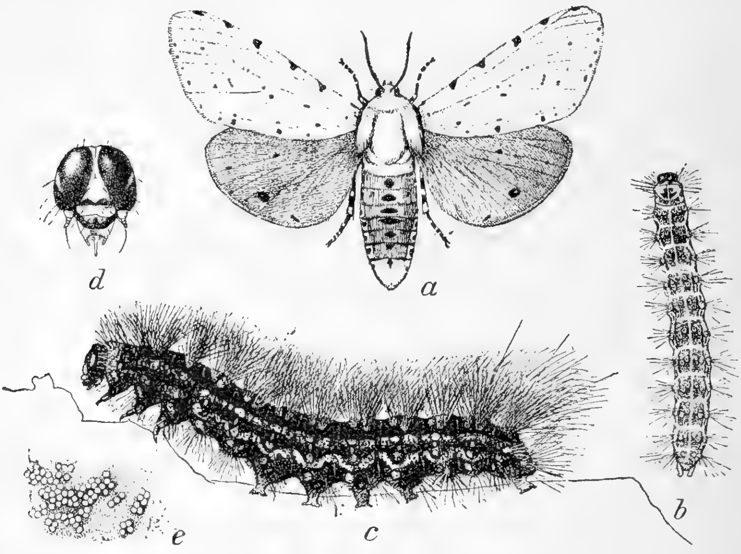

FIG. 18.—*Estigmene acræa*: *a*, male moth; *b*, half-grown larva; *c*, mature larva, lateral view; *d*, head of same, front view; *e*, egg mass—all slightly enlarged, except *d*, more enlarged (from Chittenden).

this family do not usually feed before pupating, these cocoons must have been those of the first spring generation. In this case there would probably be four generations in a season. The life history is exceedingly variable, as may be seen from the above records and by comparing them with those in Doctor Hinds' account.

Mr. Newell observed in 1902 that *Podisus spinosus* Dall., which hatched from eggs taken in the field with the larvæ of *acræa*, attacked the young larvæ vigorously and would soon have destroyed all of them.

The caterpillars of *Estigmene acræa* are parasitized by *Apanteles rileyanus* Ashm.

THE ARGE TIGER MOTH.

(*Apantesis arge* Dru.)

The caterpillar of this species is quite similar to the one last mentioned and is common on cotton, but has never been noted as very injurious. Our records concerning its life history are as follows:

TABLE VI.—*Transformation records of the arge tiger moth.*

Larva taken at Terrell.	Pupated.	Moth emerged.
May 27	June 15	June 26.
	July 9	July 23.
October 11	October 18	

Apparantly the life history is very much like that of the salt-marsh caterpillar, probably three generations occurring in a year.

The Division of Entomology received eggs of this species on a peach twig from J. W. Porter, Charlottesville, Va., April 22, 1887, which hatched May 4. The larvæ commenced to pupate June 23, and moths issued June 28 and July 2, although even on the latter date a number of larvæ were still feeding. Doctor Chittenden states that a moth attracted to light April 15 laid eggs April 16, which hatched by the end of that month. Another lot of larvæ transformed to pupæ June 4, and moths emerged June 16, while others pupated and emerged just three days later.

THE BEET ARMY WORM.

(*Caradrina exigua* Hbn. Fig. 19.)

Larvæ of this species were found eating cotton foliage at Terrell June 20, 1904. These pupated June 23, and a moth emerged July 1. July 3 at least 75 eggs were laid in several masses on both sides of the leaf. These hatched July 6, the larvæ pupated July 29, and moths emerged August 4. More larvæ were taken in the field July 2, eating leaves and into the squares. These pupated July 10, and moths emerged July 18.

A very complete account of this species has been given by Doctor Chittenden.[a] Recently Prof. C. P. Gillette[b] has published considerable data concerning the life history. His observations show that in Colorado injury by larvæ has been observed in June, the egg hatching about June 1; again in July, all of this brood having pupated by July 29, and again in August. His observations, as well as those recorded

[a] 1902: Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 37–46, figs. 8 and 9; and 1903: l. c., pp. 36–37.

[b] 1905: Bul. 98, Colo. Agric. Exp. Sta., pp. 13–15, Pl. III.

by Doctor Chittenden, would seem to indicate that the moth hibernates over winter. Professor Gillette states that the eggs require four or five days to hatch, and that the first eggs are laid about five and the last about sixteen days after emergence. No record of the length of the larval stage has been given. In Texas the eggs hatched in three days as against five, and the pupal stage was six to eight days as against ten to fourteen—approximately in Colorado. The length of the larval stage in Texas was twenty-three days. Thus the complete life cycle from the time of oviposition until the moth lays most of her eggs would require in that section about forty days.

Comparing the above data with the life history of the garden webworm, as given on pages 12–13, many points of resemblance will be seen. From this analogy the hibernating moths of the beet army worm probably oviposit early in April, the moths maturing from them—those of the first generation—being abundant about the middle of May. The second generation of moths emerges during the first or second week in July, and the third a little over a month later—early in August. A fourth generation of moths undoubtedly matures by the third week of September, as larvæ have been taken in southern California October 24 and November 5, in about the same latitude as southern Texas. The hibernating moths would thus probably form the fifth generation. Previous writers are doubtless correct in stating that in Colorado there are but three generations.

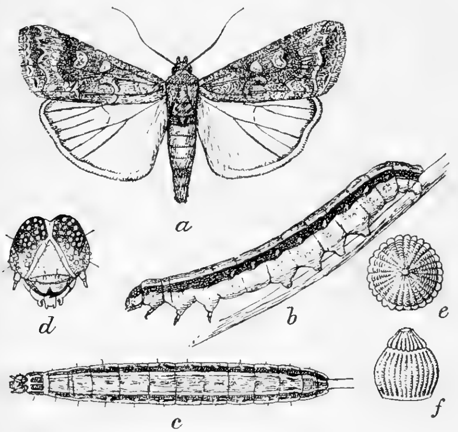

FIG. 19.—*Caradrina exigua*: *a*, moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, head of larva; *e*, egg, viewed from above; *f*, egg, from side—all enlarged (*e*, *f*, after Hofmann; *a-d*, after Chittenden).

Owing to the destructive habits which this insect has shown in the Colorado beet fields, its course in the cotton fields as it moves eastward will warrant attention.

Parasites.—The July brood of larvæ which matured early in August were badly parasitized by *Pristomerus texanus* Ashm., *Chelonus texanus* Cress., and *Apanteles algonquinus* Ashm.

PLATYNOTA LABIOSANA Zell.

Small green larvæ of this species were found rolling up cotton leaves at Terrell July 2, 1904. They pupated July 11, and moths emerged July 20. Mally has mentioned *Platynota rostrana* Walk. as sometimes working on cotton.[a]

[a] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., p. 30.

THE IO MOTH.

(*Automeris io* Fab.)

Larvæ of the io moth were found working on cotton at Paris, Tex., in August, 1904. September 8, about a dozen were found on a single stalk of cotton at Cooper, Tex.; one of them had pupated by October 1. This is a not uncommon species on cotton, but the injury is only local.

INSECTS AFFECTING THE STALKS.

THE SNOWY TREE CRICKET.

(*Œcanthus niveus* DeG. Fig. 20.)

This insect is of little economic importance in the cotton field, being beneficial, if anything; but the fact that the eggs found in the stalks in winter have been generally mistaken for those of the boll weevil by persons unacquainted with the habits of the latter insect makes it of interest. The eggs are laid in the fall in the stalks of cotton and various large weeds. They are arranged in a longitudinal row, and form a scar with numerous punctures, like the scars upon raspberry canes and fruit trees (fig. 21). These eggs hatch in early spring and the young feed upon plant lice. The habits of the nymphs have been well described by Prof. C. O. Houghton,[a] and our observations confirm his statements regarding the food habits, except that we have observed the adults to feed somewhat upon the tender portions of the foliage. The young become full grown by the middle or latter part of June in Texas, whereas in Delaware they did not mature until July 25. In the North there is but one generation a year, but there seems to be good evidence that two generations occur in Texas.

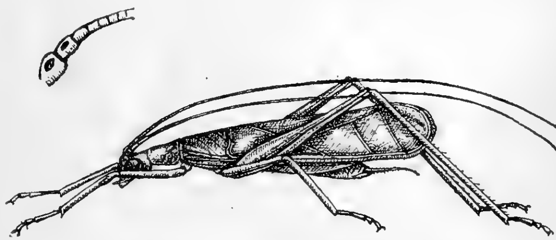

Fig. 20.—*Œcanthus niveus:* adult—three times natural size (original).

Two females were placed in a cage June 12, 1904, at which time the adults were common. A week later it was observed that the leaf petiole had been eaten until almost severed and the lobes of the leaves had also been attacked for food. July 1 it was found that the underside of the petiole toward the leaf was the favorite feeding point. July 8 eggs were found deposited in a leaf petiole, sometimes the egg-puncture extending through it. The eggs are about 1 by 4 mm.

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[a] 1904: Entomological News, Vol. XV, pp. 57–61.

These eggs hatched July 23, but the nymphs subsequently died. This observation clearly indicates that oviposition sometimes, if not always, takes place in July.[a] During July and August nymphs are commonly captured by sweeping, though the first generation matured in June. The fall eggs are not laid until October or November, and during September fresh adults are found.

Fig. 21.—*Œcanthus niveus*: egg punctures on stalk (original).

The oviposition on cotton is of no practical importance, and the crickets doubtless do much unnoticed good in consuming the plant lice always abundant.

STALK-BORERS.

AMPHICERUS sp.

Early in March, 1904, Mr. J. W. Howell, of Corsicana, Tex., sent cotton stalks containing specimens of a species of Amphicerus. Upon visiting this field as many as a dozen of these beetles were often found in a stalk. No injury could be attributed to them, and it seems probable that they work merely in the mature stalk and hibernate in it. The species may be the same as that observed at San Diego, Tex., by Mr. E. A. Schwarz, who took specimens of *Amphicerus fortis* Lec. in old cotton stalks April 25, 1895.

ATAXIA CRYPTA Say.

This species has been styled the cotton stalk-borer. It can hardly be considered a cotton insect, however, as it attacks only diseased or injured stalks, and normally breeds in cockle. It has not been recorded as injuring cotton except individual stalks here and there. The records of the Bureau of Entomology state that a larva of this species which had been boring into the root of *Xanthium strumarium* was forwarded by Mr. Schwarz from Beeville, Tex., October 26, 1895. One beetle issued June 24, another July 3, two July 27, and one July 29, 1896. May 1, 1897, a beetle was reared from a stem of cockle from Tucson, Ariz., three more emerging June 8.

[a] June 23, 1905. Mr. Sanborn states that the species has been full grown for at least five weeks and has been ovipositing. He thinks that there are undoubtedly two broods.

WORK OF ONCIDERES CINGULATA ON COTTON STALKS.

[These illustrations, running from left to right, show earlier and later stages in the girdling process.]

ORTHOSOMA BRUNNEUM Forst.

A larva, probably of this species, was sent to the Bureau of Entomology by Prof. Wilmon Newell, from Villa Rica, Ga., where it was stated to be boring into the bases of growing cotton stalks. It is probable that this injury is more or less accidental. The larva usually works in dead wood; and possibly where dead wood occurred in the cotton field and was plowed up, the larvæ might have attacked the cotton.

ONCIDERES CINGULATA Say.

In October, 1904, numerous specimens of cotton stalks cut off about 1 foot above the ground were received from Waco, Tex., the work being undoubtedly that of this species. Subsequently the fields were

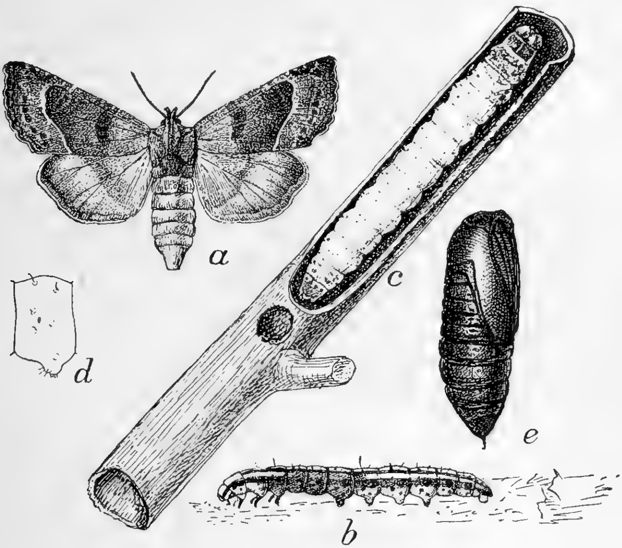

FIG. 22.—*Papaipema nitela: a*, female moth; *b*, half-grown larva; *c*, mature larva in injured stalk; *d*, lateral view of abdominal segment of same; *e*, pupa—all somewhat enlarged (from Chittenden).

visited, but none of the beetles could be found, though similar work was noticed on neighboring hackberry trees. Injury by this insect is very common to shade and fruit trees, especially to pear, in west-central Texas.

PAPAIPEMA NITELA Guen.

In July, caterpillars presumably of this species (fig. 22) were found not uncommon, boring in the cotton stalks at Terrell, especially along a small creek. The larvæ enter the stalk 3 or 4 inches above the ground, boring upward and causing it to wilt and die. The larvæ were very common in the stalks of "bloodweed" (*Ambrosia trifida*) in Brazos County, but none were found on cotton. June 24, 1904, specimens were received by the Bureau of Entomology from L. Goldman, Lagrange, Ark., who reported them boring into cotton stalks. Injury by this species seems to be rather accidental, and probably occurs more commonly where fields are weedy, or where they adjoin uncultivated fields.

INSECTS AFFECTING THE FRUIT.

THE COTTON-SQUARE BORER.

(*Uranotes melinus* Hbn. Fig. 23.)

History.—In the two brief economic accounts of this species already published[a] it has been considered as an enemy of beans and hops, but no reference to it as a pest of cotton has been found. Mally has recorded the similar habits of *Calycopis cecrops* Fab. (*Thecla pœas* Hbn.),[b] and since then much of the injury due to *melinus* has been referred to the latter species. In Texas, although *cecrops* is common, by far the largest amount of damage is done by *melinus*.

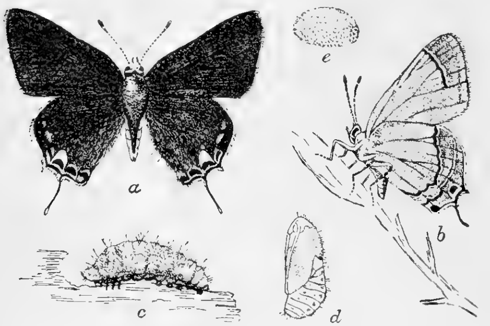

FIG. 23.—*Uranotes melinus: a*, dorsal view of butterfly; *b*, butterfly, with wings closed; *c*, larva from side; *d*, pupa; *e*, egg—all somewhat enlarged, except *e*, greatly enlarged (all except *e* redrawn from Howard).

The records of the Bureau of Entomology give the following data concerning this species: A larva sent by C. V. Riley, September 16, 1878, taken feeding on cotton at Augusta, Ga., was found to be parasitized by a species of Apanteles. September 4, 1880, a larva on cotton was received from Selma, Ala., likewise parasitized. July 6, 1880, a larva was received from R. F. Cooke, Marion, Ala., and parasites emerged the next day, seemingly *Apanteles theclæ* Riley. June 27, 1892, larvæ taken on cotton were sent by L. T. Sanders, from Plain Dealing, La. Under date of June 18, 1895, Mr. E. A. Schwarz, investigating the boll weevil, wrote from San Diego, Tex.:

> My friends here have brought me during the last two days plenty of squares said to be infested by the weevil, and I myself find others, but in every instance the author of the mischief is the cotton Thecla, which at present is the only injurious insect on cotton here.

Mr. Schwarz sent larvæ of this species from various points in south Texas in May and June. One larva was sent by him from Beeville, Tex., October 22, 1895, and another one from Bergs Mill, Tex.,

[a] 1895: Riley and Howard, Insect Life, Vol. VII, pp. 354–355; and 1902: Chittenden, Bul. 33, n. s., Div. Ent., U. S. Dept. Agric., pp. 101–102.

[b] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., pp. 29–30.

December 9. He also sent a pupa from Beeville November 29, the butterfly from which emerged December 20.

Butterflies of this species are always common about the cotton field, and may be seen laying their eggs upon the foliage. Injury is more prevalent, however, where cotton adjoins or succeeds cowpeas, upon which plant the larvæ feed readily, according to the testimony of planters preferring it to cotton. Injury to cotton squares is exactly like that done by young bollworms later in the season, but occurs when the first squares appear. Often when the squares have been destroyed a larva will bore into the young stalk. Local injury to young cotton is often quite serious.

Life history.—The butterflies appear about the middle of April and eggs are laid in May. The larvæ of this generation are most injurious to cotton, and butterflies from them emerge late in June and early in July. A third brood of butterflies emerges in August. Larvæ are taken during September and October, and pupæ later in the fall, so that it seems probable that the winter is usually passed in the pupal stage, in old leaves, under rubbish or bark, etc., though sometimes a butterfly emerges in December and may hibernate. Mr. Sanborn observed the butterflies October 15, 1904, more abundant than at any time during the summer. At that time they were feeding on castor bean blossoms. The different generations are by no means distinct, and quite possibly four may occur in a season. After the first brood the larvæ are so parasitized that injury to cotton is not usually apparent, though considerable damage was noticed October 8, 1904, at Clay, Tex.

In addition to the food plants noted in the previous accounts—cotton and cowpeas—eggs and larvæ have been taken on "goatweed" (*Croton capitatus*), and a single larva, apparently of this species but not reared, was found boring into a half-grown peach in May, other fruit bearing marks of similar injury.

The small yellowish or almost transparent egg is laid on the leaf stem just at or upon the base of the leaf. The female, in ovipositing, bends the ovipositor downward and forward, so that she may deposit her egg upon the under side of the leaf though resting upon the upper surface. No eggs have been observed upon the squares. The eggs hatch in from two to five days. The larva becomes full grown in fifteen or sixteen days in midsummer, though twenty-nine days are required in May. The length of the pupal stage averages about ten days. Thus the complete life cycle occupies about a month. The records of rearings are summarized as follows:

TABLE VII.—*Transformation records of the cotton-square borer.*

Place.	Egg laid.	Egg hatched.	Larva taken.	Days larva.	Pupated.	Days pupa.	Adult emerged.	Adults collected.
			June 11, full grown.	Died.				
			June 21		June 23	Died.		
			June 25, 29		July 11	8–11	July 17, 22	
College Station, Tex.	July 2	July 6		15	July 21	10	August 1	April 27.
					July 25	13	August 7	May 11.
	July 26	July 28		16	August 14.	Died.		June 15.
			Aug. 2		do	7	August 21	July 14, 21.
			Oct. 8, nearly full grown.	Died.				August 7.
Terrell, Tex.	April 28.	May 3		Died.				
	May 6.	May 11		29	June 9	11	June 20	April 20.
					June 30	9	July 8	August 5, 26.
			July 5		July 19	9	July 28	July 30
			October 22.	Died.				September 6.

The pupal stage is passed in a folded leaf, which is drawn together with a few strands of silk and which is attached to the stalk or under some shelter.

As yet injury by this species has been local, and rarely has any considerable amount occurred year after year in the same fields. This is undoubtedly due to the exceedingly effective work of the parasites. Should remedial measures be desired, thoroughly dusting or spraying the foliage of the young plants with Paris green or other arsenical will doubtless result in killing many of the young larvæ, as they feed somewhat upon the foliage in the same manner as the true bollworm.

Parasites.—As noted above, the June caterpillars are so thoroughly parasitized that it is difficult to rear adults from larvæ taken from the fields. Were it not for this good work of the parasites the insect would be a most serious enemy of the planter. Practically all of the parasites bred were *Apanteles carduicola* Pack., but one lot of caterpillars was parasitized by *Metadontia amœna* Say, which Doctor Ashmead states is "a rare species long lost to science."

THE COTTON-BOLL CUTWORM.

(*Prodenia ornithogalli* Guen. Figs. 24 and 25.)

The larva of this species was commonly observed in north Texas feeding upon the foliage of the young cotton plants, and later boring into the bolls in the same manner as does the bollworm. The species was under study throughout the season at Terrell, and the data concerning its life history are given in the following table:

TABLE VIII.—*Transformation records of the cotton boll cutworm.*

Eggs laid.	Eggs hatched.	Larva taken.	Days larva.	Pupated.	Days pupa.	Moth emerged.
		March 30		April 5	36	May 11.
		May 14		May 21	19	June 9.
				May 28	15	June 12.
		June 28		July 4	12	July 15.
		July 10		July 15	10	July 25.
	August 9		18	August 27	16	September 12.
	August 27		21	September 17.	11	September 28.
October 11	October 17		60	December 17.	19	January 5.[a]

[a] One moth emerged.

The first larva taken on March 30 was full grown, and was feeding upon lamb's quarter (*Chenopodium album*). All the others were taken on cotton. No eggs were secured from reared moths, but two lots were found in the field. The brown, globular eggs were deposited upon the under side of a cotton leaf, in a pile of about 200 or more. They are laid in rows in a nearly square mass, fifteen to twenty eggs in a row and about fifteen rows. The mass is covered with light-brown down from the female, which hides the eggs from view.

Of several larvæ pupating December 17, one adult emerged January 5, the remainder dying in the pupal stage.

Owing to the very complete description and account of this species given by Doctor Chittenden[a] it is unnecessary to enter into further discussion concerning it except to indicate its life history.

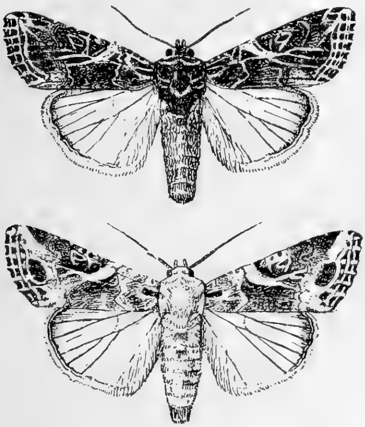

FIG. 21.—*Prodenia ornithogalli:* dark form, male, above; pale form, female, below—somewhat enlarged (from Chittenden).

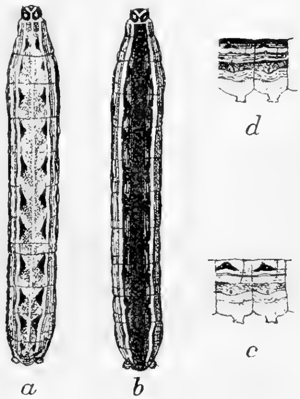

FIG. 25.—*Prodenia ornithogalli:* *a*, pale form of larva; *b*, dark form; *c*, lateral view of abdominal segments of pale form; *d*, of dark form—all enlarged (from Chittenden).

In addition to the records published by Doctor Chittenden, the following notes in the records of the Bureau of Entomology upon *Prodenia flavimedia*, which is now considered synonymous with this species, are of interest. September 13, 1878, a larva sent by C. V. Riley was received from Albany, Ga. October 5, 1878, another larva was received from Professor Riley, probably from the same locality. This specimen commenced to pupate October 8 and the moth emerged December 27. May 1, 1882, a larva was received from E. H. Anderson, who stated that he had observed the species feeding on cotton at Kirkwood, Miss., for several weeks. This larva pupated May 8 and the moth emerged June 5.

[a] 1901: Bul. 27, n. s., Div. Ent., U. S. Dept. Agric., p. 64.

These records, with those published by Doctor Chittenden, would indicate the following as the probable life history of the species in the Gulf States. The winter is usually passed in the pupal stage in the soil, though possibly a few moths, emerging late, hibernate. The first brood of moths appears from the middle of May until the middle of June, mostly early in June. A second brood appears during the latter half of July, and a third late in August and during September. A few of the fourth brood may emerge in December, but most of them do not do so until the very early spring, when they lay eggs upon various weeds on which the larvæ feed until cotton appears. The length of time occupied in the different stages is seen to be quite variable, but is approximately 6 days for the egg, 20 days for the larva, and 13 days (usually 10 to 15 days) for the pupa—making a total of about 40 days for the complete life cycle.

A larva of *Prodenia eridania* Cress. taken on cotton at Terrell October 22, 1904, pupated November 1 and the moth emerged November 22.

The caterpillars are parasitized by *Ophion bilineatum* Say.

THE COTTON LEAF-BUG.

(*Calocoris rapidus* Say. Fig. 26.)

These capsids were noticed commonly upon cotton at College Station and elsewhere late in the summer of 1903, and a few were received for

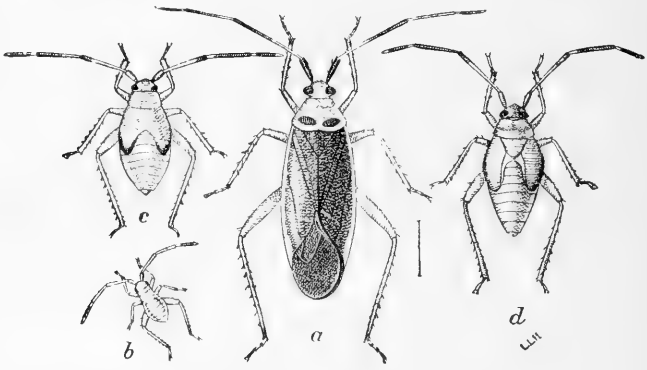

FIG. 26.—Cotton leaf-bug, *Calocoris rapidus*: *a*, mature bug; *b*, young nymph; *c*, fourth stage of nymph; *d*, fifth stage of young (author's illustration).

identification, but little importance was then attached to them. Late in August, 1904, reports of serious injury to cotton were received from Kaufman, Hunt, Ellis, and adjoining counties, and Mr. Lewis was directed to investigate the injury. He reported as follows:

On September 1 the insect was found abundant in all fields examined at Wolfe City, both nymphs and adults feeding upon the squares, young and half-grown bolls, and in the blossoms. The nymphs were most numerous on the squares, the adults on the blossoms and bolls, especially just after the blossom has fallen. Planters stated that this injury prevents squares from blossoming and that they drop. At this time but few squares were being injured, but planters stated that the bugs had been very much more abundant and injurious a fortnight previous. In the flower they feed at the base of the petals, causing it to wilt and drop. The small bolls fed upon dry up and drop off, while if the larger ones are much injured they become soft and mushy; some of them continue to grow on one side, the punctured side being found dead and discolored. The insect appeared about the middle of July at Wolfe City, and is stated to have done some damage in 1903. During the next ten days fields were visited at Commerce, Ennis, Crisp, Cooper, and Enloe, and at all of these places conditions were found much the same as those described above. Most of the damage seemed to have been done to late cotton and to the young bolls just after the blossoms had dropped.

FIG. 27.—Cotton boll showing punctures of *Calocoris rapidus* (author's illustration).

The adult bug is a quick flyer and is difficult to capture when disturbed, though it flies but a short distance, usually to the next row or for a few yards only. The nymphs are swift runners and are most common on the young squares. No eggs were secured, but a very small nymph not over 2 or 3 days old, which had probably molted but once, was taken September 8. It molted September 16, 19, and 24, when it became adult. Another young nymph was taken September 24, molted September 28, October 3 and 8, when it became adult. The complete life cycle probably does not occupy over thirty days.

Practically nothing is known of the habits of this species earlier in the season. Two specimens were taken at trap light at College Station April 18, and one was received from Wise, Tex., June 1, 1903. At Terrell, the first specimen was taken at trap light June 17, 1904. Later, on July 3, three were taken; on the 7th, 4; 8th, 5; 9th, 4; 10th, 5; 14th, 6; and 26th, 4.

Where the bugs fed upon the bolls there appeared around each puncture a black spot, much like the early stages of anthracnose (fig. 27). To determine definitely whether or not this was produced by the punctures of the bugs, six of these were placed on a young cotton plant about 8 inches high October 1. Five days later the plant was dead from the injury. October 7 six bugs were placed in a bag over a fair-sized boll, perfectly green; by the 10th it was well covered with the black marks made by the bugs. To make certain of the nature of the injury, bolls were submitted to Dr. A. F. Woods, Pathologist and Physiologist of this Department, who reported: "These resemble somewhat the early stages of anthracnose, but we have been unable to find any fungus present, and the spots have not enlarged or developed any fungus even after several days in a moist chamber." There is no doubt, therefore, as to the cause of this injury, which was quite considerable in the counties mentioned and noticeable elsewhere.

That this is no new enemy of cotton is shown by the fact that Glover in his report on cotton insects in 1855[a] mentions and figures it. Again, in his manuscript notes and plates, he states that it injures the plant by piercing the leaves and young shoots.[b] It was next mentioned by Prof. F. M. Webster[c] as injuring wheat in Indiana by attacking the heads and causing them to wither. In 1893 Mally gave a brief description of the injury done to cotton, similar to that recently observed.[d]

Calocoris chenopodii, an allied species, has been observed to feed on larvæ of the asparagus beetle in Europe, and Doctor Chittenden states[e] that the present species is not uncommon in asparagus beds.

There seems to be no feasible means of combating the adult bugs; but the nymphs would undoubtedly succumb to a spray of kerosene emulsion or similar contact insecticide, which should be applied as soon as they are observed to be numerous. By such an application during July, when there are but a few here and there, serious injury by the increased numbers late in the summer might be prevented.

CORIZUS PICTIPES Stål.

September 5, 1904, this species, which somewhat resembles the preceding, was found very abundant in all stages at Sherman, Tex., on a species of Althæa, affecting it much as the leaf-bug affected cotton. From eggs which hatched September 5 adult bugs matured October 7. Later in October the species was found on cotton at Terrell, and specimens taken on cotton were received from Cameron, La., October 10.

OTHER PLANT-BUGS.

The black spots upon the bolls and the consequent shrinking and softening are not always due to *Calocoris rapidus* Say, as several other species have been noticed as producing the same injury, although they do not occur in such large numbers and the injury is not so general.

LARGUS SUCCINCTUS Linn.

This species is frequently found on the bolls in late summer, causing some injury. Adults were found common late in July, and on the 28th a pair were confined on cowpeas. On August 6 two egg

[a] 1856: Rept. U. S. Comm. Patents f. 1855, Agriculture, p. 87, Pl. VII, fig. 6.

[b] 1878: Manuscript notes from my journal—Cotton and the principal insects, etc.—Washington, pl. 11.

[c] 1885: Rept. Comm. Agric. f. 1885, p. 317.

[d] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., p. 31.

[e] 1898: Bul. 10, n. s., Div. Ent., U. S. Dept. Agric., p. 57.

masses were deposited under trash in the soil, one mass containing 215 eggs. The species has been previously recorded as injurious to cotton by Glover and Mally (*l. c.*), and to nearly ripe peaches near San Antonio, Tex., by Lintner, who has given the only complete discussion of the insect.[a] It has been similarly mentioned by Doctor Howard.[b]

JADERA HÆMATOLOMA H.-Schf.

This dark-bluish bug often occurs on cotton, though no injury by it has been observed. It normally feeds on weeds and low growing vegetation. The young, in all stages of growth, were seen feeding on various weeds at Navasota, Tex., about the middle of May. The nymphs have the interesting habit of keeping together, so that a considerable number are found feeding in one spot; but as they grow older they drift apart, and the adults are usually found in pairs. Eggs laid July 20 hatched on the 29th. On August 4, adults which were found common on the china-berry tree were confined on cotton, and were observed to oviposit in crevices of the soil. In oviposition the female turns the abdomen upward at a decided angle and expels the egg, which falls to the ground. After laying about a dozen eggs in this manner she makes use of her forefeet to cover them with loose particles of soil. Copulation takes place after each laying. Eggs were also found in the hull of a china berry, in which they seemed to have been hidden. Probably they are laid under any sort of rubbish on the soil.

LEAF-FOOTED PLANT-BUGS.

(*Leptoglossus oppositus* Say, fig. 28, and *Metapodius femoratus* Fab.)

These insects have been frequently observed by Messrs. Lewis and Bishopp in north Texas puncturing cotton bolls and causing more or less injury. Both were mentioned by Glover as cotton insects.

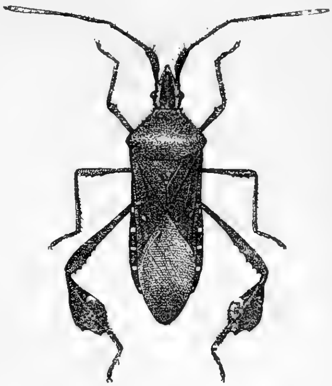

FIG. 28.—*Leptoglossus oppositus:* adult—twice natural size (from Chittenden).

THE GREEN SOLDIER BUG.

(*Nezara hilaris* Say. Fig. 29.)

A letter dated March 7, 1903, from Mr. R. L. Taylor, of Help, Tex., first called attention to this insect as a cotton pest. Mr. Taylor sent

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[a] 1885: Second Rept. N. Y. State Ent., p. 164, fig. 41.
[b] 1901: The Insect Book, p. 307, fig. 200.

a specimen he had that day found in the woods and stated that in 1902 this insect had ruined his cotton crop. As many as three of the bugs were found on one boll, and by shaking the stalks as many as five bolls would sometimes drop, presumably as a result of their injury. The statement that the injury was done by this insect may be questioned, but its identity could hardly be confused; and, judging from later observations, if it occurred in the numbers stated, the injury would undoubtedly be serious.

In September and October, 1904, Mr. Lewis frequently found these bugs puncturing bolls at Terrell, causing black spots and injuring the lint. September 1 a mass of fifty eggs was taken at Wolfe City, and several masses were previously taken at Terrell. These eggs hatched September 2, the young nymphs being almost black. The nymphs molted September 5, 19, 26, and October 1, the wing-pads appearing on the latter date. The last molt occurred on October 11.

The adult bugs hibernate over winter, as is shown by the fact that specimens have been taken at Wellborn, Tex., March 7, 1903, and at Manor, Tex., March 29, 1904.

The insect has been known as a resident of cotton fields before, but its exact status has never been determined. In the Fourth Report of the United States Entomological Commission, page 79, it was reported as feeding upon the cotton caterpillar. Riley and Howard record injury by it to cotton and also to garden plants at Tallahassee, Fla., November 14, 1890.[a] Nymphs were also recorded by them as seriously injuring beans in Stafford County, Va., September 30, 1889.[b]

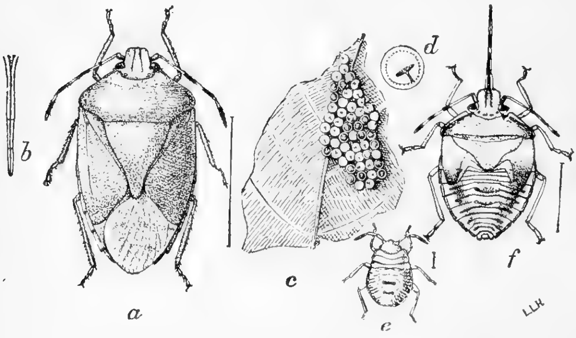

FIG. 29.—*Nezara hilaris*: *a*, mature bug; *b*, beak of same; *c*, egg mass; *d*, single egg; *e*, young nymph; *f*, last stage of nymph—all enlarged; *b*, *d*, more enlarged (from Chittenden).

The records of the Bureau of Entomology show the insect to be undoubtedly an enemy of the orange tree and to have a wide range of food plants. March 19, 1883, eggs, nymphs, and adults were received from Mr. T. Franklin, West Apopka, Fla., who stated that they were injuring orange trees. More eggs and nymphs were received April 7. October 3, 1898, specimens were received from W. L. Thomas, Valdosta, Ga., who reported great numbers injuring leaves and fruit in

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[a] 1891: Insect Life, Vol. III, p. 403.
[b] 1889: Insect Life, Vol. II, p. 148.

his orange grove, in Orange County, Fla. January 5, 1899, Mr. J. P. Donnelly, of Mount Dora, Fla., sent an adult of the species and stated that they were sucking the juices of his oranges. The specimen sent had been attacked and killed by *Euthyrhynchus floridanus* Linn., which accompanied it. Injury to cabbage, corn, cotton, and peas was reported by Mr. J. P. Cooksey, Pin Hock, Fla., January 6, 1892, and injury to peaches from the adult bugs by Mr. J. P. Lorenson, Salt Lake City, Utah, September 12, 1898. September 26, 1904, Doctor Chittenden observed the adults puncturing okra pods at Washington, D. C.

THYANTA CUSTATOR Fab. AND PROXYS PUNCTULATUS Beauv.

These insects were also frequently observed on cotton bolls, though no injury could be directly attributed to them. The former species was exceedingly destructive to various field crops—corn, sorghum, cowpeas, etc.—in north Texas in 1903.

SHARPSHOOTERS.

Although the first species to be discussed below is the one commonly known as the "sharpshooter" of cotton, we may well consider three others, nearly related and with very similar habits. All four species are found more or less on cotton, and would not be readily distinguished by the average planter.

THE GLASSY-WINGED SHARPSHOOTER.

(*Homalodisca triquetra* Fab. Fig. 30.)

Life history.—The adults pass the winter in rubbish, leaves, etc., near the food plants. On January 11, 1905, they were found feeding on yaupon (*Ilex decidua*), reported by Mr. Sanborn as one of their favorite food plants. On cold days they crawl down among the trash and leaves. They begin to leave their hibernating quarters late in March, our first record at College Station being March 24, 1904, but are not common until two weeks later. On April 6, 1904, adults were common along a small tributary near the Brazos River on hackberry (*Celtis mississippiensis*) and cottonwood, and still more numerous on elm and willow. On April 14 they were exceedingly numerous on elm and hackberry, the dropping of their exudation being very noticeable; but none were found copulating. At this time numerous jassid nymphs were found upon these trees, but, as we were then unfamiliar with the nymph of *triquetra* and were unable to rear any of them, the species is uncertain. The occurrence at this time of these nymphs, which if not the species under discussion, must certainly have been nearly related to it, indicates, in any event, the possibility of oviposition in early April, although this is certainly not common. Numerous observations were made each week, yet none were found mating until

May 13, when a single pair was observed. On May 20 several pairs were observed *en copula* and other females were found to be full of mature eggs. At this time they had left the elms and some had migrated to sorghum, cotton, corn, and sunflowers, but they were still common on hackberry. On June 10 the adults were numerous on sunflower and pigweed; and nymphs, undoubtedly of this species, were found on hackberry. On the 17th as many as fifty to the stalk were observed on sunflowers; but although common on weeds at the edges of the fields, none were found on cotton. During the weeks previous to this date none were seen on elm or hackberry, but they were quite common on cottonwood. During June and July numerous unsuccessful attempts were made to secure eggs from adults in confinement. Until about July 20 the adults were common upon sunflower and cottonwood, but at about that date they became more scarce, and were found only on young bushes. During the early summer a few nymphs in various stages of development were usually found with the adults.

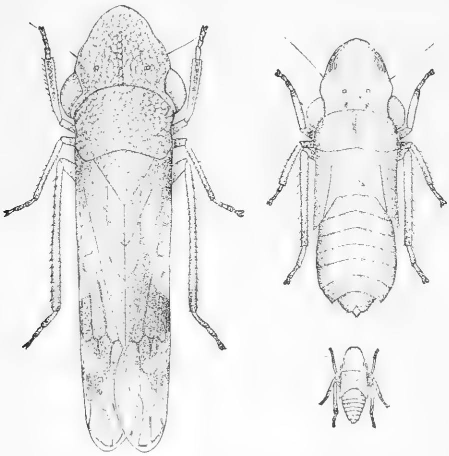

FIG. 30.—*Homalodisca triquetra:* adult at left, last stage of nymph at right, young nymph below—all enlarged (author's illustration).

At Terrell several adults were confined on cotton June 17. The next day one lot of ten eggs was laid in a row just under the epidermis. These hatched June 24, and the nymphs molted on July 11 and 25 and August 15. All died on August 26. After the third molt the wing pads were just appearing. Judging from this fact and comparing further observations on nymphs taken in the field August 8, which molted once before becoming adult, it seems probable that had these nymphs lived they would have molted twice more and become full grown early in September. During the latter half of July the adults were decidedly less abundant near College Station. About the 1st of August the cowpea was found to be a favorite plant for food and for oviposition. Young were observed hatching on August 3 and 5, and at about the same time nymphs were observed to make the last molt and become adult. During the first two weeks of August numerous egg masses were laid in cowpea leaves in field cages at the college, often two or three masses in a leaf. The eggs are usually laid in rows on the ventral side of the leaf, averaging about twenty in a row. The surface of the leaf above the eggs is covered with a whitish powder from the body of the female, which gives them a very striking appearance and at first sight seems to be a decided disadvantage, but which possibly is of some value in protecting them from parasites. This wears off in a few days, often leaving a margin of white around the eggs. Eggs known to have been laid August 17 hatched about 7 a. m. on the 25th almost simultaneously. About twenty minutes later the nymphs changed from a bright green to a metallic lead color and had increased very rapidly to about twice the size at which they emerged. On August 12 more adults were found on okra than on any other plant. Eggs were common on the bloodweed, and were also found at College Station on catalpa. Only a few sporadic adults were found on cotton. Nymphs were most common along the Brazos River on young elm, box elder, mulberry, and bloodweed. About the middle of August a very large percentage of the eggs became parasitized by *Ooctonus homalodiscæ* Ashm. n. sp., so that it was exceedingly difficult to rear nymphs. The larva of a chrysopid was also observed feeding on the young nymphs. This larva, which was colored like the petiole at the base of the leaf, awaited its prey upon the red spot at that point. On August 20 an egg mass was found deposited in the bract of the involucre in a field cage in which adults had been placed on cotton in the Brazos bottom. These were parasitized, but six eggs were found in one small boll. This is the only instance in which any injury to cotton was observed under field conditions. On August 28 the adults were quite abundant on fig trees and on cotton near the Brazos, but no eggs were found on fig. On August 24 eggs were taken on okra and catalpa. By September 1 the adults were much less common on cowpeas, but one lot of eggs deposited September 15 hatched the 22d. On October 8 adults and nymphs in the last stage were taken on the fig trees, but no eggs could be found.

At Terrell a nymph with wing pads just showing was taken August 8, and became mature upon molting August 15. On August 24, adults were found in the field, which from their bright color and texture were evidently newly transformed. Eggs laid September 6 hatched September 12.

These observations may be briefly summarized as follows:

TABLE IX.—*Transformation records of the glassy-winged sharpshooter, 1904.*

Place.	Mating.	Eggs laid.	Hatched.	Nymphs.	Grown nymphs.	New adults.
Terrell, Tex.	....	June 18	June 24	August 15	....	....
	....	....	....	3d stage, August 8.	....	August 15
	....	....	....	....	....	August 24
	....	September 6	September 12	....	....	....
	....	....	....	October 22	....	October 22
College Station, Tex.	May 13–20	Soon after May 20.	....	....	August 3	....
	....	August 5	August 11, 13	....	....	....
	....	August 17	August 22	....	....	....
	....	September 15	September 22	....	October 8	....

It will be seen that the eggs hatch in six or seven days; but that the period of oviposition lasts for a number of weeks, so that the two broods overlap more or less. There seems abundant evidence that there are two and more probably three full broods. Concerning this matter Prof. E. D. Ball, one of the best authorities on the Jassidæ, writes as follows:

If adults go over winter they would surely not have second stage larvæ by April 14, as overwintering species usually have to feed long enough in the spring to develop their eggs, and usually larvæ are later in appearing than from overwintering eggs by about a month. The record of "sexes copulating May 20" would be about the record I should expect for an overwinter adult.

However, as previously noted, the adults frequently come out and feed on warm days during the winter months, and as the season was early and the previous winter very open in 1904, it is entirely possible that there may sometimes be an additional spring brood; but this is undoubtedly not true in the large majority of cases.

These insects seem to be much more active in the spring than in the fall, but are decidedly more hardy in the fall. On October 11 it was observed that they did not move around much and were not easily disturbed. Early in the morning, in early summer, they will jump like a grasshopper when disturbed; but if the plant is slightly jarred in the middle of the day they fly with a distinct buzz.

Frequently a large white spot of lime-like matter is found toward the tip of the wing of this species, often more or less rubbed off. Mr. Sanborn has observed the formation of this spot:

It is transferred to the wing from the anus with the distal end of the metatibia. When exuded it is globular and resembles an egg, but is not pure white. With an adroit motion of the hind leg the insect secures the drop as it is drawn past the anus, and with a forward movement it is brought against the side of the wing to which it adheres. A similar spot is then placed in the same manner on the other wing. These spots occur on both sexes.

Food plants.—In addition to those mentioned above, the following food plants have been observed: Wild grape (*Vitis cinerea*), Osage orange, Johnson grass, thorny amaranth (*Amaranthus spinosus*), cocklebur (*Xanthium canadense*), grape, banana, and apple. Riley and Chittenden record it as attacking asparagus in South Carolina.

Supposed injury.—During August there is always considerable complaint that "sharpshooters" are injuring cotton by causing the squares and small bolls to flare and drop. Many of these complaints have been investigated. The writer has solicited reports of injury, with the offer to personally investigate them, and has had extensive correspondence upon the matter with many planters, but no evidence of such injury being due to this insect has been secured. On the other hand, all manner of insects were sent us, many even considering the bollworm as "the sharpshooter." Moreover, when the insect was described to planters, many recognized it as "the dodger," which name they had given it from its characteristic habit of dodging around the stalk when slightly disturbed, and stated that though they had seen it commonly on cotton for years they had never thought it injurious. In our own field observations we have sometimes seen this species quite abundant on cotton, but have never noted any injurious effect from its presence, and it is never so abundant on cotton as on other preferred food plants. It is exceedingly fond of young sorghum, sunflowers, and bananas. Prof. H. A. Morgan informs us that he has seen sunflowers considerably injured by the large numbers of these insects upon them. To further test the matter, numerous observations were made upon individuals confined in cages upon cotton, both in the laboratory and field. In only one instance was anything like injury to the squares observed. In this instance two specimens were confined on a twig of cotton bearing three squares. Five days later two of the squares were flaring, and by very close examination a very small puncture, but slightly larger than the black markings on the square, was found on the side of each. Observations a few days later in a field where the adults were very abundant on cotton showed no such injury, however, so that it is doubtful whether or not the supposed punctures were made by these insects. Indeed, it is safe to assert that the insect does not feed or oviposit upon the squares or bolls, except by the merest accident in very exceptional cases. It is always seen feeding upon the stems, and the eggs are laid in the leaves or possibly in the bracts, but preferably on other plants than cotton.

The occurrence of this species on cotton has been noted by Riley and Howard in Insect Life.[a] The only other previous observations recorded are those of Mally and Banks,[b] who give a very excellent and detailed account of the process of oviposition and state that "they feed by puncturing the epidermis at the base of the flowerbud or the very young boll * * * . Soon after the form or small boll will 'flare' and drop off. If examined when about to drop off a small roundish black spot will be found upon the peduncle, the base of the form, or boll." This is stated to refer to the feeding habits of the young. It is the popular impression, however, that it is due to the feeding of the adults. As previously stated, neither the writer and assistants nor, as we are informed, any of the other field agents of this Bureau, working in the cotton fields of Texas and Louisiana have been able to recognize any injury caused by this insect. We therefore wrote Professor Mally concerning the above account of the injury and received

[a] 1892: Vol. V, pp. 150–154, fig. 10.

[b] 1893: Bul. 29, o. s., Div. Ent., U. S. Dept. Agric., pp. 31–33.

the following reply, which it will be noticed much more closely agrees with our observations and practically explains the seeming differences:

Replying to your favor of August 11 (1904), making inquiry concerning my observations upon *Homalodisca coagulata* (*triquetra*), I beg to state as follows: The observations on the laying of the two eggs were the first in which I actually saw the deposition made. Later on, however, I found the egg-laying in greater quantities and in a row, as you indicate you have observed. So far as I have ever observed, they always lay just underneath the epidermis of the leaves or stems, and I have often found them on the outer surface or at the base of the involucre of the squares and forms. I certainly ought not to be quoted as observing them laying their eggs within the young form and squares, because it is not correct [in reply to my query concerning the statement in Insect Life to this effect]. The small black speck which you speak of on the squares is certainly not due to the egg deposition of this sharpshooter; neither is it due to the feeding habits of these leaf-hoppers, especially if they are more than half grown. The newly hatched sharpshooters feed more or less under shelter; that is, they may be more or less hidden; for this reason the very young are often found in the bud, so called, of the tender growing tips of the branches on cotton. It is here, while the leaf buds and fruit buds are bunched together and in a formative condition, that the most serious damage is done. The feeding punctures are often not serious enough to shed the squares until they grow out and attain some size. Just where the square has been punctured can not be readily determined when the injury has been done while the square was very young, as it simply yellows a little and sheds. However, there is no question but that much of the shedding charged to the sharpshooter is due to natural causes or lack of proper nutrition in the plant.

You will not find the second brood very clearly indicated by anything you will find in the cotton crop or, in fact, any of the cultivated crops which it is known to attack. It seems to prefer the indigenous plants of various kinds, where the later brood and egg laying has a better chance of escaping destruction.

Summing up all our information, we are forced to conclude that the possible injury to the cotton plant from this insect and those to be discussed below which might easily be confused with it, is inconsiderable; and that the shedding usually attributed to injury by the vague and unknown "sharpshooter" is due to purely natural causes involved in the physiology of the plant.

DESCRIPTION OF NYMPH, BY E. D. BALL.

Head long, flat, shovel-like as in the adult, but not as much inclined. Vertex flat or slightly concave on the disc, with the margins rounding. Jugæ distinct, shorter than in the adult; front very similar to the adult in the pupæ, somewhat flatter in the younger stages. Clypeus rounded. Color pale olivaceous-brown; front pale; arcs on front, a continuation of them on vertex, and a pair of depressions at base of vertex, slightly fuscous. The ocelli appear as pale-reddish spots in the pupæ. Front with median fuscous stripe widest above and fading out on clypeus. There is sometimes a faint median light stripe on abdomen and usually a row of white dots on either side midway to the margin. Legs pale, the anterior tibiæ flattened in the later stages; claws dark.

ONCOMETOPIA LATERALIS Fab.

(Fig. 31.)

This species has been fully as common in cotton fields investigated by us as the last, but being smaller is not so readily seen. We have never observed the species in large numbers on any of its food plants, Our notes upon it are meager, but indicate that the life history is probably the same as for the last species. The adults emerge from hibernation about the last week in March, though specimens were sent us from Ondee, Tex., January 25, 1903. The adults are most abundant during June and July. Mr. Lewis observed the oviposition at Terrell several times. The eggs are laid just beneath the epidermis, ten or twelve in a row, in practically the same manner as by *H. triquetra*.

TABLE X.—*Transformation records of Oncometopia lateralis.*

Eggs laid.	Eggs hatched.	Nymphs died.
May 30	June 6	June 10.
June 18	June 25	July 11.
August 10	August 18	August 20.

During the preceding summer we endeavored to rear the nymphs in a field cage, but all died. It would seem that there are two distinct generations, the larger number occurring in July being the new adults, which oviposit in August. Professor Ball, however, finds but one generation in Colorado. He writes us as follows:

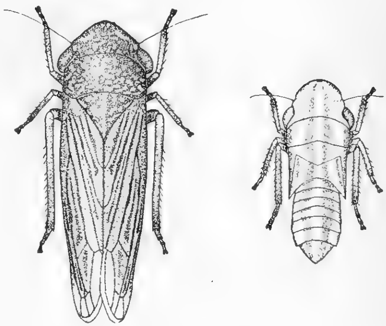

FIG. 31.—*Oncometopia lateralis:* adult and nymph—greatly enlarged (author's illustration).

The species (*O. lateralis*) is but single brooded in all parts of Colorado from the coldest to the warmest. The adults hibernate over winter, as do all of the tettigonids here, and are common from the middle of March into June, most of them disappearing by the middle of that month; but a few scattering ones run on into July. They lay eggs in May and June. The first larvæ appear about May 24 and continue to come out through June, the last ones disappearing in August, about the 15th. Fresh males appeared July 6—the females not until later—and ran on through the season, without mating or developing eggs. Thus there is a wide variation in the time of appearance of all stages; one could find nearly full grown larvæ in June and again in August, two months later. From almost daily observations on a single area where they were common, I am very positive that there is but one brood.

The difference in latitude between Colorado and Texas—equal to that between Washington, D. C., and Jacksonville, Fla.—however, will easily account for another brood occurring in Texas.

DESCRIPTION OF NYMPH, BY E. D. BALL.

Head much longer and more inflated than adult, with about the same anterior slope. Front longer and narrower, proportionately, giving the larva a much more pointed head as viewed from the side, and a long sloping face. Color: pale, creamy yellow, a round black spot at apex of head; from this two fairly definite dark stripes extend the entire length of the body; these stripes are often narrowly interrupted on a line with the antennæ. Another pair of dark stripes originate behind the eyes, and extend along the margin to the wing pads, where they divide and continue slightly obliquely to the margin of the latter, appearing again as single stripes on the abdomen. A transverse band runs in from the antennal sockets on each side. Front with five brown stripes, the median and lateral ones narrow and definite, the intermediate ones which arise on the vertex are broad and interrupted by light arcs. Legs pale.

The species is entirely harmless to cotton, and, so far as we have observed, and as may be judged from the fact that no records of injury by it have been published, it does not damage any cultivated crops.

ONCOMETOPIA UNDATA Fab.

(Fig. 32.)

The life history of this sharpshooter also seems to closely resemble those of the preceding species. The adults emerge from hibernation late in March, our first record being on the 22d. At this season and throughout the summer they are particularly fond of redbud (*Cercis canadensis*) and are also common on elm. The first eggs were laid in confinement on cotton at Terrell May 5, and the first observation on adults mating in the field was made on May 9. Three more lots of eggs were laid May 11, the deposition being much like that of *O. lateralis.* These eggs hatched in eight and ten days. Those which hatched the 13th molted on the 26th and again on June 10. On June 30 all were dead, the wing pads just appearing on the larger ones. On July 2 Mr. Lewis observed in the cotton field numbers of this species, which, judging from their fresh, bright colors, had evidently just become mature. A few were copulating. Eggs were laid July 4 by females confined on cotton. The eggs were laid, as a rule, on the under side of the leaves, the single exception being laid on the outside of the involucre, but not on the square. In the cage they were observed feeding on the leaves and stems of cotton, but never were seen resting on the squares. These eggs hatched July 10 and all the nymphs were dead by the 15th. By August 15 nymphs were found in the field with wing pads forming. On September 5 three adults were inclosed over a cotton limb, and on the 12th young nymphs were

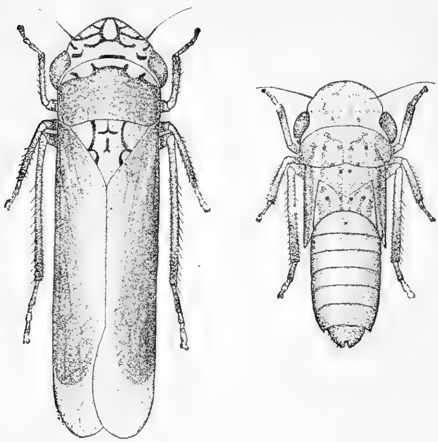

FIG. 32.—*Oncometopia undata:* adult at left, nymph at right—greatly enlarged (author's illustration).

found, though the eggs were not observed. Our latest record for the adults in the field is October 10, 1902, at Courtney, Tex., but it is quite possible that they may occur later. It seems clear that there are two generations of this species, and there is a decided probability of at least a partial third generation.

The species is entirely harmless to cotton and is much more common on trees. It was reported as quite injurious to grapes at San Marcos, Tex., May 10, 1886,[a] and at Greensboro, Ala., June 25, 1890,[b] and we have recently had similar reports. Lugger has also given a short description of the species and its work on grape.[c] It was responsible for the so-called "weeping willow," which attracted public attention in north Texas in 1889,[d] the "weeping" being due to the remarkable excretion of this species, which very frequently is ejected to a considerable distance. This has been observed and reported to us by Mr. J. C. Melcher, of O'Quinn, Tex. It has also been recorded in Insect Life as occurring on orange trees in Florida and on cabbage and okra in Mississippi. On August 8, 1896, the records of the Bureau of Entomology state that specimens were received from Joseph Husband, Leanderville, Ill. He wrote that they infested apple, pear, and plum trees, and he had counted 14 specimens on a young shoot 18 inches long.

Dr. F. H. Chittenden states that the species is abundant in the District of Columbia, and prefers for food the half-woody stems of volunteer parsnips growing in shade. The nymphs and adults are found particularly on elder. The species has been previously noted on cotton by Riley, Mally, and others, but no injury was reported. We must therefore conclude that, although occasionally injurious to grapes, the species is practically harmless to cotton.

DESCRIPTION OF NYMPH, BY E. D. BALL.

Head of general form of adult, less inclined and slightly more inflated, almost semicircular before the eyes and evenly rounding on to front. Body stout, about as wide as head, with abdomen tapering to a blunt apex. Color pale straw, marked with irregular pale fuscous lines and spots. Vertex with a fairly definite band connecting the antennæ, and another between the eyes, usually interrupted in the middle and connected by longitudinal stripes, dividing the disk of the vertex into irregular oval compartments. A median basal pair of compartments contain two very definite dark spots. Anterior margin of vertex and front with three longitudinal stripes, the median one narrow and definite, the lateral ones broad and irregular above and narrowing down to a line below, where they curve in and unite with the median one. All three stripes interrupted by a narrow light line apparently separating vertex and front. Pronotal and abdominal segments very irregularly marked with stripes and dots. Legs pale.

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[a] 1890: Riley and Howard, Insect Life, Vol. II, p. 321.

[b] 1890: Riley and Howard, Insect Life, Vol. III, p. 123.

[c] 1900: Bul. 69, Minn. Agric. Exp. Sta., p. 136.

[d] 1889: Riley and Howard, Insect Life, Vol. II, p. 161, and 1891: loc. cit., Vol. III, p. 415.

AULACIZES IRRORATA Fab.

(Fig. 33.)

This species is also not uncommon on cotton. Mr. Lewis found it feeding on cotton at Terrell, July 2, 1904. Eggs were laid in a cotton stalk in the laboratory on July 6, one bunch of twelve and another of sixteen. The eggs hatched July 14, the young nymphs being nearly white. On July 15 eggs taken on cotton in the field had also been deposited in the stem. The eggs are laid in a row up and down the stalk just below the epidermis. In ovipositing, the female inserts her ovipositor just beneath the epidermis and deposits an egg, then backs a little and deposits another until a slit about half an inch long, in which the eggs are laid, is formed.

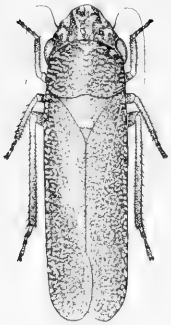

FIG. 33.—*Aulacizes irrorata:* adult—much enlarged (author's illustration).

Adults were taken at trap light at College Station, May 27, 1904, and at Courtney, Tex., October 10, 1902.

GYPONA OCTOLINEATA Say.

This is a common inhabitant of cotton fields and was specially noticed at Wellborn, May 29, 1904.

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