U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY—BULLETIN NO. 38, NEW SERIES.

L. O. HOWARD, Entomologist.

SOME MISCELLANEOUS RESULTS OF THE WORK OF THE DIVISION OF ENTOMOLOGY.

VI.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

DIVISION OF ENTOMOLOGY.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, October 6, 1902.

SIR: I have the honor to transmit the manuscript of several articles and shorter notes, none of which are of such a nature as to justify their publication in separate form. The matter presented is similar to that which has been published in other bulletins of this series, namely, in Bulletins 7, 10, 18, 22, and 30; and I recommend the publication of the present material under the title "Miscellaneous Results of the Division of Entomology, VI," as Bulletin No. 38, new series, of this Division.

Respectfully,

L. O. HOWARD,
Entomologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOME MISCELLANEOUS RESULTS OF THE WORK OF THE DIVISION OF ENTOMOLOGY.

VI.

THE SOUTHERN GRAIN LOUSE.

(*Toxoptera graminum* Rondani.)

By Theo. Pergande.

INTRODUCTION.

Aphis graminum Rond., Nuovi Ann. della Science, Series III, Vol. VI, p. 10, 1852.

Toxoptera graminum Passerini, Aphididæ Italicæ, p. 28, 1863.

This destructive little aphidid was first observed and described under the name of *Aphis graminum* by Dr. C. Rondani, who stated that the winged migrants were swarming during the month of June in immense numbers in the streets of Bologna to the great annoyance of the inhabitants. In connection with his description he gives a list of the following graminaceous plants on which this plant-louse had been observed to feed: Oats (*Avena sativa* and *elatior*); wheat (*Triticum vulgare*); spelt (*Triticum spelta*); couch grass (*Triticum repens*); *Hordeum marinum;* soft chess (*Bromus mollis*), and corn (*Zea mais*).

A lengthy article on the grain aphis was also published the same year by Dr. Dom. Luigi Mazzanti (Nuov. Ann. Sc. Nat. Bologna, Ser. III, Vol. 6, pp. 342–352), which I have been unable to consult.

Dr. J. Passerini redescribed this species in 1863 (Aphididæ Italicæ, Genoa, pp. 28, 29), removing it to Koch's genus Toxoptera. He mentions as its food plants Triticum, Hordeum, Avena, Zea, and Sorghum. The same food plants were also mentioned by Passerini (Flora degli Afidi Italiani; Bul. Soc. Ent. Ital., Vol. III, pp. 151, 248, 340, and 343).

In 1884 Dr. G. Horvath, of Budapest, Hungary, published some observations on this species ("Rovartoni Lapok," vol. 1, pp. 143–145 and XIX, and a second article on the same insect in "Fauna Regni Hungariæ," p. 60, 1897), dividing the area infested by it into regions, Regions I–IV comprising the central, eastern, and northern sections, and VI the southernmost central area. Neither of these publications is at my command.

An interesting article on the destructiveness of this species to oats was published by Dr. Karl Sajo, Budapest, Hungary (Zeitschrift für

Pflanzenkrankheiten, Beiträge zur landwirthschaftlichen Insektenkunde, Vol. IV, p. 4, 1894). He says:

Fifteen or sixteen years ago I always raised excellent oats on a field bordering a meadow; all of the plants were of a strong and healthy growth, and about one meter in height. Later, however, notwithstanding heavy manuring, the stalks became gradually more slender and lower, and the crop of the grain so scant as not to pay for cultivation. Happening once to inspect the grain during summer at the proper time, I found that the cause of the decline was a plant-louse, which Dr. Geza v. Horvath, at Kecokemet, in 1884, discovered to be the cause of "reddening" of the leaves and the total destruction of the young plants, and which proved to be the grain aphid, *Toxoptera graminis* Rond.

It occurred to me that, by abandoning the common or Bauern oats and replacing it by finer and stronger varieties, they might be able to successfully withstand the attacks of the Toxoptera. I was, however, much mistaken. I planted on some of my best fields adjoining the meadow a row of triumph oats, Anderbeck oats, and the common Bauern oats, and found that lice showed a decided preference for the finer varieties with broad, bandlike, and juicy leaves, particularly the triumph oats. Of this variety absolutely nothing was left; all of the plants were destroyed before they reached a few inches in height; the whole field was completely ruined as if it had been swept by fire. Anderbeck oats resisted somewhat, though not much better, whereas the common oats showed the best results, of which at least half a crop was obtained.

I am of the opinion that this invasion of the aphides had its origin in the meadow, because the trouble began first along the edge of the meadow and spread gradually to the middle of the field. Unfortunately all of my fields suitable for the cultivation of oats are in the immediate neighborhood of meadows or along patches of grass, while the more distant fields are of a sandy nature and can only be used for cultivation of rye, corn, etc., which renders a comparison impossible.

The consequences, therefore, were that I had to reduce the cultivation of oats to a minimum and to replace it with fodder corn, turnips, clover, etc.

Professor Sajo (p. 150, loc. cit.) says that this species has probably nowhere else, except in Hungary, shown itself to be so destructive, but that in Hungary it is one of the most destructive enemies of barley and oats. He states that its destructive habits were first described by Dr. G. v. Horvath, who discovered it to be the cause of the reddening of the oats at Kecskemet, and that during the following years similar complaints were reported from the provinces of Bacs-Bodrog, Borsod, and Csanad.

The latest contributions regarding the food plants of this species were published by Dr. Giac. Del Guercio (Nuove Relazioni R. Staz. di Entom. Agraria, Firenze, serie prima, No. 2; Prospetto Dell' Afidofauna Italica, p. 145, 1900) with the statement that this plant louse is found in considerable numbers on *Triticum vulgare*, *Hordeum vulgare*, *Avena sativa*, *Zea mais*, *Dactylis glomerata*, *Bromus* sp., and *Lolium perenna*.

HISTORY OF THE SPECIES IN AMERICA.

The earliest record in the possession of the U. S. Department of Agriculture of the presence of this pest in the United States dates

back to June, 1882. Unfortunately, however, the locality from which the insects were received was not obtained.

In June of 1884 this species was discovered on wheat at Cabin John Bridge, Md., though not in sufficient numbers to cause any appreciable damage. During summer and fall of the same year, and January of 1885, specimens were observed by Prof. F. M. Webster at Oxford, Ind., on wheat transferred from the field to breeding cages, in which they continued to breed and multiply, enabling him to make some interesting observations on the rapidity of reproduction of the species. On isolating some pupæ, which soon became winged, he found that during the following twenty days they produced about 40 young, or at a rate of 1 to 4 a day; as a rule, however, the apterous or wingless females are still more prolific.

During June of 1890, after an intermission of about five or six years, this grain louse again became quite abundant, and was found in Indiana by Professor Webster in injurious numbers upon wheat at Lafayette and in southern portions of the State, while in Posey County, in the extreme southwestern section, they were so numerous, both on the fully developed and on the tender unfolding leaves of wheat, as to cover them in some cases completely. The oat crop was a total failure; many of the fields were as brown as though the plants had been winterkilled. During the same year they spread over a large area of some of the grain-producing States of the South. They were first reported about the middle of January by Mr. P. C. Newkirk, Jalapa, Monroe County, Tenn., as being very injurious, killing all the wheat in his section. The following March he wrote again that the insects had not been able to survive the heavy rains and frost of the month, as far as he could see, though much damage had been done to wheat, patches the size of an acre or more being apparently dead, and he had doubts that one of his fields would recover from the damage done.

January 29, 1890, it was reported by Mr. B. F. White, Mebane, Alamance County, N. C., as ruining all the wheat and oats there. February 26 specimens of this insect were sent to this office by Mr. J. L. Fookes, Era, Cook County, Tex., with the statement that the species had played sad havoc with the wheat in that section. In a communication of the 31st of March Mr. Fookes writes:

> You ask me about the amount of damage done to the crop and how long they have abounded in our fields. It is believed now that they have been in the fields since early fall; they still remain in great numbers in some fields. As to the amount of damage, we place it, after a careful estimate, at 75 per cent in one-half of this county, which includes the wheat belt. One-half will be planted in other crops and the remainder will be about one-half stand. There are some small crops of Fultz wheat which are not hurt. The rest of the crop is Mediterranean wheat.

Early in April specimens were received from Mr. D. J. Eddleman, Denton, Denton County, Tex., with the statement that the species was

destroying the wheat. It was also received June 2 from Mr. J. G. Barlow, Cadet, Mo., who observed it to be very injurious to oats.

REPORTED INJURY DURING 1901.

During the spring of 1901 this species became extremely numerous in the grain belt of Texas, as the communications received during that year show.

Mr. W. R. Peters, Caddo Mills, Tex., wrote March 15: "I inclose you a sample of red winter wheat that has been killed by a small green bug. The wheat in our county is badly damaged by the insect. I have 50 acres destroyed by this bug." The same day specimens were also received from Mr. C. A. Kelsey, Sherman, Tex., who said: "These little flies are fast destroying the young wheat; they are beginning to sap the oats, and have been working on the grain since early fall."

Mr. H. K. Jones, Valley View, Tex., in a letter dated March 16, says:

> I inclose you a sample of insects which are killing the young wheat in this section; they are on the wheat by the million. They first made their appearance about ten years ago, at which time they killed all the wheat, or about all, in this county, and what was left made only 1 to 3 bushels per acre. The next time we noticed them was last year, when they made their appearance early in spring. After the wheat headed they went to the heads, and we thought they would surely ruin the wheat, but we had a good yield; after the wheat headed we had a great deal of rain, which may account for it. We first noticed them this season in December last; they were not numerous, but have been increasing ever since. We find that cold does not hurt them; they have gone through a zero spell and come out all right; have seen the wheat covered with sleet and the bugs frozen up, but on thawing they seemed to be as hungry as ever. Wet weather is no drawback to them; we have just had a good rain a week ago, but the wheat looks worse and the bugs better.

Mr. J. C. Coit, Denton, Tex., wrote March 18 that wheat in his section was badly injured by this insect and that a few days previous it was noticed that the wheat did not have so deep a color as usual at that season. Upon an investigation it was found that the outer leaves of the wheat were dead. The aphides were found on the ground under the protection of the leaves, in some spots as many as six or eight around the same plant. In 1890 the wheat was destroyed by this or some similar pest.

In a communication from Mr. B. H. Hamilton, Weston, Tex., March 18, it was stated that this insect was ruining the wheat in that part of Texas, that it had been at work for six or eight days prior to the date of writing, and it was noticed that on striking a bunch of wheat the ground would be covered with numbers of the insects. It was in that vicinity this year (1902), but did not appear until the last of April or first of May.

March 26 Mr. F. C. Ratcliff, Vernon, Wilbarger County, Tex., reported that this louse infested the wheat fields, and that the crop in some parts of that county was suffering from its depredations.

March 27 Mr. Oswald Wilson observed this species on wheat near Houston, Tex., and on the 10th of April near McKinney, Tex.

March 29 Mr. D. M. Hamilton, Austin, Tex., reported that these plant-lice were worse on stubble land of wheat than on corn or cotton land.

On the 1st of April specimens were received from Mr. J. Booze, Sherman, Tex., who stated that "these flies or gnats" are very numerous in low places and that they had entirely destroyed the oats and wheat.

Under date of April 22 Mr. A. E. Jenks, of the American Thresherman, Madison, Wis., forwarded to this office specimens of this insect received from Elmont, Grayson County, Tex., with the report that wheat, oats, and corn were all ruined by it, and that during the year or two previous it had done great injury to these crops in Texas. On the same date the following note was received from Mr. S. E. Russell, Fate, Tex.: "I send you herewith a few of the little green bugs which are destroying our crops in toto. Wheat and oats are gone; there are not so many on corn to-day."

Specimens were also received April 24 from Ralli Brothers, New York City, which they had obtained from their Greenville, north Texas, cotton agency, with the accompanying report:

> This insect has seriously injured wheat and oats and is now attacking young corn. Wherever they have attacked wheat or oats the field looks as though it had been swept by fire. A number of farmers have been forced to plow up their wheat and plant corn.

A letter was received April 25 from Mr. J. W. Bussell through the American Thresherman, complaining of injuries by this insect at Mountain Peak, Tex., saying that it was playing havoc with the grain crop there; oats were entirely ruined, and wheat cut 50 per cent.

April 30 specimens were received from Mr. J. C. Crispin, Saratoga, McDonald County, Mo., with report that this insect was very numerous on wheat, and that some fields might have to be plowed up.

In a communication of May 14, Mr. W. E. Campbell, of Ralli Brothers Agency, Greenville, Tex., stated that a few days previous to writing the weather became quite warm, causing the insects to leave that section and go farther north. They appeared to be better suited to cold, damp weather. A number of fields in that vicinity were visited where the insects had been particularly troublesome, without finding a specimen at that time, the warmer weather having apparently driven them completely out of the country.

NEWSPAPER REFERENCES TO INJURIOUS OCCURRENCES IN 1901.

Numerous clippings were received from newspapers relative to the spread of this grain louse and destruction wrought by it to small grain crops in Texas and adjoining territory during the spring of 1901. The following are transcribed:

[Galveston News, March 21.]

Denton, Tex., March 18.—W. E. Smoot, of Argyle, was here to-day with a quantity of the little green insects that are doing so much damage to the wheat. The insects are present in myriads and the big wheat farmers are taking a very gloomy view of the prospect, many of them believing that their crops are irreparably ruined. Many of them, in fact, are making preparations to plant the injured wheat land in cotton or corn.

Farmers who were here ten years ago say that the present visitation is exactly like that of 1891 and that the entire wheat crop of several counties was almost entirely lost, some of the yield being as low as half a bushel to the acre and the highest not more than 10 bushels.

Gainesville, Tex., March 12.—Dr. W. H. Freeman, who lives at Era, 15 miles west of Gainesville, in speaking of the growing wheat, said: "The wheat in my section is literally ruined, and the farmers will have to plow it up and plant the ground in corn and other products."

Sherman, Tex., March 18.—The condition of the wheat crop from the inroads of the Hessian fly or some similar pest is attracting much attention. In some localities it is said that the wheat crop will be plowed up and cotton or some other late crop planted instead.

[Dallas (Tex.) Herald, March 21.]

Sherman, Tex., March 21.—Great alarm is felt here by the farmers at the ravages of a small green bug that is infesting the wheat and oats.

[Dallas (Tex.) Herald, March 22.]

W. H. Marshall, a prominent farmer of Whitesboro, Grayson County, said: "The reports about the damage being done to the wheat in our part of the State are not exaggerated in the least. Hundreds of acres have been killed around Whitesboro and in other parts of Grayson County. The flies have also gotten into Collin County and are doing considerable damage there, and some damage has been done in Denton County. Unless the ravages are checked soon we will have to buy our flour and seed wheat."

[St. Louis (Mo.) Republic, March 24.]

Reports from Texas say that at least 25 per cent of the wheat crop in the northern part of the State has been ruined by the bug, and the entire crop is threatened.

The insects are seen in countless numbers in the growing wheat. Advices from all parts of Texas say that the pest is spreading, but appears to be working only the stubble-ground wheat.

Owing to the mildness of the winter, instead of being killed it propagated rapidly, and apprehensions are felt for the entire crop. So far wheat on the cotton ground does not appear to be damaged.

[Galveston (Tex.) News, March 26.]

Waxahachie, Tex., March 26.—Mr. B. F. Cherry, of Midlothian, this county, reported that a little green bug was doing a great deal of damage to wheat in that

section of the county and that some of the wheat fields near there had been almost entirely destroyed by the insect.

Hutchins, Tex., March 26.—Mr. A. W. Carnes writes to the News that he has just returned from an examination of the wheat and oat fields upon the county farm, and finds that the entire oat crop—30 acres—and 15 acres in a wheat crop of 75 acres, have been entirely destroyed. The bugs are still working upon the wheat, marching from east to west, maintaining a straight line from north to south, as though they were under the leadership of a trained tactician.

Ennis, Tex., March 26.—Mr. E. D. Champion, a farmer of Oak Grove, said to a News correspondent that wheat in his community has been suffering from an insect pest, though it is coming out well since the recent rains.

[Houston (Tex.) Post, March 29.]

Sherman, Tex., March 28.—Holmes Colbert, one of the prominent Indian planters of the Choctaw Nation, was in the city to-day. Colbert has 4,000 acres in wheat and oats, and says the pest has appeared in the Indian Territory.

[Fort Worth (Tex.) Register, March 31.]

J. C. Martin, who lives at Riverside and has recently been in the northern part of the county, says that the damage there is not as great as recorded, although there are many spots perfectly bare.

D. M. Morgan, of the cotton belt, says the crop is ruined between that place and Sulphur Springs, and between Dallas and Sherman, and also between this city and Thurber. Mr. Morgan says he has saved his own crop by cultivation with a weeder.

Milt Hampton, who was in from near Crowley yesterday, said that his crop of 200 acres was so badly damaged that he turned his cattle in on it and will plow up the ground and plant cotton and some other crop.

John Day, who was in from his farm in the northern part of the county, said that he had not suffered much, but some of the crops in that portion of the county were ruined.

T. N. Bradburn returned Friday night from a week's trip up the Fort Worth and Denver road, stopping at nearly all the stations between here and Iowa Park. He says that up to a week ago the Panhandle had the finest prospects for a great wheat crop, but now the wheat has been greatly injured and in some places entirely ruined. The bugs reached Wichita Falls on Tuesday last and now there are millions of them laying waste the crops. Many fields, he says, between here and there are ruined.

[Dallas (Tex.) News, April 2.]

Denison, Tex., April 1.—W. B. Chiles, a prominent farmer living near Pottsboro, states that the grain-destroying insect is doing great damage in his section of the country. They fly about late in the afternoon. At times the air is full of them and they travel with the wind. They are now working especially on oats.

J. W. Badgett, who lives east of Colbert, Chickasaw Nation, said: "I stated last week that we had no signs of the insect, but the case has been reversed; this week we have them, and by the thousands. They seem to be concentrating on oats, but I believe that unless steps of precaution are taken, they will kill our corn before it is old enough to escape them. I have been farming a long time, but I have never seen anything like this work on grain. I am going to make an experiment Monday. I will run a harrow over my grain and then roll it with a heavy log. This will kill the insects and even if our oats are killed by the remedy, we will thereby save our corn.

[Dallas (Tex.) Herald, April 11.]

Rhome, Tex., April.—The ravages of wheat and oats insects are causing great depression of spirits among the farmers of this county. A large part of the wheat acreage

is completely ruined by the insects, while other portions are scarcely touched. Much of the wheat will be plowed up and cotton planted.

[Galveston News, April 17.]

Ennis, Tex., April 15.—Mr. George Hoggs, of Telico, said to-day that myriads of green bugs fell upon his corn yesterday and covered it up, and he will begin to-morrow to plant June corn between the rows.

[Dallas (Tex.) News, April 17.]

Kingston, Tex., April 15.—The ravages of the green bug have almost destroyed the oat crop in this vicinity. The wheat crop is improving and looking better; it seems to be outgrowing the injuries of the bug. Yesterday it was warm and the bugs seemed to be on the move south. The air was thick with them during the entire day and some farmers report them leaving their fields.

Fate, Tex., April 15.—Large fields of the spring oats have been entirely destroyed by the little green bugs. Winter oats and wheat have not fared better, but can hold out longer on account of being better rooted. It was thought that the little pest would not bother the corn, but all corn is badly damaged and some fields look as if they would have to be planted over.

[Nevada (Tex.) News, April 19.]

We have interviewed several farmers this week from different parts of the county relative to the work of destruction that has been done to the small grain crop. The majority of them say that the oat crop will be a total failure and that the wheat crop at the outside will be cut short 50 per cent. The farmers say that where corn has come up that it is being attacked by the pest and will no doubt be ruined. Some few have begun to plant their corn over.

[Dallas (Tex.) Herald, April 23.]

McKinney, Tex., April 23.—The green bugs filled the air yesterday, making their exodus, leaving behind them hundreds of acres of blighted wheat and oats.

[San Antonio (Tex.) Express, April 23.]

Sherman, Tex., April 23.—Farmers from various sections of the country who were in Sherman to-day stated that green lice are still swarming. They seem to be leaving the corn, to the great satisfaction of the farmers.

[Galveston (Tex.) News, April 24.]

Fort Worth, Tex., April 23.—The executive committee of the Millers' Association held a meeting here this afternoon, and the greater portion of the time was consumed in hearing reports of the damage done to the wheat crop by the green bugs.

Henry Landa, a member of the committee, from New Braunfels, said that the damage to the large wheat counties would reach 75 per cent; and that, in Grayson, Cook, and Denton counties especially, it was reported the farmers would not make seed, and would not, in a number of the larger wheat counties, get back as much wheat as they had put in the ground. Mr. Landa thinks the situation is very unfavorable for the millers, as some will not be able to run their mills, and others will have to go out of the State to get their grain.

[Dallas (Tex.) News, April 24.]

Persons who were on the streets in certain portions of this city were vexed by the countless numbers of little bugs that clung to their clothing so tenaciously that it was almost impossible to brush them off. In some places they were so numerous as to present the appearance of an Indian summer haze.

These were the famous green bugs or plant-lice, whose ravages in this section this year have cost the farmers many and many a dollar. They were all northward bound, their departure from the grain fields being caused doubtless by the warm weather now prevailing.

Of the number that took wing for cooler regions there are probably several billions that will never raid another grain field. The English sparrows—the pest of the city—began at daybreak a war of extermination upon the pests that ended only at twilight. Twittering with delight, they sailed in flocks through the clouds of bugs, devouring all they could hold. These attacks, however, caused no perceptible diminution in numbers.

An instance of the loss caused by the lice was reported here during the day. A Dallas County tenant farmer had many acres in wheat and oats which these bugs completely destroyed.

[Houston (Tex.) Post, April 25.]

Cleburne, Tex., April 22.—The green bug is killing oats north of the city and has devastated several fields in this neighborhood.

[Dallas (Tex.) News, April 25.]

McKinney, Tex., April 24.—The News correspondent traveled over the county from McKinney to the Shain ranch beyond Celina, a distance of 22 miles; thence south along the Denton and Collin County line to the ranch of Parvin, 18 miles west of McKinney; thence east of McKinney yesterday. The devastated wheat and oat fields presented a fall-like appearance, owing to the brown color so much like stubble land. Thousands of acres will be idle this year for want of labor to replant. It is a scene of desolation in every direction in west Collin.

Denison, Tex., April 24.—James Jacobs, a farmer from the country a few miles west, says the bugs are still active and seem to breed as long as there is anything green to feed upon. He has noticed, however, that the sun kills them as quickly as their wings grow.

Sherman, Tex., April 25.—Statements from authentic sources that the green bugs are leaving in great swarms continue to come in from all sides.

[St. Louis (Mo.) Republic, April 26.]

Kansas City, Mo., April 24.—Grain men who are going over the wheat fields of Oklahoma say there is a genuine alarm entertained because of an invasion of the green bugs.

Henry Lason, of El Reno, and C. H. Stevens, of the Purcell mill, report the louse as making inroads in the summer wheat to the extent of threatening to destroy a vast acreage. The Government report shows last week the louse was confined south of Guthrie, but now it is reported nearing the Kansas line. The winter hard wheat is not attacked. Cold weather has no effect. In places the entire space in the fields attacked is absolutely dead, though wheat is knee-high.

[Fredericksburg (Tex.) Star, April 27.]

The wheat fields of Meridian have a new and destructive enemy. The farmers are very anxious about them. They fear that the wheat crop will be utterly destroyed by them. Some crops are reported as already destroyed, and the owners are thinking of plowing up the fields and planting them in corn.

The oldest inhabitants have never seen anything like them. They are about the size and shape of the mites which are sometimes seen on cabbage-stalk sprouts in the spring, but their color is a deep dark green, about the shade of the green blade on which they feed, and sometimes 6 to 8 will be found on a blade. In a few days the blade turns yellow and begins to dry up. They also abound on the winter oats.

[Galveston (Tex.) News, May 18.]

Sherman, Tex., May 17.—J. P. Harrison, president of the Texas Grain Dealers' Association, in reviewing the grain crop, said to the News reporter: "There will be no oats raised in Texas north of Waco. In Coryell and adjacent counties the reports are not quite so discouraging, and it may be that sections may produce enough to supply Texas with seed. The condition in Texas is duplicated in the Indian Territory, where the situation can be attributed directly to the green bugs. In Oklahoma the bugs did not do much damage. But for drought, which came and finished their work, Oklahoma might have had a pretty fair crop. There will be little or no wheat made. Occasionally a field is heard from that will harvest a fair yield. I can only account for it on the theory that the fields were a little forward and the stalks tough enough to withstand the bug."

[Galveston (Tex.) News, May 30.]

The small grain crop of the State will not exceed one-fourth of last year's yield. The average in wheat and oats is less and the conditions 75 per cent below the average of May, 1900. The yield is cut short owing to the early spring drought and to the ravages of the aphis or green bug. The damage by the pest, although amounting to total losses in many fields in choice grain counties, is slight compared with general damage due to want of moisture early in the growing season. The reports annexed cover 161 counties, 105 of which were free of the insect pest, while all the counties reported suffered for the want of moisture.

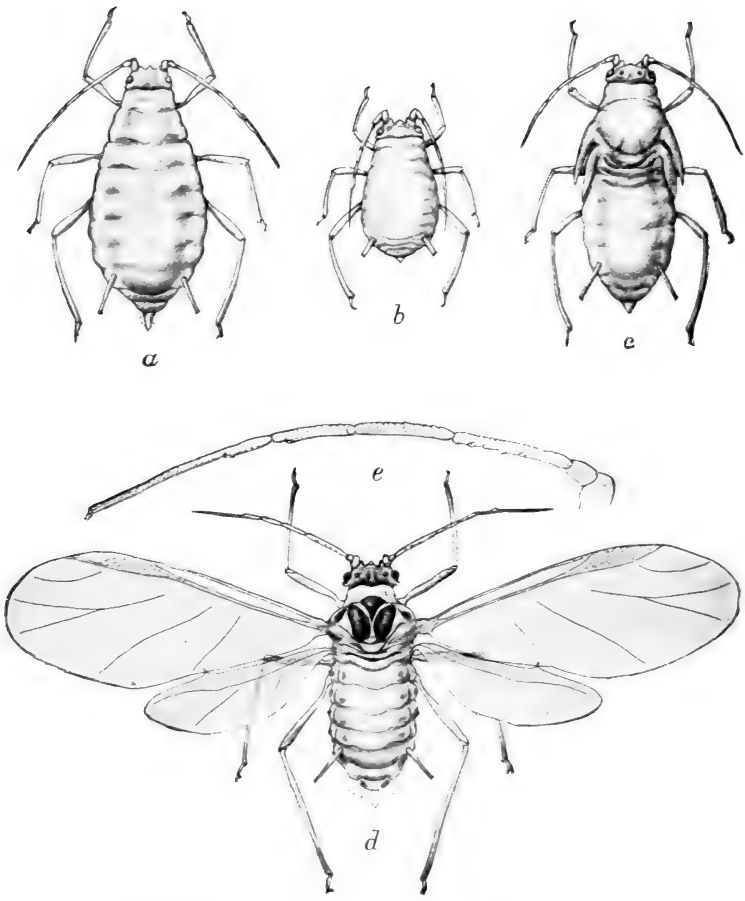
The pests appeared in numbers early in April, multiplied rapidly, were rapacious of appetite, and gluttonous without apparent satiation, repletion, or surfeit, and began to disappear in flurries in May. When the bugs attained the aerial stage they rose in a body from the ravaged field, took flight, remained on the wing for hours, and drifted with the wind. During storms they sought safety near the base of the wheat or oat blades. The farms intervening between the points of ascent and descent sustained no insect damage, but suffered from drought. The drought preceded the advent of the aphis, the 40 counties reporting "green bugs" also chronicling an early spring drought. The percentage of losses where not separately given combine the damage from both causes.

The wheat crop in the Chickasaw and Cherokee and portions of the other three nations in the Indian Territory, and in Oklahoma, ravaged by the grain louse, has greatly reduced the value of this year's crop in those Territories. In some regions the injury has been so great that farmers have preferred to replant the wheat acreage to some other crop. The louse, like its relative in Texas, is capable of very rapid multiplication, is gluttonous in appetite, and is favored by dry weather. The general trend of the migration of the insect, as in Texas, was from south to north.

GENERAL REMARKS.

In view of the overwhelming evidence as to the destructiveness of this pest to wheat and oats in the grain-producing States, it seems strange that it should have escaped notice until the year 1884.

Whether this plant-louse is indigenous to this country or whether it has been introduced from abroad is a difficult question to answer. At any rate, according to the notes of the Department of Agriculture, it was first observed in the more central section of States bordering the Atlantic Ocean, which seems to indicate that in some way it managed to reach our shores on a vessel from the southern part of Europe, entering one or the other of the ports of this central section, from



THE SOUTHERN GRAIN LOUSE (TOXOPTERA GRAMINUM).

a, Apterous female; *b*, larva; *c*, pupa; *d*, winged migrant; *e*, antenna of migrant—all enlarged (original).

which it managed to spread and to establish small colonies here and there on various grasses, suited to its taste, which insured it a foothold in this country and enabled it to multiply without being detected in time to adopt heroic measures for its extermination. The assumption of its foreign origin seems the more reasonable since otherwise its presence on small grain would have been observed from the earliest time that these cereals were grown in this country.

After its introduction it has naturally migrated in various directions, and established small, isolated colonies which have given it a chance to obtain a foothold and to escape observation and detection. From these centers of infection and with the assistance of air currents it would be enabled to spread unobserved to far distant sections until it reached grain-producing areas, the tender and succulent plants of which are more suited to its taste. Thus it has multiplied rapidly and spread from field to field and from State to State. Notwithstanding that millions of the migrants are killed during this flight, enough remain to stock new regions.

At the time of migration, which in the Southern States, as far as observed, takes place in May, most of the wheat and oats which escaped injury had become so tall and vigorous as to withstand attack. Possibly such growth may be unfit for the sustenance of this plant louse.

Whether the species really thrives on corn or not is an open question. Thus far it has never been received by this Department from any of the corn-growing sections. The writer is rather of the opinion that the plant-louse frequently observed on corn is the common corn aphis, *Aphis maidis* Fitch, which somewhat resembles this grain louse both in size and general coloration.

What becomes of the survivors after leaving the grain remains an unsolved problem. It seems, however, quite natural that during the warmer season, after the harvesting of the grain, they will subsist upon various succulent grasses growing in damp and moist localities, such as the borders of rivers, creeks, swamps, or similar places, and perhaps also on volunteer wheat and oats coming up in the fields. These would afford them a chance to survive and multiply until the new grain makes its appearance above ground.

As with other aphides, a sexual generation will appear at the proper time, and with it the eggs, for the preservation of the species. The great majority of our indigenous species of plant-lice produce the sexual generation during the fall of the year, the eggs of which remain dormant till the time at which a new cycle of plant life appears. A few, however, produce the sexes and their eggs during the latter part of spring or early summer, to hatch the following spring. What are the habits of this grain aphis in this respect it is difficult to say. Taking into consideration the very early appearance of the lice in

perceptible numbers on young grain, it appears probable that one or another generation, descendants of the migrants from grain, produces a sexual generation and consequent eggs on some kind of grass, which may hatch during the fall of the same year instead of the following spring, in time to produce a winged generation. This last probably re-migrates to young winter wheat, to restock it with lice, and many would undoubtedly perish during the cold and wet season, though enough of them would survive to reproduce when the climatic conditions become more favorable.

The whereabouts of the species after leaving the grain, the hiding place of the sexes and their eggs, and the reappearance on grain, are highly interesting and important questions, which entomologists of infected sections should strive to solve for the benefit of those engaged in the cultivation of small grain.

DESCRIPTION OF THE SPECIES.

Apterous female.—Length 1–1.8 mm; color yellowish green and slightly pruinous, the median line darker green, the head and prothorax somewhat paler than the rest of the body. Eyes black. Antennæ black, the two basal joints and more or less of the third joint at base yellowish. Legs yellowish, the tibiæ brownish toward the apex, tarsi black; nectaries greenish and frequently with a dusky tinge, their apex black. Tail dusky. The general color of the larvæ and pupæ is like that of the apterous female. Wing pads of pupa dusky to black. Antennæ slender and about one-half the length of the body. Nectaries slightly tapering, reaching to or slightly beyond the end of the body. Tail slender, somewhat constricted about the middle, and about two-thirds the length of the nectaries. There is a distinct fleshy tubercle each side of the prothorax and similar tubercles along both sides of the abdomen.

Migratory female.—Expanse of wings 5–7 mm; length of body 1.5–2 mm. General coloration of the abdomen as in the apterous forms; head brownish yellow; the eyes brown; antennæ, thoracic lobes, the posterior margin of the scutellum and the sternal plate black; the two basal joints of the antennæ yellowish green; legs yellow, the femora more or less dusky, the posterior pair darkest; apex of tibiæ and the tarsi black; nectaries and tail yellowish, the latter changing gradually to dusky or black toward the end; wings transparent; costa and subcosta yellow; the stigma somewhat paler, its inner edge and the veins black. Third discoidal vein with but one fork. Antennæ long and slender, reaching nearly to the end of the body, the third joint provided with 3 to 7 sensoria. Nectaries, tail, and lateral tubercles, as in the apterous females. (See Pl. I.)

NATURAL ENEMIES.

As natural enemies of this species in Europe, Rondani mentions *Scymnus 4-pustulatus* Fab., a small Coccinellid or ladybird, the adult and larvæ of which feed upon the lice; *Paragus coadunatus* Rondani, a two-winged Syrphid fly, whose larva preys extensively upon all kinds of plant-lice; and a minute hymenopterous insect, *Aphidius aphidum* L., a true internal parasite.

Of the most effective predaceous insects which have been observed to feed upon this grain aphidid in the infested regions of the United States, the following may be mentioned: Two ladybirds, *Hippodamia*

convergens Guér., and *Coccinella 9-notata* Hbst., both of which, in the adult as well as in the larval state, feed ravenously on the lice, though the larvæ are frequently suspected by grain growers of being the parents of the lice, especially if found to be numerous in infested fields; and larvæ of various Syrphid flies and Chrysopids or lacewing flies, which are even more voracious than those of the Coccinellids.

Many of the lice are also killed by the larvæ of a small and slender black internal parasite, *Lysiphlebus tritici* Ashm., which preys upon various species of plant-lice, frequently killing within a short time large colonies. The larva of this does not leave its host, but transforms within the puffed up and empty shells of the aphides, many of which may readily be observed adhering tightly to the stems or blades of the grain. The little parasite, when ready to leave its host, cuts out a neat circular piece, generally near the end of the body, and through the opening it escapes.

METHODS OF CONTROL.

Owing to the practical impossibility of applying kerosene emulsion or similar washes so as to destroy insects which develop on standing grain, particularly such as feed by suction, we must look to other methods for the successful treatment of this plant-louse. Three or four other forms of plant-lice usually occur in more abundance than the species under discussion, and it has been found by experience that these, as well as the present species, are very largely controlled by natural conditions, sudden changes in the atmosphere, and such parasitic and other natural enemies as have just been considered. Ladybirds and fungus diseases are the most important factors in reducing the numbers of this pest. The year 1901 was particularly favorable for the multiplication of this plant-louse in Texas, but, as usually happens, the cool, moist weather of early spring, which favored the increase of the pest, was followed later in the season by a sufficient period of dry and sunny weather to enable the natural enemies, nearly all of which are most active in such weather, to gain the ascendency, and this they did, practically exterminating the lice in the region affected. It should only be necessary to add that most other species of plant-lice are controlled in precisely the same manner, and it is seldom that they are destructive for more than one or two seasons in succession. Examples are to be found in the cabbage louse, melon louse, and the destructive green pea louse, which was such an enemy to the pea industry throughout the more northern portion of our country during the years 1899 and 1900, from the Atlantic coast to Wisconsin. This last insect practically disappeared as a pest during 1901, and up to the date of writing has only appeared in numbers in a few isolated localities, so far as we know, in the District of Columbia and immediate vicinity.

REPORT OF AN INVESTIGATION OF DISEASED COCOANUT PALMS IN CUBA.

By August Busck.

In August, 1901, I was instructed to proceed to Habana, Cuba, and report to the military governor there in order to investigate a disease which threatened the cocoanut industry in the province of Santiago.

In accordance with instructions, I left Washington August 7 and, arriving in Havana on the 10th, reported in the palado to the adjutant-general, Col. J. H. Scott. The same day I sailed with his instructions for Baracoa, on the northeast corner of the island, arriving there August 14. The country around Baracoa is the only remaining cocoanut region of importance in Cuba, and the industry is the main support of that part of the island, from which large shipments of great value are annually exported to the United States.

The country of that region is mountainous, rough, very fertile, and picturesque with palm-covered mountain sides, deep valleys, and large rivers. There are no wagon roads, and travel is on horseback along narrow and often difficult trails.

There were no diseased palms in the immediate neighborhood of Baracoa, but going out some 10 miles east along the coast, yellow, drooping tops and naked trunks began to appear, and still farther out around Mata and neighboring towns the disease reached its highest development. Here large areas were attacked, and already from 10 to nearly 100 per cent of the trees were lost. Serious damage was quite evident, and the lamentations of the natives and their anxious inquiries as to how to save their sole property were most natural.

The first outward indication that a palm is attacked is the falling of the young fruit; shortly afterwards the larger nuts drop and the leaves assume a pale yellowish color.

Within a month all the large lower leaves droop and fall, leaving the pale, sickly tops, which at the first heavy wind blow over and then only the naked trunks stand as ghastly tombstones where a few months before stood graceful valuable palms. Palms of all ages are subject to this disease, though it seems more prevalent among the older plants.

On felling a palm and examining it, it is apparent that the trouble is not found in the root or main part of the small trunk. From the root upward to within a few inches from the top, the trunk may be fresh and sound with practically no insect of any kind and with no fungus mycelium. Just below the top and in between the bases of the leaves was found in nearly all of the three hundred odd palms in different stages of disease, which were cut down during my investigation, the galleries of scolytids or ambrosia beetles (*Xyleborus* spp.), rarely, however, in such numbers as to arouse suspicion of the beetles being the cause of the death of the palms.

In and around these holes and perforating the entire upper part of the trunk for 2 to 10 inches downward was found the mycelium of a fungus, the fruiting bodies of which came forth as small white spots on the under sides of the leaves and which might easily, on hasty examination, be confounded with Aspidiotus scales which were often found there.

This parasitic fungus has been identified by Mrs. F. W. Patterson, mycologist, and Mr. A. F. Woods, pathologist, of the Department of Agriculture, as *Pestalozzia palmarum* Cooke. They inform me that though they have no record of the particular damage, "it is extremely probable that this fungus is the cause of the diseased condition of the trees," as they have records of similar causes in other trees.

Breaking off the lower leaves and cutting the center of the green growing part open, the heart of the palm is found to be one putrid offensive-smelling mass, filled with maggots of various scavenger flies. By examining palms in various stages of sickness, it was found that the putrefaction began within the sheet around the young still unfolded flower stalks and gradually worked downward to the center of the plant, and while the primary cause of the death of the palm undoubtedly is the fungus, the nature and foul smell of the diseased parts seemed to indicate some bacteriological influence, when the palm is already weakened by the fungus and doomed to die.

In from one to three months after first attack full destruction takes place and the trunk stands naked, and though it is still fresh and apparently sound, it soon disintegrates through the work of termites or white ants and other insects.

The fatal nature of the disease precludes a remedy for trees already infected and leaves only the prevention of the spread of the disease as the object for man's intervention.

As the most natural means of preventing the spread of the disease, the cutting down and burning up of the diseased palms suggests itself, and Mr. A. F. Woods agrees that this is one of the best ways of combatting it. In a small and necessarily incomplete way I satisfied myself of the practical results of this preventive. Shortly after my arrival I observed one large grove with only two isolated dying palms. These I had cut down at once and removed the infested parts to my headquarters for examination. During my entire stay no more palms in that grove showed signs of disease, although in other tracts with sick palms left standing new cases of infestation were observed in numbers every week.

The procedure of felling and burning many palms may seem too enormous an undertaking, but considering the interests at stake it is a small matter and comparatively easy of execution.

Without such drastic measures the present conditions and the rapid spreading of the disease certainly foreshadows total destruction of the

cocoanut industry, a very serious matter for the population of that part of the island of Cuba.

It is not necessary to burn the entire trunk, which would involve extra labor, but only the top with a couple of feet of the upper end of the trunk.

But it is necessary to have united action in order to make the remedy of any real value, as it is evidently futile for the proprietor of one estate to eradicate the disease within its limits if the owners of neighboring estates omit the precautions and allow the disease to multiply and send its spores abroad to the others. I therefore suggest local legislation, which would make it compulsory on every owner to cut down palms as soon as they show infection and have the diseased parts burned; and, furthermore, that some trustworthy, intelligent man be constituted inspector with the duty to inspect weekly the entire region and with power to have cut down at once and burned at owner's expense any sick palm found omitted.

Such action, together with advice to plant new cocoanut palms, will, I fully believe, save the greater part of this important industry, which otherwise seems doomed to annihilation.

The insects found to be connected with the cocoa palm in this Baracoa district were few and all of secondary or of no economic importance. The only ones which may form an exception are the Scolytids (*Xyleborus* spp.) through the holes of which the fungus doubtless gains easy entrance to the palms. These beetles are not always present and evidently do not constitute the only means for the spores to reach their destination. It is not impossible that they are altogether innocent and merely come after the weakened condition of the palm, as Mr. E. A. Schwarz suggests is probable. But as carriers of the spores from palm to palm these insects and numerous scavenger flies which are attracted to the sick palms may be of importance. The most common of these are the striking, beautiful metallic-green *Volucella obesa* Fab. and the curious long-legged *Calobata nebulosa* Loew.

On the underside of the leaves and on the green fruit was found quite commonly, but never in dangerous numbers, the destructive scale insect, *Aspidiotus destructor*, which everywhere in that region was kept well in check by the black, red-spotted ladybird, *Chilocorus cacti* Linn.

A large beetle, *Stratægus titanus* Fab., was often found among the flowers of the cocoas and was invariably accused by the natives of being the cause of all the trouble, while in reality it did little or no harm in eating the pollen and possibly the tender shoots. The larva lives in decayed wood.

Of the palm weevil, *Rhynchophorus palmarum*, which before my trip was suspected as being the possible cause, not one was found and no other borer than the Scolytids previously mentioned.

The long double rows of egg-holes of the large *Cicada bicosta* Walk. were quite commonly found on the undersides of the stalks of the lower leaves, but the damage is insignificant.

THE PALM AND PALMETTO WEEVILS.

By F. H. Chittenden.

As in a measure supplementary to the report of an investigation conducted by Mr. August Busck, of this office, on diseased cocoanut palms in Cuba, due to the fungus, *Pestalozzia palmarum* Cooke, but supposed to have been caused by the palm weevil (*Rhynchophorus palmarum* Linn.), the following account of that species and the palmetto weevil (*R. cruentatus* Fab.) has been prepared. It is somewhat singular that at the time Mr. Busck was prosecuting this investigation the palm weevil was not once encountered, but the palmetto weevil was doing injury to the date palm in Florida. The latter, although well known, has not attained any prominence as a pest, but we have an extensive account of the palm weevil by Mr. W. F. H. Blandford, published originally in the Kew Bulletin of February-March, 1893 (pp. 27–60).

THE PALM WEEVIL.

(*Rhynchophorus palmarum* Linn.)

With the establishment of the growing of cocoanut palms in British Honduras, the ravages of the palm weevil seriously discouraged that industry. In the year 1888 the government of that country, becoming cognizant that the losses apparently resulting from the palm weevil menaced the prosperity of the colony, appointed an investigating commission, the result being the publication of the article above cited. Until the injurious occurrence of this species in British Honduras, the palm weevil was better known to the public as the parent of the "gru-gru" worm, which was eaten by the natives of Central and South America, and mentioned by most writers of early times as "being considered a delicacy." On this head Mdlle. Merian, in her "Dissertation sur la Génération et les Transformations des Insectes de Surinam," etc., published in 1726 (p. 48), wrote as follows:

> The Dutch name it Palmyt-Worm, that is, the Worm of the Palm, because it feeds on that tree. In the trunk of the palm tree, swarm certain worms feeding on the pith. At first no larger than cheese-maggots, they grow like the one here represented. Certain folk grill them, and consider them a most savory morsel. From this worm comes a black beetle, such as I have depicted, which the Indians and the Dutch both call the *Mother* of the palm worm.

The next article of importance bearing upon this species is entitled "Insects infesting the Sugar-Cane." It was written by Rev. Lansdown Guilding, and published in 1828 (Trans. Soc. Encour. Arts, LXVI).

Through the kindness of Prof. M. E. Peck, Iowa Falls, Iowa, we have received some information relative to this same insect and its injuriousness to palms in British Honduras. Under date of January 1, 1902, he writes that during several months' stay there he became considerably interested in the cocoanut industry, and especially in the methods in use for meeting attacks of this palm weevil and other beetles infesting the cocoanut. Numerous plantations were reported to be seriously injured or wholly ruined by these insects, which are considered the chief drawback to the industry in that region. One grower, Mr. John T. Seay, of Manatee District, British Honduras, succeeded to some extent in conquering these pests. Mr. Seay had a plantation about 20 miles south of Belize and extending for 3 miles along the coast. His trees were in flourishing condition, ranging in age from two or three to fifteen years. Mr. Peck examined the larger part of the adult trees and found that nearly half of those with trunks over 6 feet in height had been attacked by the weevils, but had been successfully treated and the insects destroyed. Mr. Seay's method of treatment was described as so easy and rapid that one man could attend to many thousands of trees at very slight expense. He stated that if these beetles were as destructive in our newly acquired tropical territory (according to present accounts they are not) as they are in Central America, it would certainly be worth while for the Department of Agriculture to inquire into the matter.

Mr. Seay was written in regard to his experiences, and he answered January 22, and later in 1902, giving much information concerning this and other insects associated with injury to palms cultivated in British Honduras. His acquaintance with this weevil dated back about thirty years, and for half of that time he had been studying its habits in order to be able to use his knowledge to advantage in the application of remedies.

ASSOCIATES OF THE PALM WEEVIL.

The associates of this weevil, specimens of which accompanied other material, were a large shining black Histerid beetle (*Hololepta quadridentata* Say), a large dipterous larva or maggot, which proved on rearing to belong to the tachina fly, *Willistoniella pleuropunctata* Loew, an Ortalid, *Epiplatea erosa* Wied., and two forms of mites identified by Mr. N. Banks as belonging to the genera Uropoda and Holostaspis. The latter mite was observed singly in the material furnished us on both the weevil and the Histerid sheltering in clusters on the hairy portions of the under surface of the weevil and more especially on the tibiæ, although also clustered on the abdomen and prosternum. There is no doubt that these mites are of some value in destroying the weevils in their different stages, more particularly, perhaps, when in the pupal stage, if they have opportunity to penetrate

the pupal cells. Histerids are, as a rule, predaceous, at least in the larval stage, and these may also do some good by destroying the eggs and young of the weevil when the latter are first hatched.

Rhina barbirostris Fab.—June 19, 1902, we received from Mr. Seay, through Mr. E. J. F. Campbell, superintendent of agriculture, botanic station, Belize, Honduras, specimens of this large weevil, with the expression of opinion that, first of all, the cocoanut trees were in a more or less unhealthy state when attacked by it and that it did no harm to healthy trees; but some injury must in the first instance happen to some part of the plant, stem, roots, or leaf, to cause a flow and subsequent fermentation of sap to attract the insect.

The Ambrosia beetles (*Xyleborus* and *Monarthrum* spp.) bore into the cracks of the stem of the injured plants; and the palm weevil (*Rhynchophorus palmarum*) follows. The ambrosia beetles make holes in the trunk and bore straight ahead, the size never increasing, and throw out sawdust, which the weevil does not usually do. The latter makes a small hole and inserts an egg which hatches into a grub, and the grub excavates cavities which constantly increase until finally it forms its cocoon.

AS TO WHETHER INSECTS ATTACK HEALTHY OR ONLY SICKLY TREES.

The belief is quite prevalent in British Honduras that the palm weevil is the chief cause of the great damage to cocoanut trees in that colony. Mr. Seay is of the opinion that the ambrosia beetles are more responsible as conveyers of disease than the palm weevil. Mr. Campbell states that the disease locally known as "fever," presumably due to the fungus *Pestalozzia palmarum*, or a similar species, is the sole forerunner of the trouble. He supposes it to be conveyed from unhealthy trees growing in unsuitable ground. On this head he expresses himself substantially as follows:

> From my own observation I am of the opinion that cocoanut trees are never attacked by weevils unless the plant is more or less in a sickly condition—a fever of some kind. This fever may originate from different circumstances, such as sudden cold weather, excessive wet, causing water to lie around and affect the roots, the want of good drainage, inferior soil, sudden exposure of the stem to the direct rays of the sun, or other conditions due to planters neglecting to clean their trees for months or years. * * *

He is convinced that "no fly, bug, or weevil" will attack a perfectly healthy cocoanut tree that receives proper attention by its owner.

THE PALMETTO WEEVIL.

(*Rhynchophorus cruentatus* Fab.)

September 10, 1901, we received specimens of this species in the grub state from Mr. Lee Mulford, Fort Ogden, Fla., that had been taken from a 10-year-old seedling date. The entire trunk was found

to be honeycombed, and fifty or more of the grubs were observed. They were stated to be quite active and capable of traveling some little distance, and to be noisy when at work, making a sound like the escape of water with an occasional screech like a choked hen.

April 4, 1902, Mr. W. F. Fiske, Atlanta, Ga., sent fragments of this beetle, taken from its cocoon in the trunk of *Sabal palmetto*, the tree having died and the crown fallen. Other trees in the neighborhood were killed and some showed evidence of attack.

DESCRIPTIVE.

The beetle.—The general appearance of the beetle is shown in figure 1, at *a*. The thorax, and frequently the elytra, are usually more or less reddish; sometimes both are decidedly red, marked with black spots which form a pattern more or less like that depicted. The under surface is also partly red and partly black, but frequently specimens are met with which are entirely black, some decidedly polished, and

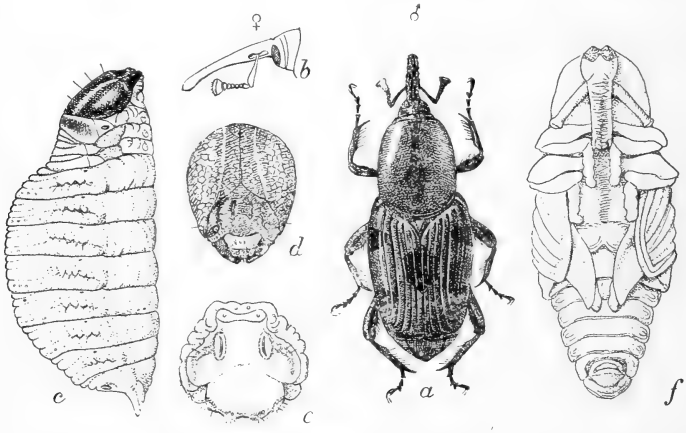


FIG. 1.—Palmetto weevil (*Rynchophorus cruentatus*): *a*, male beetle; *b*, head and appendages of female from side; *c*, larva; *d*, head of same; *e*, last ventral segment seen from above; *f*, pupa—*a*, *c*, *f*, slightly enlarged; *b*, *d*, *e*, more enlarged (original).

others dull and velvety. The body above is depressed and, as with other weevils, the head is prolonged into a snout, which is comparatively short and very rough in the male, while in the female it is longer and more slender and almost perfectly smooth along the upper surface. (Compare *a* and *b*, fig. 1, the latter a side view of the female head with snout and antenna.) The antennæ are geniculate or elbowed, as in most curculios of this group, and the last joint is strongly expanded. The elytra, or wing-covers, are deeply striate or furrowed, as shown in the figure. The legs are fringed on the inner surface with long reddish-yellow hairs, and the tip of the tibia bears a long apical spur and two shorter teeth. The length, exclusive of the snout, measures from eight-tenths of an inch to upward of an inch and an eighth. A technical description is furnished on page 408 of Dr. Horn's paper entitled "Contributions to a knowledge of the Curculionidæ of the United States." (Proceedings American Philosophical Society, 1873.)

The larva is shown in figure 1, at *c*. It very closely resembles that of *R. palmarum*, which is figured in both the articles of Messrs. Guilding and Blandford. It is of robust form and somewhat different from any other rhynchophorous larva that has

ever been under observation by the writer. Its color is rather pale yellowish-brown, with exception of the first thoracic segment, which is chitinous, and the head, which is dark brown. The latter is illustrated at *c* (fig. 1). It will be noticed that the eyes compose a large proportion of the head, and are divided into irregular areas. As will be seen in the illustration, the segments are quite distinct, and there are 9 spiracles, including 8 abdominal ones. The length, when in somewhat retracted position, is about $1\frac{1}{4}$ inches. In many respects this species resembles that of *R. palmarum;* hence a detailed description is scarcely necessary, as nearly two pages have been devoted to the description of that species in Blandford's article previously quoted. It should be stated, however, that Horn, quoting LeConte as authority, says that these stigmata are completely absent, because neither of these specialists had an opportunity of observing fresh alcoholic specimens, and drew their deductions from "a carefully prepared skin."

The pupa (fig. 1, *f*), in specimens which the writer has had under observation, is of a similar color to the larva, and is noticeably larger than the beetle, a rather unusual matter with pupæ, but readily accounted for because the pupa is necessarily rather delicate, while the beetle is decidedly hard like all of its kind and quite compact. The length of four pupæ before the writer afford an average of $1\frac{3}{8}$ inches. This species appears to be most abundant in Florida, but is recorded as occurring from South Carolina to Louisiana.

REMEDIAL TREATMENT.

Owing to the somewhat peculiar habits of these weevils and their resistance to poison, we can not treat them by any single method, but must employ several, both cultural and mechanical. Perhaps one of the best preventives that has been suggested consists in cutting down or wounding several young trees or wild species of palm or palmetto which may be found growing in the vicinity of the date or cocoanut trees to be protected. The sap which exudes from the dead or wounded trees ferments and acts as a strong attraction to the beetles. Frequently a multitude are thus attracted and can be captured without trouble and killed before they have had time to oviposit. The trunks of felled trees soon become filled with larvæ, and infested portions should be sawed off and burned before the insects mature, leaving the remainder of these trunks to act as traps for other insects. It is also recommended that care be taken in the choice of sites for new plantations, undue proximity to what is known as a "cohoon" ridge being avoided, and that all stumps and felled trees not used as traps be promptly destroyed. Thorough drainage and wide planting are also advised. The trees should be left as far as possible in a natural state and unnecessary trimming should be avoided. Wounds might be dressed with any mixture that would deter the beetle from attacking them and prevent fermentation, such as tar or grafting wax.

The beetles can easily be killed by dropping them into hot water.

Some of the remedies above described were first suggested by Mr. Blandford (loc. cit.) and others by this Division.

Mr. Seay is most successful in the treatment of the palm weevil by the use of traps, which have been in use for many years by himself

and others, both against this species and related ones. The traps he uses are mostly what is termed the cabbage portion of the palm while it is fermenting. When fresh cut, the "cabbage" will attract the weevils somewhat, but when it reaches the vinous stage it emits a powerful odor, which the insects can detect from a great distance. They soar about for a while, then alight and proceed to work. After feeding for some time, they look about in search of a "nice heap of rubbish to hide and sleep in, but if no suitable place is close, they fly away. The idea of a handful or two of rubbish catching them took me five years to find out," says Mr. Seay. "I kept trying everything I could think of to hold them, but as soon as the vinegar fermentation sets in, the weevils stop coming and the yellow bugs [ambrosia beetles] come; also several kinds of flies." When the putrid stage arrives, Mr. Seay destroys his traps. The "salt-water pimento" is the palm most used, and one or two cuts of a machete an inch or an inch and a half above the "cabbage" takes off the top, and with the point of the machete a hole is opened into the "cabbage," breaking it a little. Then the trap is set. The odor arising from these bruises attracts the insect in the vicinity, and the weevils enter the holes and also stow themselves in the leaf-stalks. In the afternoon of the following day until 2 or 3 o'clock our correspondent states that he frequently obtains half a dozen or more in such a trap. The trap lasts a week or two. When the trap has been thus used, it is cut off below the "cabbage," and the scraps are burned or thrown into the sea.

There seems little doubt that all of the flying species of insects—the weevil, the Histerid, and the two-winged flies—whose larvæ were received are instrumental in spreading the disease or so-called fever which attacks palms grown both in British Honduras and in the West Indies. Mr. Seay is unfortunate in having neighbors who also grow palms and who do not take the pains to employ remedies against the weevils. He states that 3 or 4 miles is no distance for the insects to fly in search of a sickly tree or one that is beginning to bear fruit, because then the bark is soft and the sun will make cracks and the sap oozes out in quantities, which is liked by all of these pests.

NOTES ON THE RHINOCEROS BEETLE.

(*Dynastes tityus* Linn.)

By F. H. Chittenden.

Few insects attract greater attention when they occur in any numbers than the giant Scarabæid known as the rhinoceros beetle, *Dynastes tityus* Linn., sometimes called the spotted hornbug. In former years it was tolerably abundant in the vicinity of the District of Columbia, and is still to be found quite frequently in neighboring portions of

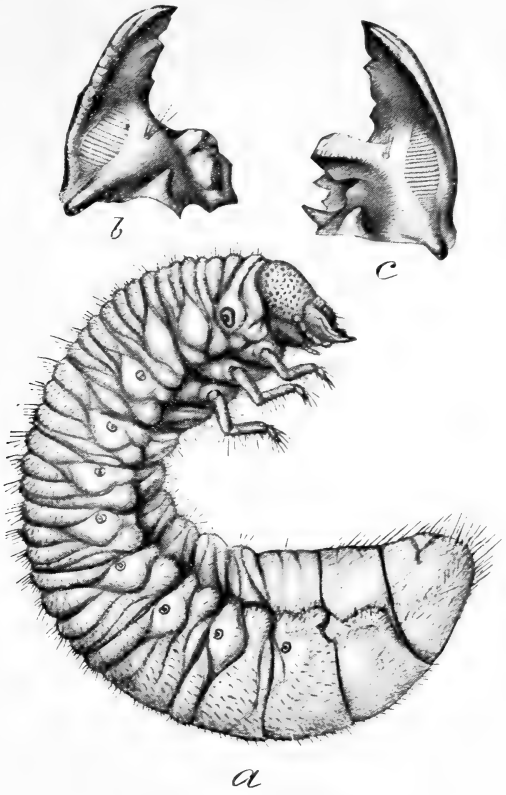


FIG. 1.—*a*, Larva (natural size); *b*, *c*, mandibles of larva (enlarged).

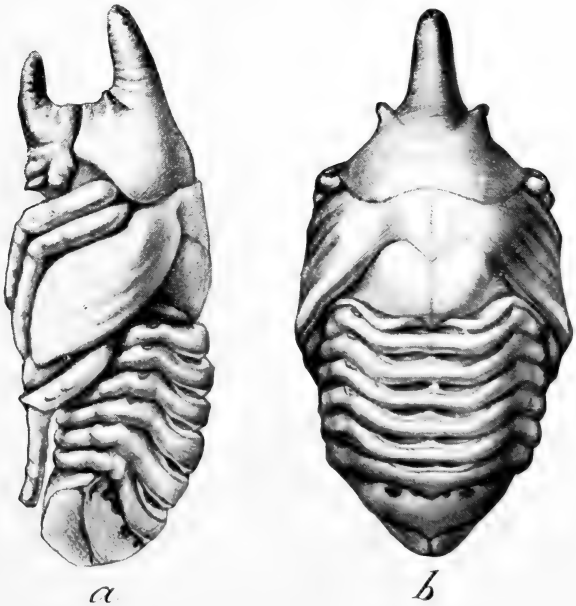


FIG. 2.—Pupa: *a*, lateral view; *b*, dorsal view.

RHINOCEROS BEETLE (DYNASTES TITYUS).

Virginia, and more commonly southward. It was not until the year 1891 that any considerable information regarding the insect's earlier stages was published. In that year Dr. J. A. Lintner published in his Seventh Report on the Injurious and Other Insects of the State of New York an extensive account (pp. 246–255), which included detailed descriptions of the larva and pupa by Mr. E. A. Schwarz, of this Division, with figures prepared in this office under the direction of the late Dr. Riley. These illustrations, not hitherto used in departmental publications, are now used as an accompaniment to the present notes, which add somewhat to our knowledge of the life history of this our largest and most striking native beetle.

Recently Dr. A. K. Fisher, of the Biological Survey of this Department, furnished the writer with a pair of this species from Sandy Spring, Md., and from these July 16 we obtained the egg and later the young larva. As this stage has not hitherto been described, the following description is submitted with other notes:

DESCRIPTION OF THE EGG AND YOUNG LARVA.

The egg of *Dynastes tityus* looks precisely like a very small bird's egg. It is one of the largest insect's eggs that the writer has ever seen, measuring upward of an eighth of an inch at its widest diameter. In outline it is broadly oval and perfectly symmetrical, of firm consistency, and quite elastic. It is of a dull cream color and without polish or visible sculpture. The length of a freshly deposited egg is a little more than $\frac{1}{8}$ inch (3.5^{mm}), and the shorter diameter 3^{mm}.

The newly hatched larva is nearly a counterpart of that of Lachnosterna and related white grubs, being about double the size and width of that of *Lachnosterna arcuata*, which was figured and described by the writer on pages 74 and 76, respectively, of Bulletin 19 (n. s.), of this office. These differences, however, are observable: The head is larger, more globular, darker brown in color, and of firmer consistency, being more strongly chitinized than that of Lachnosterna; the mandibles are proportionately shorter and less sickle-like, and the teeth are nearly the same on both sides, the single tooth being placed nearer the tip of the mandibles. [In *Lachnosterna fusca* there are two teeth on the left side, near the base of the mandibles, and only one tooth on the right side.] The legs are proportionately shorter and the pubescence longer.

DESCRIPTIONS OF LATER STAGES.

For the benefit of those who have not seen this species, the accompanying illustration of the male is furnished, slightly enlarged, in figure 2. It measures from 2$\frac{1}{4}$ to 2$\frac{1}{2}$ inches from the tip of the horns to the end of the body. The female is similar, but is unarmed with horns. The general color above is a pale bluish gray in life, and the

elytra, or wing-covers, are marked with darker irregular spots similar to those on many kinds of birds' eggs. The ventral surface is a bright mahogany brown, and moderately hairy.

The larva, shown in Plate II, figure 3, at *a* in natural position, is of the usual curved Scarabæid form, dirty yellow or yellowish white in color, measuring when mature upward of 5 inches in length when extended. Enlarged illustrations of the mandibles are shown at *b* and *c* of the same figure.

The pupa is light brown in color and covered with a very fine velvety pruinosity. The male is illustrated in Plate II, figure 2, *a* showing a lateral view and *b* the dorsal, natural size.

The peculiar odor of the beetle is shared by larvæ and pupæ and lasts long after death, preserved specimens seeming never to lose this strange scent, which also remains for years in the insect boxes in which the beetles have once been kept.

FIG. 2.—Rhinoceros beetle (*Dynastes tityus*): male—slightly enlarged (after Riley).

In the reports of Dr. Lintner rather full bibliographical references can be found.

DISTRIBUTION.

The exact distribution of this species has never been defined, hence the following list of localities from which specimens have been sent by correspondents of this Department together with some recorded localities should be of interest, this beetle being so well known to collectors of insects:

York County, Marietta, Lancaster, Wrightsville, Pa.; Cape May, Wildwood, N. J. (Smith); Baltimore, Hughesville, Sandy Spring, Centerville, Md.; Washington, D. C.; Amherst, Sewells Point, Bonney, Perrowville, Gills, Friedens, Coffee, Culpeper, Warren County, Va.; Wilkesboro, Raleigh, Happy Home, Fayetteville, Hooverhill, Greensboro, Asheville, Laurelbranch, N. C.; Coozan, Coronaca, Beaufort, Winnsboro, Pomaria, S. C.; Molino, Liveoak, New Smyrna, Archer, Fla.; Smithville, Pearson, Albany, Ga.; Florence, South Calera, Birmingham, Mobile, Selma, Ala.; New Orleans, Cypress, Gansville, La.; Covington, Memphis, Claiborne County, Tenn.; Ojo Caliente, Grafton, N. Mex.; Louisville, Scottsville, Ky.; Hackett City, Ark.; Paoli, Columbus, Ind.; Missouri.

BIOLOGIC NOTES.

The date of deposition of the egg was not ascertained, but was about July 18, or a few days before. When examined a week later it was

found to have grown half a millimeter in diameter by a process of absorption well known in eggs of the beetles of this family.

The exact duration of the egg stage could not be observed, but it was at least sixteen days and probably longer, the weather for this period being a little warmer than normal.

Several years ago the writer received from the late George D. Bradford, at that time traveling in the South, a number of larvæ of this species collected in the spring at Beaufort, S. C., from which material some interesting observations were made.

For several weeks after the receipt of these larvæ they did not manifest any signs of feeding, but later in July and August they ate freely of the mold or dead woody matter in which they were sent. There was originally over a gallon jar full of this mold, and as that in the jar was consumed, the remainder, perhaps a quart, was added. Three larvæ were kept in this, and almost the entire contents had become consumed and converted into pellets, resembling on a small scale those of a goat or rabbit, when the larvæ became full fed. They ceased feeding during the third week of August and remained for a few days as if resting, then went to work to form cells for the pupal transformation. When larvæ are disturbed they roll over and over, like the larvæ of many other Coleoptera and some other orders of insects, and the same motion was continued by the pupa. By this motion, in time, the interior of the pupal cell is rolled quite smooth.

August 27 the skin was noticed to be shriveled, and on the following day this increased. On the 29th all three pupated. One was still white toward evening, the other brown. Transformation to the imago occurred on the 20th of October, all undergoing this metamorphosis the same day. This gives a pupal period of fifty-one days, probably the longest warm weather pupal period of any of our Coleoptera.

The pupal cells were coated externally with excremental pellets and bits of rotten wood, and showed an average measurement of from 2 to 3 inches in length and 1⅛ to 1¼ inches in width.

Hibernation takes place normally in the beetle state, and the beetles obtained in this instance were kept until some time in July of the following year, when they died during the writer's absence.

The rhinoceros beetle seldom occurs in such abundance as to be reckoned a pest. According to Dr. Lintner, however, the beetles are sometimes capable of injuries of considerable importance. He states (Fifth New York Report, p. 230), on the authority of Mr. J. W. Murrell, Perrowville, Va., that numbers of the beetles were observed feeding on the tender shoots of spring growth of ash trees, causing the leaves to fall and cover the ground as if a frost had passed over them. Their food consists largely of sap, which flows from the plants attacked. Beetles may be attracted by bruising ash twigs.

The beetles are sometimes troublesome on account of their strong and disagreeable odor.

Ash, although evidently the favorite, is not the only food plant of this species. The larvæ are probably not particular, as they live upon decaying wood and have been found feeding in decayed wood of cherry, willow, oak, and other trees.

During June, 1898, we received a specimen of this species from Mr. W. W. Thompson, Smithville, Ga., with the statement that it had been found eating a pear, an unusual food habit, judging from records.

In writing of the noise produced by this species when alarmed, the late Dr. John Hamilton says (Can. Ent., Vol. XVIII, p. 112):

> While no real stridulating organs are present, they have the power to produce a sound that may answer the same purpose, somewhat resembling that of an angry goose. The pygidium and part of the last ventral segment are very hairy, and by withdrawing the abdomen from the elytra so as to admit air, and then suddenly forcing it out through the hair by a sudden extension, a noise is produced that is rather alarming to one unacquainted with their harmlessness.

NOTES ON ENEMIES OF MUSHROOMS AND ON EXPERIMENTS WITH REMEDIES.

By August Busck.

During the winter 1901–2 four enemies of mushroom culture came under observation: (1) snails, (2) roaches, (3) maggots of some undetermined Diptera (not bred), and (4) mites.

(1) Against the snails was used with perfect success the old remedy of trapping them under loose boards.

(2) The roaches (*Periplaneta americana*) were quite troublesome, but were at least temporarily driven away by the pyrethrum and bisulphid of carbon experiments, employed against the mites and mentioned below.

(3) The maggots, which in the cases under observation were scarce and of small importance, were not bred. They worked in the fruit bodies of the mushroom and of course spoiled such individual mushrooms as were infested. Possibly the experiments with all kinds of insecticides, conducted against the mites, killed the majority of adult flies, and thus prevented egg laying and consequent injury.

Reports from other places show that certain flies (*Phora* spp. and *Drosophila* spp.) may be very dangerous enemies of successful mushroom culture.

The present experiments tend to show that the screening of all windows or beds where feasible, and the liberal use of pyrethrum, are effective preventives against these pests.

(4) The only truly important and at the same time the most pernicious and difficult enemy to handle which has come under my observation hitherto is the very prolific and astonishingly destructive mite, *Tyroglyphus lintneri*.

It attacks the fruit bodies in all stages, thereby making these unsightly and unsalable. When present in large numbers it actually eats big holes right through them. It not only attacks the fruit bodies, but even feeds on the mycelium underground, thus destroying the plant entirely.

Many cases where beds have not yielded at all, and where the blame has been credited to "old and dead" spawn, are doubtless truly the results of this pest, which being so small has escaped notice.

In two or three cases where the failure of a bed was attributed to poor spawn, it was found on investigation that the "brick" had been all right and had begun sending out mycelium under favorable conditions, but that myriads of these mites in the ground actually consumed it as fast as it grew. In some beds they were so numerous that they covered the surface entirely, and any such bed might as well be given up at once, and the danger to surrounding beds somewhat minimized by the killing of all the mites. This may be done by pouring boiling water on the bed, using enough to reach the bottom and soak the bed thoroughly.

The following remedies were thoroughly experimented with and none proved of much value:

(A) *Bisulphid of carbon.*—Some twenty-odd beds, 3 by 6 feet, and two beds, 5 by 10 feet, were under observation in two different places. These beds were originally prepared with these experiments in view, and the boxes were made 1½ to 2 inches higher than is usually necessary, so as to leave that much space above the ground. In other respects the beds were prepared in the usual manner, the spawn was put in, and in due time mycelium developed and mushrooms appeared.

As soon as the mites put in their appearance (they were probably brought in the adolescent stage with the manure) the bisulphid of carbon was applied. From one-fourth of a pound to 1 pound was poured into each of three or four shallow receptacles placed on top of the bed, and the whole was then tightly covered with heavy oilcloth.

This was done in the evening and the bed left overnight till the next noon, when the soil was examined.

It is possible that some of the mites had perished from the effect of the poison. Several were found dead or dying, but many more specimens crawled upon and in the soil as lively as ever and apparently not the least harmed.

The treatment was repeated next night on some of the beds, and for several nights on other beds, but with the same very doubtful success.

A number of living mites were placed in a vial on a bit of mushroom and the vial closed with cotton saturated with bisulphid of carbon. After two days several mites were still alive, and the cause of the death of the others may as well have been lack of moisture or injury in handling them as the bisulphid of carbon.

One thing was ascertained through these experiments, namely, that the mushroom mycelium is not injured by the treatment with vapors of bisulphid of carbon; in fact, the growth seemed rather stimulated if affected at all, and such beds, when not ultimately killed by the mites, produced as good a crop as those not treated. The fruit bodies above ground, however, can not stand the treatment, but disintegrate very soon, for which reason all should be plucked before the application.

(B) *Pulverized sulphur* was applied liberally with a blower, and mixed with about 1 inch of the top soil by means of a rake. Aside from such mites as were injured in the handling, and such as were actually buried in the sulphur, from which they had difficulty in extricating themselves, none seemed in the least affected.

(C) *Vapors of sulphur.*—The burning of chips of sulphur in proper receptacles on top of the beds did not have any apparent effect on the mites.

(D) *Pyrethrum powder* applied liberally with bellows had no serious effect on the mites, though they evidently did not like it. It did not seem to act even as a deterrent in such beds as were little or not at all infested. However, the undoubted beneficial results against roaches and flies, which might otherwise have become serious factors, would warrant the use of this insecticide freely in all mushroom beds as a good precaution.

(E) *Hydrocyanic-acid gas.*—Conditions did not allow a thorough test of this, but I have no doubt, from what was done, that it is as ineffective against the mites as bisulphid of carbon. One large bed in a cellar by itself was left from Saturday 4 o'clock to Sunday 4 o'clock, exposed to the fumes of hydrocyanic acid, produced in the usual way. When the windows were pulled open on Sunday strong fumes were still found.

No living mites were noticed at the inspection on top of the bed, but digging into the bed the following day revealed them apparently as well as ever. Concerning the influence of these vapors on the growing mycelium this experiment gave no information, as the mycelium in this bed was already dead when exposed to the gas.

(F) *Tobacco dust* was tried in a single bed, and gave the same negative result as sulphur, acting at most only as somewhat deterring but not killing the mites.

(G) *Chloride of lime and gasoline.*—Neither was given sufficient trial to warrant final conclusions. The former killed the mites which came in contact with it, but two beds on which it was applied did not produce any mushrooms either. The gasoline did not seem to have any fatal results either to mites or mushrooms.

(H) *Moisture.*—A mushroom bed does not allow much variation in moisture if good results are to come. However, it was soon observed

that the mites easily got too much moisture, and in this direction observations should be continued to find out whether it be possible to find a degree of moisture which will either kill or drive away the mites without being detrimental to the growth of the mycelium.

NOTES ON COLORADO INSECTS.

By A. N. Caudell.

Acting under authorization from the Department of Agriculture, I arrived at Denver, Colo., May 5, 1901, where I was joined by Dr. H. G. Dyar. With Denver as headquarters, daily excursions were made into the canyons and foothills of the mountains, and the life histories of many western Lepidoptera were worked out, notes being taken on more than 200 species. In the months of July and August trips were made across the divide to various localities, adding materially to our collections. According to instructions, I "collected such economic and other insects as came convenient and made observations on economic species whenever possible." My first duty of assisting Dr. Dyar in working out Lepidopterous life histories prohibited my making large collections in other orders. Some 5,000 specimens of Orthoptera, however, were collected, together with some hundreds of miscellaneous insects, mostly Coleoptera, of which a few were reared. Such observations on economic insects as I was able to make are here reported.

The minute false chinch bug (*Nysius minutus* Uhl.).—At Delta occurred an extreme case of injury to radish by this insect. The leaves were completely killed to the ground, and the shriveled remains were still covered by many hundreds of the little pests. Mr. O. Heidemann identified the species.

The beet army worm (*Laphygma exigua* Hbn.).—This has become an important enemy of the sugar-beet industry in the West. Specimens of the larva in all stages were taken on sugar beets at Palisades in Mesa County, and at Delta. At the latter place they were taken also on the table beet, though they did not occur in injurious numbers. This insect is reported as having caused great injury to sugar beets in Colorado, defoliating thousands of acres of beets. It is also said to be injurious to potato, pea, and apple leaves. Professor Gillette, of the Colorado experiment station, has employed arsenical sprays against it with beneficial results. Professor Forbes concludes from data furnished by Professor Gillette that there may be expected at least two broods of larvæ each year—one in June and one in August. But the broods doubtless merge one into the other, as larvæ in all stages were taken at Palisades on July 8.

The bean ladybird (*Epilachna corrupta* Muls.).—An extreme case

of injury by this spotted bean beetle was observed near Fort Collins, where a large patch of beans had nearly every leaf killed by the larvæ of this insect. At that time, in July, the beetles were in the pupal state, hanging in great numbers on the underside of the leaves. Professor Gillette stated that no effective remedy for them was known, the insect being able to withstand anything that did not injure the plants. The adult beetles are said to exude a tiny drop of yellow liquid of a pungent odor from each knee joint when disturbed. The insect is discussed by Professor Gillette in Bulletin 19 of the Colorado Experiment Station.

The apple flea-beetle (*Haltica bimarginata* Ill.).—July 19 a collecting trip was made up Platte Canyon. At Pine Grove, some miles up the canyon, the alders along the river were found to be infested by beetle larvæ which ate the upper side of the leaves, in some cases completely skeletonizing them. An attempt was made to rear the adult beetle, but other duties interfered and it was not successful. A number of the larvæ were collected, however, and Mr. Schwarz identifies them as those of *Haltica bimarginata*.

The tent caterpillar (*Clisiocampa fragilis* Stretch).—On July 20 the ascent of Pike's Peak was made, and here occurred the worst case of forest depredation by insect foes that ever came under my observation. The aspens were completely defoliated by the larvæ of *Clisiocampa fragilis*. The imagos were then issuing, and, even in the middle of the day, they swarmed about the tops of the leafless trees like bees, thousands and thousands of them. The cocoons literally covered the twigs, one a foot in length often containing a dozen or more of them. So completely defoliated were the trees at this place that Mr. Dyar failed to find a single leaf with which to supply an aspen-feeding Notodont larva which he was rearing. Our observations were made mostly at 9,000 to 12,000 feet altitude. The willow and rose were also attacked, but not nearly so severely as the aspen. Over what area this injury extended I can not say, being unable to make sufficient observations. In the vicinity of Cripple Creek the aspens were also infested, but not nearly so badly as those on Pikes Peak. On reaching the summit of the peak we found hundreds of the moths lying dead or helpless on the snow banks. They had evidently flown up from the timber line, and, becoming benumbed, fallen in the snow, there to die.

The lilac borer (*Podosesia syringæ* Harr.).—In West Denver numbers of ash trees were completely killed by this Sesiid borer. The trees were small, about 6 inches in diameter, and dozens of empty pupal shells were protruding through the bark.

The fruit-tree leaf-roller (*Cacœcia argyrospila* Walk.).—The leaves of living ash trees were badly infested with the larvæ of this Tortricid.

A new tent caterpillar (*Clisiocampa tigris* Dyar).—The scrub oak in the eastern foothills, especially just west of Sedalia, between Denver and Colorado Springs, was badly infested with the larvæ of this new

species of Clisiocampa. Many of the trees (or more properly bushes, as they seldom, if ever, attain sufficient size to be properly called trees) were killed through repeated defoliation by the larvæ of this insect. A resident farmer stated that the caterpillars were much more numerous some years than others. This beautifully marked larva was first found some 5 miles up Platte Canyon, back of Denver, but occurred there very sparingly. It eats only oak and confines its attacks to young, tender leaves. It seems unable to eat old leaves, and so must mature before they become tough.

The eggs are laid near the ground on twigs at the base of the trees, and have no frothy covering as have many species of the genus. The larvæ are gregarious when young, but soon scatter and feed singly. They spin no web.

Trypeta galls on Bigelovia.—At the little station of Platte Canyon, at the mouth of the canyon of that name, there are great numbers of Bigelovia. During the latter part of May every bush bears a number of white fluffy but compact galls as big as hazelnuts. Often there will be found 50 or more galls on a single bush. They are caused by a beautiful little fly, *Aciura bigloviæ* Ckll. At this time of the year the pupæ may be found within the galls, snugly incased in cells at the center. The pupa is about 5^{mm} long by 3^{mm} wide, oval in shape, and varying in color from pale yellowish red to brown, probably according to age. The insects emerge by the first of June, the first ones appearing in the breeding cage on May 28.

The cabbage looper (*Plusia brassicæ* Riley).—In the early part of July a few observations were made on injurious insects of the garden in the vicinity of Delta, in Delta County. Several interesting items were noted. The larva of *Plusia brassicæ* was the main pest, and seemed to be quite omnivorous, eating not only the cabbage, but also the potato, turnip, rutabaga, lettuce, and table and sugar beets; it was also found on a prickly poppy-like plant locally called "wild lettuce." While the cabbage in some cases was almost ruined, it was on the lettuce and potato, especially the lettuce, that the most damage was done. Quite large fields of potatoes were so eaten by this larva as to be easily noticeable at a considerable distance, having something the appearance of being badly infested with the potato beetles. On the lettuce the damage was extreme. In some cases the plant was entirely devoured and was eaten out below the surface of the ground. The rutabagas and peas were also badly eaten. The larvæ occurred in various stages, some very small and others full grown. Specimens were sent to Dr. Dyar at Denver to be reared, but they failed to transform. An inflated larva was preserved.

The cottonwood leaf-beetle (*Lina scripta* Fab.).—The willows in the eastern foothills visited by Dr. Dyar and myself were badly infested with a Chrysomelid larva which often occurred in sufficient numbers to completely skeletonize the leaves of large branches. The beetles were

reared, and were determined by Mr. Schwarz. The eggs are deposited on the leaves about the middle of May, and are continually deposited for two or three weeks thereafter, all stages—ovum, larva, pupa, and imago—being found on the trees in the earlier part of June. They remain in the pupa state about five days, specimens in the breeding cage pupating on June 1, and giving forth imagos on the 6th. The larval period lasts but a couple of weeks, and breeding experiments would probably show the insect to be at least double-brooded.

The boll worm, or corn ear-worm (*Heliothis armiger* Hbn.).—Young corn a couple of feet in height near Delta was badly infested with the bollworm. The leaves were in some cases completely riddled near the base, and the stalks badly burrowed and eaten. This exceptional injury was probably accounted for by the nearness of the worst infested patch (a small area) to an irrigating ditch of considerable size. Corn in dryer locations seemed little injured. Corn on low wet soil is usually much more liable to excessive injury from the corn worm than on high dry ground. Some years ago in Oklahoma I saw a small area of field corn planted in a very low wet spot in the bend of a small creek that was completely eaten up by the worms. The stalks attained a height of only about 4 feet and were very weak and slender, yet 20 or more larvæ could be found in a single plant, burrowing the stalks so that many fell over. Some plants had all the leaves riddled and the stalk so completelly eaten out that but part of the outer shell remained. So numerous were the larvæ that many of them were in a fully exposed position, feeding upon the leaves.

Grasshoppers.—Grasshoppers were very abundant in Colorado this year. Several reasons may be assigned for their unusal numbers. The season was favorable for their development, and the increasing abundance all over the State of the Russian thistle, which is a food plant of a large number of species, may have had considerable influence on the matter. Professor Bruner suggested also that the rapid killing off of pheasants may be a cause of grasshopper increase.

The prairie along the eastern foothills was swarming with various kinds of Acridiinæ. *Melanoplus bivittatus* was probably the most common species. At Delta this locust threatened to do some damage, and it occurred sparingly at Grand Junction, while at Palisades, 12 miles north, none at all were seen. This is a very injurious species, and Professor Gillette places it on an equal footing with the codling moth as an injurious insect.

The saltbushes, *Sarcobates vermicularis*, about Palisades were infested with *Æolophus chenopodii* Brun. in large numbers. A small patch in the center of the little town was swarming with them. They were quite active, diving headlong into the prickly bunches of weeds, and proved quite difficult to capture. They were not at all common at Grand Junction, and were not taken on the saltbush there.

GRASSHOPPER NOTES FOR 1901.

By Lawrence Bruner, *Temporary Field Agent.*

Owing to numerous reports received at Washington from many localities in the central West concerning the continued presence in more than normal numbers of several species of native grasshoppers or locusts, the subject was deemed worthy of investigation. Reports coming from portions of western Nebraska, eastern Colorado, and eastern and central Wyoming seemed so serious in their nature that the writer was commissioned by the United States Department of Agriculture to make an investigation, so as to ascertain, if possible, the true causes leading up to this undue increase among the several species of locusts concerned, and to report the results to the Entomologist.

Accordingly, August 8, in company with Mr. M. A. Carriker, jr., an assistant, who was to make some special observations and collections of specimens for the Nebraska Agricultural Experiment Station, a start on this tour of inspection was made. The route chosen was first to southwestern Nebraska via the Denver branch of the Burlington and Missouri River Railroad, and the first stop was at McCook. From this place the party proceeded by short journeys to Haigler, then to Akron, and to Brush. At the latter place turning to the north, and passing through Sterling, Colo., Sidney, Nebr., Bridgeport, and Scotts Bluff, they reached westward as far as Guernsey, Wyo., before returning to Alliance, Nebr., and Lincoln, by way of the Billings branch of the same railroad. On this return journey the central sand hill region was crossed and some notes on locust abundance were there secured.

Leaving Lincoln again on August 18, a second journey was made; this time via the Fremont, Elkhorn and Missouri Valley Railroad up the Elkhorn Valley, the Niobrara, the White River, and the North Platte, to Lusk, Douglas, and Casper, Wyo., where investigations were made concerning the locust problem as it existed in those regions; then returning as far as Crawford, in which vicinity some work was done, and finally going on to Denver, Colo., where the annual meeting of the economic entomologists was attended. From here the return trip to Lincoln was made over the Union Pacific Railway down the Platte River Valley. Thus most of the remaining territory occupied by the locust pest under consideration was covered. In these investigations the writer was greatly aided by having transportation furnished him by the railroad companies mentioned.

Other sections of the country were also visited and carefully studied, both before and since the period embraced by the commission mentioned, and the results of such investigations have been included in the conclusions arrived at and hereto appended.

The following notes pertaining to the subject under investigation were jotted down as the work progressed, and in part form the basis for the conclusions reached:

At McCook, Nebr., August 9, we collected some thirty-odds pieces of the native grasshoppers, which abound in this vicinity. Most of these were from common to numerous as regards abundance. In fields, both on the table-lands and in the valley, the *Melanoplus differentialis* was exceedingly abundant; in fact it appeared to be the principal species that was causing the injury to crops and cultivated plants. It was aided, however, in this work by such other forms as *M. bivittatus*, *M. atlanis*, *M. packardii*—of the form usually referred to as *M. fœdus*—and *M. femur-rubrum*. Among the other species which existed in unusually large numbers were *Dissosteira longipennis*, *Æoloplus turnbullii*, *M. occidentalis*, *M. conspersus*, *M. lakinus*, *Amphitornus bicolor*, *Aulocara elliotti*, *Mestobregma kiowa*, etc.; but these latter were feeding mainly upon grasses, weeds, and special food plants other than cultivated ones.

In trying to ascertain just where the insects which were concerned in the devastation of crops had hatched, it was found that old breakings seemed to furnish many, while the forsaken roads, edges of fields and irrigating ditches, railroad beds, and like places, grown up to weeds, had provided still others with the required breeding places. Alfalfa fields growing next to corn nearly invariably occasioned much injury to the corn. Some of the fields of corn observed between McCook and Culbertson had been entirely destroyed, and in some instances even the weeds between the rows and about the edges were badly eaten. A few fields showed only here and there the remnants of bare stubs, just as I had seen fields appear in the early seventies after a visit from the Rocky Mountain locust plague.

In observing what plants, if any, were free from the ravages of the various locusts mentioned above, it was noticed that sorghum in most cases had suffered but little, while Kaffir corn was nearly exempt. Only when Kaffir corn was wilted did the locusts seem to touch it at all, and then but slightly if other food was available. Millet, too, seemed to be fairly immune against their attacks. Of course most kinds of garden truck suffered severely.

One feature noted in connection with the abundance of the supposedly harmless locusts was the presence in large numbers of *M. lakinus* and *Æoloplus turnbullii* on the Russian thistle and lamb's-quarters. Nearly everywhere that these weeds grew the grasshoppers just mentioned abounded. Only a few years ago both of these species of locusts were rare, usually extremely rare, and at the same time very local in their distribution. Since they have already been observed to attack the beet, they may both prove troublesome in the future should attempts be made at sugar-beet growing in the regions now overrun.

On the prairies and other uncultivated grounds two or three grasshoppers besides those mentioned above seemed to be abnormally abundant. *Mermiria bivittata*, *Opeia obscura*, and *Amphitornus bicolor* or

coloradensis being the chief ones. These, with the exception of the first, are found upon the higher grounds among the shorter grasses like the Boutelouas.

In driving and walking about over the country, in which movements 10 or 12 miles at a time were covered, few dead or sick locusts were seen, and inquiry among the farmers and other interested parties gave the same impression as to their comparative healthiness. No Empusa-killed 'hoppers had been seen by anyone during the present year, so far as could be learned, and only a few had been observed to die from "grubs" and from what is apparently either a bacterial disease or such a disease in conjunction with a Sporotrichum. At least this last surmise seems to be warranted, since the conditions of death coincide with observations made a week prior in an alfalfa field on the North Platte, about 17 miles to the northwest of the little town of Ogallala, where the locusts of various species had succumbed in large numbers. When these were placed in a dish for the purpose of ascertaining the cause of their demise there was obtained a fungous growth, pronounced by Dr. C. E. Bessey, of the University of Nebraska, to be a species of Sporotrichum. Several bacteria were also present in large numbers within the bodies of some of the above-mentioned dead locusts.

Inquiries made among the railroad employees at McCook showed that these insects reached eastward as far as Red Cloud in numbers sufficiently great to perceptibly injure cultivated vegetation in both gardens and fields.

In passing westward from McCook along the line of the Burlington and Missouri River Railroad, locust injury was observed all the way to Haigler, but seemed to be the most pronounced between the former place and Stratton.

From different persons questioned concerning the various measures that had been taken to combat the locusts in this portion of the State, it was learned that the kerosene pan had been used in a few cases, while disking had been resorted to by some, and several had even attempted the use of poison in the form of Paris green mixed with bran. In some instances also large flocks of chickens and turkeys produced some good results. Altogether, however, but little had been accomplished, and no concerted action had been undertaken by the settlers to rid themselves of the pest. It would require a concerted action over the entire area affected, for at least two or three years in succession, to obtain complete control of the pest.

Whether or not the killing off of the native birds in this section of the State has been much of a factor in permitting this abundance of the locust is a query. One farmer near McCook remarked that a couple of years ago a certain locality near one end of a particular field of his had been protected by blackbirds, a hundred or more pairs

of which built nests and reared their young near by. Recently, however, the small willows among which these birds nested had been removed, and the birds no longer protected that particular field.

At Haigler it was ascertained that various species of locusts have been more than normally abundant for the past six years. At least this can be said of the species which attack cultivated plants like alfalfa, corn, wheat, garden truck, etc. If any change in their numbers has occurred it is thought that perhaps there is a slight decrease from last year. As in the vicinity of McCook and farther east, they seem to breed chiefly in alfalfa fields, along roadsides, and in old breakings. In addition to the breeding places here recorded, the Russian thistles, which have become generally dispersed over this section of the State, seem also to offer safe and desirable retreats for several species of these insects when laying their eggs. Not only is this true at egg-laying, but also at other times. These rank-growing plants provide shelter during hot, dry weather, as well as from rain and hail storms, and offer safe retreats to the insects, even when pursued by such enemies as predaceous insects and birds.

Of the enemies to wild plants among these insects those which appear to be most beyond the normal in numbers in this vicinity seem to be *Opeia obscura*, *Mestobregma kiowa*, *Melanoplus lakinus*, *M. bowditchi*, *M. packardi*, *Mermiria bivittata*, *M. neomexicana*, and one or two others. As noted at McCook, several of these latter are partial to certain food plants which have recently increased enormously, which fact probably explains their excessive numbers. On the other hand, species like the Mermirias and other grass-infesting forms now abnormally abundant have become so from some other cause. Perhaps the nonoccurrence of prairie fires for a number of years may account for this, at least in part, while the destruction of such birds as the sharp-tailed grouse and Bartramian sandpiper, with the meadow lark, and a few other kinds of prairie-inhabiting species, will explain the excess in numbers of some of the remaining grasshoppers. Three species of Decticinæ were also quite abundant here, as was also one of the walking sticks.

In journeying westward from Haigler grasshopper injuries were detected nearly as far as Akron, Colo., but beyond this point only about the normal numbers of these insects appeared to be present, since none of their injury was visible from the train. At Brush, where a great deal of alfalfa is grown, not many of these insects were reported or seen. Hence it was judged that matters here were nearly normal as regards locust abundance. From this point the direction of the journey was changed and we went north. At Sterling, which was passed before daylight and where considerable injury was reported a year ago, the condition was not ascertained, but judging from what was seen some distance beyond along the line of railroad toward Sid-

ney the locusts may be on the decrease—a result, perhaps, of some concerted efforts on the part of the farmers toward their destruction during the past two or three years.

It was also found upon investigation that these insects were not nearly so numerous at Sidney as they were farther to the east along the Lodgepole Creek and the South Platte River. Still, even at Sidney, wherever and whenever cultivated fields occurred, more of these insects were to be met with than is normally the case in the region. They were of the usual species observed under similar conditions the present year, viz., various species of the Melanopli, as *differentialis*, *bivittatus*, *femur-rubrum*, and *atlanis*. Some of the other forms that were not so rare as at times in the past were species like *M. packardii*, *M. occidentalis*, *M. luridus*, *M. infantilis*, etc., while a few of the prairie-inhabiting species mentioned before were also quite plentiful.

In conversing with Mr. George Oberfelder, a merchant of Sidney and a ranchman, I learned that at Lodgepole the locusts were not nearly so plentiful on his ranch as elsewhere in the neighborhood. It developed from further conversation with him that on this particular ranch are located several quite extensive private fish ponds and low and swampy ground, where two or three species of blackbirds breed, and were, at the time referred to, gathered in immense flocks. The presence of these birds will undoubtedly explain this comparative freedom from locusts on the ranch in question. Mr. Oberfelder also mentioned the fact that a great destruction of the bird life, in general, of the region had been accomplished during recent years by local and other would-be sportsmen.

While at this place, in conversation with a gentleman from Gering, Scotts Bluff County, it was learned that during the present year there were more grasshoppers in the Pumpkinseed Valley, to the south of Gering and Mitchell, than there were last year, and also more during the present year (1901) than at Gering and Mitchell. This he accounted for on the ground of a partial migration southward both by the old insects prior to their egg laying last fall, and again since hatching during the past spring and early summer. Just what species of these insects were present in this last-named region was not ascertained, but it is presumed that most of them were of the kinds noted at nearly all other points where cultivated vegetation suffered from grasshopper depredations. It is also quite evident that several of the prairie-frequenting species like *M. packardii*, *M. occidentalis*, the Aulocaras, some of the species of Trimerotropis, *Trachyrhachis kiowa*, *Opeia obscura*, etc., were present in more than normal numbers, since a scarcity of food on the ranges is reported, notwithstanding the fact that more than the usual amount of rain had fallen during the past spring and summer.

In running west from Bridgeport to Guernsey, Wyo., it was observed

that locust depredations appeared to lessen materially as the train progressed westward after entering Wyoming. Still even here more of these insects were to be seen among the weeds along the railroad track than was the case during their normal abundance in past years. There were a number of kinds to be met with in the grasses about Guernsey, but the prevailing species seemed to be *M. packardii*, *M. occidentalis*, *M. atlanis*, *Aulocara elliotti*, *A. femoratus*, and still others, which, like the *M. differentialis* and *M. atlanis*, seem to hatch among rank-growing weeds as well as upon cultivated or disturbed grounds.

In trying to find a reason for the greater increase of locusts in certain localities during different years, the matter of rainfall seems to offer an explanation for at least a portion of this variation. It is quite noticeable that when rains fall early in the season the eggs of these insects hatch much earlier than they do when the rains come later, although the temperature may be normal or even above normal. Then, too, after each shower during late spring and throughout the summer, it is seen that additional young ones hatch. During some years it may even be possible for many of the eggs that were deposited the previous fall to remain unhatched for lack of the requisite amount of moisture. Should the following year prove to be a wet one these eggs might then hatch along with those deposited a year later. That the present year has been an exceptionally wet one in portions of the Northwest may, therefore, account for the immense numbers of grasshoppers that were to be found in that section. Still, there are limited localities even in this region where scarcely any of these insects were to be met with during the present summer, while immediately adjoining they were literally swarming. While returning eastward from Guernsey a severe rainstorm accompanied by hail was passed through. Fully an inch and a half or two inches of rather large hailstones fell over a strip of country several miles in width and many miles in length. During the progress of this storm the thought occurred to me that possibly here was an explanation of the comparative freedom of certain areas right in the midst of others that were greatly overrun by destructive locusts. The hail in this instance certainly fell with force and in quantity sufficient to crush out the life of the majority of locusts inhabiting the region in question. Then, too, these sections of comparative freedom from the pest so frequently observed by the writer are such as are subject to severe hailstorms.

As intimated on a previous page, the Russian thistle, in addition to affording an abundant food supply for certain species of the native locusts, provides excellent shelter for their eggs as well as the insects themselves. Tucked away beneath these formidable plants both the insects and their eggs are well protected from most of their natural enemies, as well as from sudden changes of weather. This being true, the Russian thistle no doubt must have had something to do with pro-

ducing the present conditions in portions of the region now covered by the locust plague.

At Caspar, Wyo., August 20, conditions while rather bad were not nearly so alarming as they were in some portions of Nebraska, and farther east in Wyoming. In driving out among the ranches and over the range some new light on the probable cause of the recent increase among grasshoppers in this and other regions of the country was secured.

Upon driving up to the buildings on a ranch on Goose Creek, about 10 or 12 miles southeast from Caspar, a very nice flock of sage grouse (30 or more) was observed walking about the premises and picking up grasshoppers. These grouse were so tame that they reminded one of domestic fowls as they worked about among the vegetation in search of grasshoppers. During the day several additional coveys of these grouse were seen and the remnants of several dead birds that had been shot and drawn by hunters offered opportunities for examining the stomach contents. Such examinations invariably resulted in the finding of large quantities of grasshopper fragments. By inquiring around among ranchmen it was also ascertained that a great slaughter of these birds had been going on for the past few years in the sections of Wyoming now most overrun by locusts. A careful survey of the field brought out the fact that a similar destruction of these birds, as well as of the sharp-tailed grouse, has been progressing over considerable country. It was learned that such slaughter had occurred at Chadron, Crawford, Harrison, McCook, Culbertson, Trenton, Haigler, North Platte, and Sidney, in Nebraska; and at Lusk, Douglas, Orin Junction, Guernsey, and elsewhere in Wyoming. At each of these localities the grasshoppers were more numerous during the past summer than formerly.

When this idea first came up in connection with other probable reasons for the increase of the various species of locusts found it did not seem at all probable, but the more I consider it, the more I am inclined to accept it as an important factor in the problem. When we take into consideration the fact that when man occupies a new area he finds the forces of nature nearly or quite in a state of equilibrium, no one form of life having much the advantage over others, then does this explanation of the matter appear quite possible. The country undisturbed by man affords food for a certain number of mammals, birds, reptiles, and insects, all of which are more or less interdependent. If, for instance, man removes a few hundreds of the individuals of any one species, he soon finds a change taking place in the numbers of individuals of some other form. The birds feed on both vegetation and insects. If grasshoppers are included in their food a smaller number of birds will require a less number of 'hoppers, and the latter will thus be given the opportunity to increase beyond the normal. This

surplus goes on increasing and very soon causes a greater drain on the vegetation that forms their bill of fare. Supposing that a single sage hen will destroy on an average 100 locusts each day during the months of June, July, and August, the removal of this bird from the field of action will mean at least 9,000 grasshoppers saved to swell the army of these insects that may go on eating and propagating. If half of these should be females, and each one should deposit its normal quota of 100 eggs, there would be a possible 150,000 more of these insects than if the bird had not been killed. But when we destroy the birds by the hundreds of thousands the possibilities become startling, and this solution to the problem seems more than probable.

Aside from the killing off of these birds by man, it is stated that they are destroyed to a considerable extent by grazing sheep which break up their nests. While conversing with an intelligent sheepman and herder on this feature of the subject, he mentioned the fact that he had heard of more than a hundred nests being thus destroyed in a single year on Hams Fork in western Wyoming. Whether or not the destruction of locusts by the trampling of sheep will equal the number that would have been killed by the birds thus destroyed, I am not prepared to state at this time.

The species of grasshoppers concerned in the depredations on cultivated tracts in the vicinity of Douglas and Casper, Wyo., were: *M. bivittatus*, *M. atlanis*, *M. femur-rubrum*, and *Camnula pellucida;* while the ones most abundant on the range were *Aulocara elliotti*, *A. femorata*, *Mestobregma pardalinum*, *Melanoplus packardii*, *M. infantilis*, *M. occidentalis*, and several others.

While occupied in other work in portions of Dawes and Sioux counties during June, July, and August, 1901, the writer gave considerable attention to the locust problem as it existed there. A couple of students who were engaged in making collections of various forms of the animal life of northwestern Nebraska were also instructed to pay particular attention to these insects in the region being worked by them. The forms that frequent both cultivated and uncultivated grounds were found to be unusually abundant over much of the country traversed. Still some sections were much more overrun by them than others. Especially was this found to be the case in portions of Dawes and Sioux counties, Nebr. In the latter county in particular the insects were most plentiful on the slopes adjoining the Pine Ridge and for a few miles away; but not so on the table-lands nor in the Hat Creek Valley itself. In many places the insects were so numerous as to cause a shortage in the feed on the range notwithstanding the great amount of rain that fell here during the early part of the year. As noted in other localities, some species of insects normally rare in this section of the State were found to be present in large numbers.

Not only were the "native" locusts abundant throughout the western

counties of Nebraska, but in many localities even in the central and eastern portions of the State, where they did much local injury to garden truck and some field crops. Some of the localities where such a state of affairs existed were in Antelope, Knox, Dixon, Cedar, Holt, Valley, Custer, Lancaster, and counties adjoining these. In these sections the differential, two-lined, red-legged, and lesser migratory species predominated, though others were also present in fair numbers both upon the prairies and in cultivated fields. A number of the local districts thus overrun were visited by myself or some member of the entomological department of the University of Nebraska, while others could not be reached for investigation. It was found that some of these outbreaks embraced only a few farms or several hundred acres of territory, while others extended throughout entire counties. The species of locusts concerned in these also varied with the districts and the nature of surroundings and crops grown. It was noted, however, that *Melanoplus differentialis* and *M. bivittatus* were usually the chief offenders.

One of the most important of these local or detached areas of locust abundance was that in Custer County, with Broken Bow as a center. In this region the plague assumed really alarming proportions, and caused not a little uneasiness among the citizens, who earnestly sought aid from the State entomologist and all other persons who might be in a position to give expert advice.

After carefully going over all the notes which have been brought together during the various trips made while investigating this and other insect pests and those accumulated in other ways, it is found that the area now occupied by these insects in injurious numbers has become much larger during the present summer (1901) than it was a year ago. Practically all of the State west of the one hundredth meridian is embraced, while the valleys of the Niobrara, Elkhorn, North and South Loup, Platte, and Republican rivers are all more or less largely overrun for 50 to 100 or more miles eastward. In some instances this is true locally, even to the extreme eastern edge of the State.

In order to show clearly the principal species of locusts thus concerned, and their distribution over the country, the following list has been prepared:

Mermiria bivittata Serv.—McCook, Haigler, Sioux County, and in the sand hills generally on unburnt prairies.

Mermiria neomexicana Thom.—Haigler and other southwestern Nebraska localities, where it is found in company with the preceding species.

Amphitornus bicolor Thom.—A plains locust which occurs from middle Nebraska westward to the Rocky Mountains, where it is to be met with in great numbers, especially on the higher grounds among the shorter grasses.

Opeia obscura Thom.—McCook, Culbertson, Haigler, Sidney, Scotts Bluff, Crawford, and Harrison, Nebr.; Akron, Sterling, and Brush, Colo.; and Guernsey, Douglas, and Casper, Wyo.; most abundant in buffalo grass.

Alpha occipitalis Thom.—Western Nebraska and eastern portions of Colorado and Wyoming; partial to gravelly and sandy soils.

Alpha crenulata Bruner.—Southwestern Nebraska, western Kansas, and the plains of Colorado, in company with the preceding.

Philibostroma quadrimaculatum Thom.—In the same general region as the two preceding.

Ageneotettix scudderi Bruner.—This locust occurs throughout the plains region, but is most abundant among the short grasses on high grounds.

Boöpedon nubilum Say.—Observed in abnormal numbers at Haigler and Stratton, Nebr., and Wray, Colo.

Aulocara elliotti Thom.—McCook, Culbertson, Haigler, Sidney, Scotts Bluff, Sioux County, Nebr., and Guernsey, Lusk, Douglas, and Casper, Wyo. It was also present in abnormal numbers in portions of western Kansas and eastern Colorado. It is a grass-infesting insect.

Aulocara femoratum Scudd.—With the preceding species, but most abundant southward.

Camnula pellucida Scudd.—This locust was seen only in the extreme western part of Nebraska and at Casper, Wyo., where it occurred on low land about streams and in mountain meadows.

Dissosteira longipennis Thom.—A native of the high prairies of western Kansas and Nebraska and eastern Colorado and Wyoming; not nearly so abundant as it was four or five years ago.

Mestobregma kiowa Thom.—A grass-infesting locust that occurs everywhere between the Missouri River and Rocky Mountains, but chiefly on high ground.

Mestobregma pardalinum Sauss.—A grass insect found chiefly in western Nebraska, northeastern Colorado, and eastern and central Wyoming.

Schistocerca alutacea Harr.—This insect was reported to be present in large numbers at Neligh, Albion, Haigler, Ogallala, and throughout the sand hills of central Nebraska generally.

Hesperotettix pratensis Scudd.—Antelope, Holt, and Wheeler counties on the prairies, but usually on low ground, where certain species of golden-rod abound.

Hesperotettix viridis Thom.—Eastern Colorado and Wyoming and western Nebraska, where it is restricted to certain localities.

Hesperotettix speciosus Scudd.—Western Kansas and Nebraska and eastern Colorado, among different species of sunflowers.

Æoloplus turnbullii Thom.—In the same general region as the preceding, where it seems to be partial to chenopodiaceous plants.

Æoloplus regalis Dodge.—Northwest Kansas, southwest Nebraska, and eastern Colorado, on rather high grounds.

Melanoplus bowditchi Scudd.—Western Kansas and Nebraska and eastern Colorado and Wyoming on *Artemesia longifolia*.

Melanoplus flavidus Scudd.—This insect was noticed in numbers at Culbertson, Sidney, Scotts Bluff, North Platte, Ogallala, and Neligh, Nebr., and at Guernsey, Wyo. It appears to be partial to low, sandy soil.

Melanoplus packardii Scudd.—McCook, Culbertson, Haigler, Ogallala, Sidney, North Platte, Crawford, and Harrison, Nebr., Wray and Sterling, Colo., and Guernsey, Douglas, and Caspar, Wyo. The rufous form usually mentioned as *M. foedus* is by far the most numerous.

Melanoplus coccineipes Scudd.—Fairly abundant at Culbertson, Sidney, Ogallala, North Platte, and Fort Robinson, in Nebraska, where they seemed to choose the *Cleome serrulata* as a food plant, or at least upon which to perch.

Melanoplus infantilis Scudd.—On the high prairies in western Nebraska and eastern Wyoming.

Melanoplus femur-rubrum De G.—Throughout the region in cultivated districts.

Melanoplus plumbeus Dodge.—At Haigler, Nebr., on weeds and other rank vegetation.

Melanoplus lakinus Scudd.—Western Kansas and Nebraska and eastern Colorado, on Russian thistle and lamb's-quarters.

Melanoplus occidentalis Thom.—On the open prairie, west of the one hundredth meridian, in all four States in which work was done during the summer.

Melanoplus atlanis Riley.—Cultivated grounds generally, but less numerous than *M. femur-rubrum*.

Melanoplus bivittatus Say.—In nearly every locality where locust depredations were reported, and especially in cultivated districts.

Melanoplus differentialis Uhler.—Possibly the most abundant of all the species of locusts mentioned in this paper, and present in all localities except those in the extreme northwestern corner of Nebraska and central Wyoming. The chief insect in alfalfa districts.

Of these the following species seem to be confined more or less closely to special food plants, and are therefore somewhat restricted in their distribution:

Hesperotettix pratensis Scudd.—On *Solidago graminifolia* or *S. caroliniana*.

Hesperotettix viridis Thom.—On *Haplopappus spinulosus*.

Hesperotettix speciosus Scudd.—On Helianthus, several species.

Æoloplus turnbullii Thom.—On Russian thistle and lamb's-quarters.

Melanoplus bowditchi Scudd.—On *Artemesia longifolia*.

Melanoplus lakinus Scudd.—On Russian thistle and lamb's-quarters.

Those which are especially noticeable as enemies of cultivated crops are *Melanoplus differentialis*, *M. bivittatus*, *M. femur-rubrum* and *M. atlanis*, along with *M. packardii*. The remainder are chiefly grass eaters or feed upon various uncultivated plants.

WHY LOCUSTS INCREASE ABNORMALLY.

After having carefully scrutinized the notes relating to the locust problem in the region embraced in the investigations chronicled on the preceding pages, together with all other available information on the subject in general, the writer has come to the following conclusions as to why grasshoppers increase abnormally:

(1) The growing of alfalfa without regularly disking the ground each spring.

(2) The abandoning of once cultivated fields, and permitting thereon the growth of weeds and other rank herbage.

(3) The very general carelessness of allowing weeds and other rank growths to flourish along roadsides, irrigating ditches, and railway tracks.

(4) The presence in great abundance of the Russian thistle in portions of the country year after year.

(5) The non-burning of prairies over wide areas for a number of years in succession.

(6) The undue destruction of game and other insectivorous birds over wide areas.

(7) The recurrence of unusually wet years after several abnormally dry ones.

(8) The absence of insect enemies and diseases brought about by various causes, chiefly climatic.

It is but just to state here that lack of space prevents a very elaborate discussion of these various reasons for locust increase.

KILLING DESTRUCTIVE LOCUSTS WITH FUNGOUS DISEASES.

By Lawrence Bruner, *Temporary Field Agent.*

The fact that various kinds of insects are at times attacked and destroyed by different species belonging to several distinct genera of fungi has been known to both botanists and entomologists for many years. It is, however, a matter of comparatively recent discovery that some of these fungi can be artificially grown and afterwards communicated to the insects which it is desired to destroy. Numerous examples of the propagation and spread of such fungi have been recorded in this and other countries. Some noted examples of this kind are the artificial spread of *Isaria densa* Link, the fungus that attacks the European cockchafer and that has also been tried on the white grubs here in the United States; *Sporotrichum globuliferum* Spag. as used against the chinch bug and several other insects, and *Empusa muscæ*, the common fungus of the house fly. Along with what has been recorded concerning these attempts at utilizing the fungi just mentioned, it might be well here to outline some of the efforts that have been made during recent years toward fighting destructive locusts or grasshoppers by similar means. It is not necessary, however, for one to devote much time in investigation to ascertain that the whole matter relating to this subject is still in great confusion. It will at once be apparent that nothing very definite exists in the shape of reliable information concerning the particular fungi that may be present and available in each of the regions where there is need for waging war against the locust plague. Even the botanists who are interested in this group of plants seem to have done comparatively little toward isolating and separating the species, from the standpoint of the systematist.

During the early seventies, when such vast swarms of the Rocky Mountain or migratory locust were devastating the country between the Mississippi River and the Rocky Mountains, attention was frequently called to an apparent disease which occasionally made its appearance among the devouring hordes of that pest in various sections of the country. After a little investigation on the part of members of the Entomological Commission and others, this fatality among the locusts was found to be due to the presence of a fungus which is now generally recognized as *Empusa grylli*, although it has been several times described under other names.

While locusts in general are more or less frequently attacked by these fungi, particular ones among the locusts indigenous to each country seem to be more subject than others. These usually, though not always, happen to be the forms that at times become so greatly multiplied as to be pests. This fact would indicate that it is necessary for the insects to come in contact one with another in order to spread the fungus sufficiently to develop an epidemic.

These epidemics of the disease usually occur during warm, wet weather, or after such conditions of climate have been prevailing for several weeks in succession. They are also quite apt to develop among the insects living along the edges of irrigating ditches or on grounds which have been thoroughly watered, rather than on those which are comparatively high, dry, and more or less widely removed from water or rank, succulent vegetation.

Early in 1896 (March) the subject of utilizing locust-attacking fungi as a means of destroying these insects came more prominently before the public. In South Africa, where two species of these insects had been a pest for several years, it was found that a disease of a virulent nature had broken out and was prevalent in the form of an epidemic among the swarms in certian localities. An investigation instituted at the time showed this disease to be due to the presence of one of these species of fungi. Armed with the assurance that other insects had been successfully inoculated and destroyed by fungous diseases in Europe and the United States, members of the staff of the Bacteriological Institute in that country took the matter in hand and were successful in their attempts to isolate a fungus which was thought to be the one that was destroying the insects in question, a species of large migratory locust (*Acridium purpuriferum* Walk.). A brief account of the methods followed and results obtained from this work is given by Alexander Edington, the director, in his annual report for 1898 of the Colonial Bacteriological Institute, located at Grahamstown, Cape of Good Hope.

A year or so later (June, 1897), during investigations that were being made at the time in connection with the large migratory locust of the Argentine Republic (*Schistocerca paranensis* Burm.), the writer discovered what appeared to be still another and quite distinct species of these locust-destroying fungi—a Sporotrichum. This discovery was made at Carcaraña, a little town in southern Santa Fe, on the Central Argentine Railway, and some experiments conducted later during the same year demonstrated its usefulness, under certain limitations, as a means of combating that insect. The South African fungus referred to above was also tried on the same locust, but with exceedingly poor results so far as could be ascertained at the time. Still more recent attempts at destroying various kinds of our North American locusts with both of these fungous diseases (South African and Argentinian) have resulted in no marked degree of success, so far as the writer is concerned at least.

During the past two or three years other persons have been conducting similar experiments with these same, and apparently some other, locust-killing fungi. A few of these recent experiments carried on by other workers seem to have proven more successful than those just mentioned above. One in particular appeared to be very prom-

ising at the time it occurred. This was at Sterling, Colo., and was conducted by a Mr. George W. Martin, who obtained tubes of the fungus culture from the Department of Agriculture in Washington. The writer on visiting the locality found that, although the native locusts of two or three species were dying in large numbers, they all fell to the ground instead of clinging to the vegetation, as they should have done if death had resulted from the South African disease according to the account referred to above. Then, too, reports of similar fatalities among the 'hoppers, coming from localities widely removed from where the fungus in question had been distributed, seemed to indicate the presence of another and entirely distinct disease. During the present year (August, 1901,) a culture of a species of Sporotrichum has been secured from such dead insects gathered on the North Platte River and about 16 miles from Ogallala, Nebr.

In Australia it is reported that a fungus determined as *Mucor racemosus*, cultures of which were obtained from South Africa, has proved so useful in destroying the destructive locusts of Victoria that it is no longer considered an experiment, but has passed into a matter of everyday practice. Either this same Mucor or a closely allied one is also claimed to have been secured from insects which died as the result of an outbreak of a locust disease in Mississippi, as will be referred to more fully further on.

It will be seen from what has just been said that there are without doubt several distinct kinds of these locust-killing fungi, and that they are not the same the world over. The knowledge of this fact is perhaps very fortunate if we are to profit at all in our attempts to make use of them in dealing with the locust pest.

Since each species of locust differs in structure and habits more or less markedly from all others, and the climatic and other conditions by which they are surrounded in their respective habitats are so dissimilar in many instances, it must be true that a great diversity likewise exists among them as regards hardiness. Hence it is natural for us to suppose that the various fungi which are apt to attack and destroy them must also vary in these respects. That such a conclusion is warranted can be gathered from what follows.

EMPUSA GRYLLI.

Perhaps the most characteristic of these different locust-attacking fungi is the one recognized the world over as *Empusa grylli* Fres. It has been known, botanically at least, since 1856, when it was first described by G. Fresenius (Botanische Zeitung, Band XIV, p. 882, 1856). Not only does it attack the different species of destructive locusts (members of the family Acridiidæ), some of the hairy caterpillars, and a few of the crane flies along with their larvæ, but it is also frequently to be found as an enemy of various other Orthopter-

ous insects. Among these latter it has been observed especially as an enemy of some of the representatives of the two remaining families of saltatorial Orthoptera—Locustidæ and Gryllidæ.

This malady is quite readily recognized, since the host when affected by it has a tendency before death to crawl upward upon the vegetation where it chances to be at the time of infection. Here it grasps the leaf, twig, or stem closely and fastens itself so securely that it remains clinging tenaciously even after death. As stated above, all kinds of locusts and also their relatives are affected alike by it; and many of their dead bodies may frequently be seen still attached to the vegetation in late fall and early winter. Just what the pathological effect is upon the victim, which causes this tenacious grasping or clutching with the front and middle legs, may never be known. Yet, in a general sense, it may be remarked that all insects dying from the effects of any of the allied species belonging to the genus Empusa exhibit this same characteristic of climbing before death. Even such characteristically subterranean insects as the various species of Ceuthophilus, or camel crickets, when attacked by this fungus, are known to leave their customary moist, dark haunts and climb up bushes and other vegetation even to the height of several feet, where their dead bodies may occasionally be seen hanging for some time afterwards.

Whether or not the Empusæ which attack the various orthopterous insects in different portions of the earth are identical in species is not definitely known, although they are supposed to be so by some of the leading mycologists who have studied these peculiar parasitic plants. Be this as it may, minor variations in growth and structure have been noted among the forms indigenous to the different countries where collected and studied. These differences have led to the multiplying of names, so that we now have at least three distinct names, if not that many actual species.

An insect, when once attacked by this fungus, soon shows signs of unrest and ceases feeding. It shortly becomes "dumpish" and in due time attaches itself to the vegetation as stated above. The whole body, but more especially the abdomen, swells greatly and seems to be literally filled with a mushy, granular substance which, upon drying, changes to a brownish, dust-like character. A little later this dust, which is made up largely of resting spores, escapes through the breaks between the joints of the insect's body and is scattered broadcast by the winds.

Comparatively little is known concerning the life cycle of this fungus or of the methods by which infection of the host occurs from year to year. That it must be done by contact rather than through the alimentary canal is quite probable, judging from reports of experiments made by Dr. Roland Thaxter and mentioned in his Monograph of the Entomophthoreæ of the United States. The resting spores must also

be exceedingly tenacious of life, since several years may elapse between outbreaks of the disease. Still no such regular intervals of recurrence of the disease have been noted as would tend to show a periodicity. Neither does there seem to be a regular time of the year for its appearance, nor has it a preference for insects of any particular age, since those of all ages seem at one time or another to succumb to its attacks. Sometimes, though rarely, it may be noticed first in late spring or early summer; at others, and more frequently, during midsummer, and again even in late summer and early autumn, or possibly not until just before cold weather commences in late fall, when it seems to be most common.

Dr. Thaxter says: "The artificial propagation of Empusæ by the infection of fresh hosts I have found a much more difficult matter than one would suppose, even where the infected host was of the same species as that from which the spores were obtained for this purpose." (L. c., p. 152.) Not alone has Dr. Thaxter found this difficulty in securing artificial infection, but other persons have also learned the same fact fully when attempting to make use of the fungus as a means of destroying locusts. In truth, the writer has found it impossible to impart the fungus artificially to a single insect in either the laboratory or the field. It might be well, however, to state here that these experiments by the writer were purposely carried on in a very crude manner, since their object was to secure results that might also be obtained by farmers who are not equipped with carefully arranged laboratories.

If we make an exception of the matter on this subject that has been reported from the Bacteriological Institute of Grahamstown, Cape of Good Hope, it appears that up to the present time all of the experiments that have been attempted for the purpose of growing this fungus artificially in the laboratory have been very unsatisfactory. After having studied the subject carefully by reference to the available literature, and noting critically such facts as appear pertinent, and which are given below, it is the writer's opinion that the exception just suggested is justifiable.

The typical region for *Empusa gryllí* is Europe, and in that country perhaps it has been most frequently reported. But the reader should not infer from this statement that this fungus is of rare occurrence elsewhere, for such is not the case. Here in North America it is among the most abundant of fungus plants, and it is to be regularly met with each year in suitable localities throughout the length and breadth of the land. In fact, it very frequently occurs as an epidemic among the locusts in regions where various species of these insects have developed as pests. This same or a closely allied fungus was occasionally referred to by correspondents as indigenous to Argentina while the writer was in that country several years ago, and quite recently notices of its occurrence in Japan and the Philippine Islands have been seen.

By referring to the annual report of the Director of the Colonial Bacteriological Institute of the Cape of Good Hope for 1898 it will be learned that the much-advertised South African locust fungus has been determined by the working force of that institution to be an Empusa; and the name *Empusa acridii* has been suggested for it since it was reported to have attacked other species than the red locust (*Acridium purpuriferum* Walk.), one of the chief destructive species of that section. Plates I, II, and III, which are photographic reproductions accompanying that report, show these locusts as they appear upon the vegetation after death caused by the fungus. Judging from what is known concerning the actions of insects after having been attacked by different fungi, a person who is conversant with the subject would at once pronounce the malady portrayed here to be that resulting from the presence of an Empusa. To verify this conclusion in part we have the following records: Mr. Charles P. Lounsbury, government entomologist, in the Agricultural Journal of the Cape of Good Hope, February 2, 1899, says that the disease is apparently identical with *Empusa grylli*, and quotes as authority for this statement Dr. Schönland and Dr. Black, of the Bacteriological Institute of Natal. Also Dr. Munro, in his book on the Locust Plague (p. 182), quotes from a Mr. Evans as follows:

> On the 4th of this month I wrote a letter stating that a fungus had been found in a locust causing its death, and it was afterwards determined by Mr. George Murray, F. L. S., head of the botanical department of the British Museum, as *Empusa grylli*.

While the insects in question have apparently died as a result of the presence of an Empusa, an entirely different fungus appears to have been isolated from the dead locusts and afterwards grown in quantity and sent out from the laboratory to be utilized in fighting the same pests. In this report, referred to above, we find a description and illustrations of a fungus which in no wise resembles or approaches Empusa. In fact, both the descriptions and figures suggest a Mucor instead, and possibly the world-wide distributed *Mucor racemosus* Fres., which does not belong to the insect-destroying fungi at all, but to the ordinary molds. Strangely enough the tubes of the so-called South African locust fungus received by the writer, both while in Argentina during 1898 and here in Nebraska two years later, contained fine growths of what was evidently the above-named Mucor.

In glancing over the files of the Journal of the Department of Agriculture of Western Australia for July, 1901, a statement was found to the effect that "The destruction of locusts by means of a parasitic fungus (*Mucor racemosus*) has now passed from the domain of experimentation into that of everyday practice. The method which has been tried in various places where swarms of locusts proved troublesome to vegetation, notably South Africa, has been for the past two or three years successfully applied in Victoria."

The Agricultural Gazette of New South Wales (vol. 10, 1899, p. 1213) contains "A brief report of locust fungus," by D. McAlpine, in which the writer says that a fungus which has been used against locusts at Cape of Good Hope with good success has also been introduced into New South Wales and identified by him as *Mucor racemosus*.

In looking up the bibliography of the fungus called *Mucor racemosus* it was found that two quite distinct plants have received this name. One of these was described by Bulliard in Hist. Champs., France, and is said by DeCandolle to belong to the genus Botrytis as now limited. The name of this fungus would then appear as *Botrytis racemosa* (Bull.) DC.; while the other, which has been the one under consideration, should be known as *Mucor racemosus* Fres. (Beiträge zur Mykologie). The Botrytis has been found upon putrid, oily, or greasy substances in France and Germany, while, on the other hand, the Mucor occurs quite generally over the world as a common mold that attacks decaying, starchy, and other substances.

Being so generally distributed, and withal so readily grown, there is no wonder that this last mentioned should have been the fungus isolated, as heretofore stated, instead of the Empusa, which is extremely difficult to grow upon various culture media, such as are used for the artificial propagation of bacteria.

It might be mentioned also that in our experiments here at the University of Nebraska we have experienced great difficulty in isolating any particular fungus, and especially with recognized insect-attacking genera like Empusa, Botrytis, Sporotrichum, and Isaria. Almost invariably these would be accompanied by saprophytic fungi, such as Mucor, Fusarium, Alternaria, Macrosporium, Aspergillus, etc., which would very quickly crowd the others out.

If the reader will take the trouble to refer to the instructions which accompany the various tubes of this South African locust fungus when they are distributed he will find the following directions given for securing an abundant supply of the material:

> Collect a large number of grasshoppers which have died from the fungus. Dig a hole in the ground about 18 inches deep and 1 foot wide. Strew some grasshoppers over the bottom, then sprinkle some water over them. Repeat with grasshoppers and again sprinkle until the hole is full. Do not press the grasshoppers in the hole, but leave them lightly packed. Then cover with a piece of tin or board and keep the hole thus carefully covered for four or five days. If warm weather, four days will be sufficient, but if colder a longer time will be required. At the end of this time remove the grasshoppers and spread them out in the sun for an hour or two, or until thoroughly dry. Now grind them into a meal. Of this meal, which may be kept dry for a long time until wanted, take two tablespoonfuls and add it to a large tumblerful of water, into which some sugar has been placed. Leave this in a warm place for twelve to forty-eight hours, and then treat live grasshoppers by dipping, etc., just as one does when using the fungus when supplied in tubes.

If such a proceeding as that just described does not result in the growth of a variety of common molds, *Mucor racemosus* among them,

nothing will do so. Even had the insects which were collected and buried been killed by poison, boiling water, heat, or in some other violent manner, and treated in a similar way, the result would in all probability have been quite similar. But when these insects die from disease and drop to the ground in a variety of localities, and later are gathered together, there is no telling how many different kinds of saprophytic fungi may have come in contact with and adhered to them. Even Empusa-killed insects, attached to vegetation a considerable distance from the ground, would themselves become infested, and under favorable conditions support a great variety of these molds.

In our experiments with the fungus mentioned in this paper as *Mucor racemosus* we have found that such locusts as have been dipped or sprinkled with sugar-water cultures of it are killed; but when turned loose in the field there is no apparent spreading of the fungus to other 'hoppers. Neither did we have any success in destroying them when the inoculation was attempted by feeding the fungus to the insects along with bread crumbs, etc., that had been used for culture media. It is surmised that by thus dipping the insects into the liquid containing the fungus some of the mycelial threads and spores of the latter enter the stomata, as well as the sutures between the rings of the abdomen and thorax, and start to grow, and in a short time use up the fluids and vital tissues of the body sufficiently to cause death.

Since none of the other fungous diseases of locusts, aside from that caused by *Empusa grylli*, seem to have received much attention heretofore, it has been thought best to devote some space to their discussion here. Especially does this seem warranted because of the numerous references made to them in these pages.

SPOROTRICHUM sp.

The first of these other locust-attacking fungi that deserves mention was discovered by the writer in 1897 while investigating the destructive locust problem of Argentina, South America. In the month of June, when the insect then under investigation was hibernating, or, more correctly speaking, resting, and confined chiefly to the more northern districts of that country, it was thought best to occupy the time in gathering data of various sorts. It was on one of the field excursions which were regularly made at intervals, as this work was progressing, that dead fungus-covered nymphs of the destructive locust were discovered securely tucked away in dense bunches of a species of grass common to a large portion of the open country. These dead *saltonas* (as the nymphs of these insects are called in that country) had evidently been destroyed by the fungus in large numbers during the previous year. Still, so securely were they tucked away in these clumps of grass that fully eight months later they not only remained nearly perfect in form, but also retained their colors sufficiently to make their identity certain.

Having had some previous experience with an insect-destroying fungus of a similar appearance in the destruction of quite a different insect in the United States, a preliminary examination of these fungous-covered locusts at once suggested a Sporotrichum. But in order to obtain a verification of this surmise, or to learn definitely the nature of the find, specimens of the dead fungus-covered insects were submitted to Prof. C. E. Bessey, of the University of Nebraska, who reported that the identification was correct. Although the genus to which this South American locust-killing fungus belongs has been definitely settled, various unavoidable circumstances have thus far prevented its specific identification.

Locusts that have been attacked by this South American fungus, instead of climbing to the top of various plants so as to get as much air and light as possible, creep away from the light and seek dark, moist places in which to die. Consequently they are most often found hidden away near the roots of bunch grasses, in the midst of dense, juicy foliage. Here, after death, their bodies become entirely filled with mycelial threads and spores of the fungus. In many cases, under certain conditions, the fungus growth also appears upon the outside and almost completely covers the dead body of the insect.

Some breeding-cage experiments attempted later in the year indicated that the fungus could be quite readily transmitted from these dead fungus-covered saltonas to live, healthy locusts of the same species. While out in the open "camp," the invading swarms soon began dying in rather large numbers in the vicinity where the fungus had first been discovered. On gathering the dead bodies of these latter and pulverizing them, and afterwards strewing this powder upon others along with their food, the result was that they too were found to sicken and die.

The action of this fungus upon the host is similar to that of *Sporotrichum globuliferum* on the chinch bug. At first the victim becomes restless, ceases feeding, and begins to wander aimlessly about, and, shortly before death, it seeks a secluded spot in some dark nook upon or near the ground. Quite frequently, after a passing flight of an infected swarm, the ground was found to be strewn with the dead bodies of such insects as had succumbed to the disease. These soon turned bright pink in color, and where they failed to reach a sufficiently moist and shady place shortly became quite hard and leathery in texture instead of rotting and breaking into fragments, as is customary with dead insects of this class. Also at the "roosting places" of such swarms many of these pinkish-colored locusts were found upon the ground, having succumbed and dropped during the night. Some of these latter, although winged, have been known later to exhibit the characteristics of those shown in the illustration already referred to.

During the period in which this fungus was epidemic among the

locusts in the southern portion of Santa Fe, and while under the observation of the writer, only four distinct species of locusts were found that had died as the result of its attack. These were the large migratory species of Argentina and the neighboring countries, *Schistocerca paranensis* Burm., *Zoniopoda tarsata* Serv., *Diponthus communis* Brun., and *Dichroplus elongatus* Giglio-Tos. It might be of interest, however, to know that each of these, aside from the *paranensis*, becomes locally destructive at times. This fungus, like Empusa, flourishes best during warm, humid weather.

Having obtained such satisfactory results in transmitting this disease to other locusts while conducting experiments in Argentina, a quantity of dead fungus-covered insects, like those described above, were gathered and brought back to the United States for use in attempting to destroy our North American species. Accordingly, in July and August, 1898, large numbers of several of our most common Melanopli were gathered and placed in breeding cages along with a goodly supply of green food and the bodies of the dead fungus-covered insects. The powdered bodies of such dead locusts were also strewn over the food and moistened earth at the bottom of the cages. In addition to these, similar experiments were attempted in fields where our native locusts were exceedingly numerous, but in all cases these experiments failed to show a single instance of the possible transmission of the fungus to our native species.

More recent attempts at obtaining an artificial growth of this South American locust-killing fungus on various media in the laboratory have likewise proved utter failures, the reason for this being, no doubt, the great age of the material at hand.

Notwithstanding the failures in the experiments just recorded, this, in the opinion of the writer, is one of the most promising locust-attacking fungi, since it was found to withstand considerable variation in climate and to attack at least four widely different insects. Then, too, its close relationship with the so-called chinch-bug fungus (*Sporotrichum globuliferum*) gives us some reason for encouragement in the future.

On July 17, 1900, a letter was received from Mr. George W. Martin, Sterling, Colo., who had undertaken some experiments with the South African locust fungus, a supply of which was furnished him from Washington. This letter reads as follows:

DEAR SIR: I have succeeded in killing a large number of grasshoppers on 60 acres of alfalfa, covering the ground with them for one-fourth mile. The disease is still spreading and is now 500 yards from where the infected ones were placed. I do not see why it will not kill all of them. I use corn meal, 2 parts sugar, 1 part, for dose, feeding at 4 p. m., again 6 p. m., putting them out at 7. I drive over the fields to be infected. The fungus seems to be better a week old than earlier.

Yours, truly,

GEORGE W. MARTIN.

A visit to the locality, as already stated, revealed the fact that although several species of native locusts were dying in large numbers, yet, contrary to the rule with insects that had been attacked by Empusa, these Colorado hoppers all fell to the ground instead of remaining fastened to the vegetation. About the same time, and also somewhat later in the season, other reports were received of similar epidemics occurring among the grasshoppers in localities where no infection of any kind had been distributed. This year again other reports of similar epidemics occurring among these insects were received here at the University of Nebraska. One of these was so remarkable in nature that a representative of the experiment station visited the locality to make an investigation. He was also requested to secure specimens of the dead and dying insects so as to ascertain, if possible, the cause of the epidemic. Other material was received at the station from correspondents, and from both of these lots of dead insects there was obtained, among other things (as Spirillum and Bacterium), a Sporotrichum, the specific identification of which was not ascertained at the time, as the botanists were then all away on their summer vacations. Since their return school duties have prevented their giving the necessary time to the matter, hence we can only suggest that this may be a second species of the genus which attacks locusts.

While most of these local outbreaks among our native locusts occur in moist localities, such as irrigated fields and bottom lands, the one near Ogallala, Nebr., was in a field which irrigation did not reach, and came at a time when little or no rain had fallen for several weeks. The species of locusts found generally among the dead were *Melanoplus differentialis*, *M. bivittatus*, *M. atlanis*, *M. femur-rubrum*, *M. packardii*, *Spharagemon collare*, *Brachystola magna*, and *Dissosteira carolina;* these were numerous in the order named; a very encouraging record when we take into consideration the differences in the habits and structure of these insects. All the occurrences of this last-named disease were in fields of alfalfa.

The isolation of this fungus came so late in the year, and at a time when other matters were so pressing, that further work with it was, for the time being, impracticable. It is impossible, therefore, to predict its probable future value as an artificial factor in the control of the locust pest in the region where it was found.

The *Sporotrichum globuliferum* is reported as having been successfully used against the different species of destructive locust in Algeria during 1899, but whether the identification of the fungus concerned is reliable is not known.

CONCLUSIONS.

After having spent considerable time in experimenting under various conditions and in different regions, as well as in the study of the researches carried on by others, it is the opinion of the writer that

fungous diseases as a means of killing off insect pests is greatly overestimated. Especially is this true with reference to their use against destructive locusts. The chief objections are the difficulties with which pure cultures are obtained and later transmitted to the insects to be destroyed, and the frequent adverse influence of climatic conditions.

Much of this false notion as to the absolute effectiveness of inoculation as a cure-all, which has gained a firm lodgement in the minds of so many people throughout the land, is, no doubt, due to the careless way in which agricultural and other newspapers of the country make definite statements on incomplete information. Then, too, very frequently contributors to such papers write concerning matters they know little or nothing about. This sort of business on the part of the press certainly places the economic entomologist in a peculiar position since it creates a misunderstanding between him and the people in whose interest he is supposed to labor.

Were the writer required to give his opinion as to which of these different fungi seems the most promising, he would, without hesitation, say, "The native one." He would say this, because the importation of these locust-killing fungi from one country into another depends greatly on the similarity which exists in the climatic conditions of the countries concerned, in the relationship of hosts to be considered, and in the ease with which the fungi can be handled in the laboratory. Between the Empusæ and Sporotricha the latter seem the more preferable, because they are more readily handled artificially, growing, as they do, quite readily on different culture media.

THE CONFLICT OF THE RUSSIAN ZYEMSTVOS[a] WITH THE ENEMIES OF AGRICULTURE.[b]

By V. Morachevski.

[Abstract by Dr. Peter Fireman.]

Not the measures employed by the individual farmer in his fight against the animals and insects injurious to agriculture are described in the present article, but those adopted by the local self-government organs in Russia.

Grasshoppers (Acridiidæ).

(*a*) *Pachytylus migratorius.* It is at present accepted as proved that the islands of some rivers (Ural, Volga, Kuma, Kuban, Terek, Manich, Egorlik, Don, Dnieper, Danube, and Sarpa) serve as nurseries for this insect. Such islands furnish an enormous store of food for grasshop-

[a] Zyemstvo—A governmental body in Russian provinces and local districts, elected by the people. It consists in each case of a council and an executive board.

[b] (Syelskoye Khozyaistvo e Lyesovodstvo (Agriculture and Forestry), vol. 193, 1899, April, pp. 183–208; vol. 194, 1899, August, pp. 193–226, September, pp. 445–454.)

pers, sufficient in the great majority of cases to maintain them from the time of their hatching to their death. Moreover, on these islands they are safe from their natural enemies. Therefore, the investigators of the grasshoppers, as well as some of the zyemstvos, have arrived at the conclusion that radical measures for preventing the calamities caused by the incursions of these insects must be directed not so much toward the destruction of the insects as toward the conversion of these islands into cultivated lands.

In the appearance of the grasshoppers in enormous numbers some periodicity has long been observed.

In the Taurida government some of the zyemstvos took up the combat against the grasshoppers in 1877. The rules which are at present obligatory in the contest in the whole province were elaborated by the provincial zyemstvo and confirmed by the Minister of the Interior. The work is paid for according to a scale fixed by the district zyemstvos. For the performance of the work all persons of the lower classes are required to present themselves (peasants, workingmen, and the like, not excluding the women and children above 10 years of age). Each relay of workmen can be held not longer than three days. The council of the district zyemstvo elects special organizers for stated sections of the district, whose duty it is to watch the appearance of the grasshoppers in the district, to study the extent of the area infested with the eggs of the grasshoppers, to keep the district as well as the provincial zyemstvo informed about their observations in this regard, and to personally participate and superintend the work of destroying the insects. In 1896 there were 17 such organizers in the Simpheropol district, with a compensation of 3 rubles per day during the time of fighting the grasshoppers.

The Bessarabia government began the contest in 1876 and stopped it in 1887, since when the grasshoppers have not appeared.

In the Kherson government the provincial zyemstvo conducts the fight against these insects as well as against others, and sussliks (*Spermophilus citillus*), covering the expense by collecting a tax of one-half cent per dyessyatina (2.7 acres).

In the Voronyezh government the provincial zyemstvo in 1882, in view of the fact that the grasshoppers deposited their eggs in the autumn over an extended area, especially in the Novo-Khopyor district, petitioned the Imperial Government to defray the expenses of fighting the grasshoppers from the general funds of the Empire, to appropriate for this purpose 1,000,000 rubles, and to impose a natural tax. Meanwhile the Novo-Khopyor district zyemstvo was directed to urge the land owners to plow up those places where the eggs were deposited. The Minister of the Interior, however, refused to grant to the provincial zyemstvo the subsidy of the Imperial Government, but agreed to loan that sum to the zyemstvo. In 1883 the grasshoppers made

their appearance in the spring. They were combated very energetically, with the cooperation of the police, local population, and six battalions of soldiers. At an expense of 52,000 rubles the zyemstvo destroyed completely the grasshoppers in the province.

In the Oryol government all the work directed to the destruction of the grasshoppers is divided between the provincial zyemstvo and the district zyemstvos, the duty of the former being the ascertainment of the places infested with the eggs of the insects, the instruction of the population in the methods of combating them, and a general supervision over the carrying out of all the operations, while the duty of the distric zyemstvos is the immediate execution of those operations.

The Tambov government in 1893 petitioned the imperial administration to consider the destroying of the grasshoppers as a duty of the whole nation. The minister of the interior replied that similar petitions were received repeatedly from zyemstvos, but were invariably declined by the minister of the interior, with the concurrence of the ministry of finance, on the ground that, according to the existing laws, measures for the destruction of the injurious insects are incumbent upon the zyemstvos. The executive board of the provincial zyemstvo then organized the fight against the grasshoppers, a fund of 100,000 rubles being appropriated by the zyemstvo. The wages were fixed as follows: To a workingman with a horse, 12½ cents a day; to one without a horse, 5 cents a day; for 36 pounds of grasshoppers collected, 12½ cents.

The zyemstvos of the Ekaterinoslav, Chernigov, Kursk, Ryazan, Samara, and Penza governments had also to fight grasshoppers, which they did more or less successfully.

(*b*) *Caloptenus italicus* (Italian grasshopper).—This insect appears in some places in enormous quantities. In three districts of the Saratov government the peasants destroyed in one season 36,000 poods (1 pood = 36 pounds); on one estate alone during five weeks 15,000 poods were collected; in the Bobrov district 40,000 poods were destroyed.

In 1897 the following regulations were adopted by the Bessarabia government, with the approval of the imperial administration: A natural tax and a money tax are fixed. The natural tax is imposed on persons belonging to the lower classes (peasants, workingmen, etc.), not excluding women and children; all these persons must do the work of destroying the Italian grasshoppers, without compensation, within a radius of 7 versts (1 verst = ⅔ mile); if called to more remote places they receive a certain compensation fixed by the provincial zyemstvo; each relay of workingmen can not be held longer than three days. The money tax is imposed upon all the landowners who are not subject to the natural tax. The money so collected goes to cover the expenses incurred in fighting the grasshoppers, in payment to the

owners for their crops destroyed, in payment of the workers who came from places farther than 7 versts, etc. For the crops destroyed while fighting the insects the owners are reimbursed to the amount of the value of the seeds, the cost of cultivation, and the rent for the land.

In the Orgueyeev district, over an area of 2,000,000 acres, the fight against the Italian grasshoppers in 1897 required more than 26,000 adult workers, 20,000 boys, and over 2,000 wagons.

In the Kherson government the Odessa district zyemstvo spent in fighting the Italian grasshoppers in 1895, 4,000 rubles; in 1896, 20,000 rubles (paying to the workingmen 25 cents per day, young lads 12½ cents, to children 6¼ cents, and for man and wagon 50 cents, and 12½ cents, besides, for each pood of grasshoppers killed and collected); and in 1897, 9,500 rubles.

In the Taurida government the Dnieper district zyemstvo reports that the fighting of the grasshoppers pursued by it at a great outlay of money during three years is quite successful, as witnessed, among other things, by the considerable falling off of the expenses: The expenditures in 1894 were 37,000 rubles; in 1895, 9,000 rubles; and in 1896, only 2,760 rubles.

The Kursk, Ryazan, Voronezh, and Saratov governments fight the Italian grasshoppers by similar methods.

(*c*) *Gomphocerus sibiricus*, *Stenobothrus elegans*, *Stenobothrus melanopterus*, *Psophus stridulus*, *Bryodema tuberculata*, *Stauronotus cruciatus* or *Stethophyma flaricosta*, *Stethophyma fuscum*, and *Pezotettix pedestris*.—These do much damage, chiefly in the east of European Russia, in the Ural region, and in western Siberia.

The zyemstvos of the Ufa, Vyatka, Perm, Nizhni Novgorod, and Kostroma governments conduct the fight against these insects on lines similar to those described with regard to the grasshoppers.

MEANS OF COMBATTING THE GRASSHOPPERS.

(1) Shallow replowing or harrowing in the autumn of those places which are infested with the eggs of the grasshoppers, etc., is one of the best and most effective measures. By shallow plowing, 2 to 2½ inches deep, the eggs are turned out to the surface of the ground and perish, partly from atmospheric conditions and partly from birds.

(2) Burning up by means of straw is practiced with great success to the destruction of the larvæ of the grasshoppers. The straw is usually piled up in the field in a few places; the larvæ gather to these piles toward evening in large numbers in search of drier places; the straw is then ignited simultaneously from all sides. In extreme cases, when it is too late to drive out the insects from among the crops, the crops themselves are burned up. For cereals thus destroyed the owners

receive from the zyemstvos an indemnity, which is usually somewhat less than the real value of the burned crop.

(3) The larvæ are sometimes destroyed by crushing with shovels, rolls, bundles of brushwood, etc. The brushwood drags give the best results. The laborers surround a certain section and drive the insects toward the center. When the circle becomes small a few brushwood drags are drawn along the circumference of the circle, describing circles of smaller and smaller diameter each time.

(4) The driving of the larvæ into ditches and destroying them there by crushing or burning is not effective in the case of adult insects or too young larvæ (the latter remaining immovable when the attempt is made to frighten them up by brooms, etc.). Protective ditches used for preventing the insects from passing over into the unattacked fields must be deep and well guarded to be effective.

(5) Collecting by means of bags, sheets, etc., is also much practiced. Certain trap bags have been invented and are very effective.

(6) Some apparently successful experiments were also made in destroying the insects by infecting them with the fungus *Empusa grylli*.

OTHER INJURIOUS INSECTS.

The zyemstvos have so far confined themselves principally to the combating of the sussliks and of the grasshoppers (including in the latter a number of allied insects), not taking up at all the contest against other insects equally injurious to agriculture, or taking it up only now and then, without regularity or system, in years of very great ravages.

(*a*) *Agrotis segetum* and *Agrotis exclamationis* are the most dangerous and most common enemies of the winter cereals. Their caterpillars are usually called (in Russia) the winter worms. Against these insects a fight is conducted only by the zyemstvos of some northeastern governments—Kostroma, Perm, Kazan, and others. Only the provincial zyemstvo of the Kostroma government has imposed a natural tax. In this government peasants have to appear with plows, brooms, and shovels for two days; within a radius of 7 versts they get no remuneration, but beyond that distance a certain daily wage.

(*b*) *Anisoplia austriaca* (grain beetle).—The Imperial Government proposed in 1879 to all the southern zyemstvos to hold an extraordinary meeting in order to discuss the question of the grain beetle. All the zyemstvos (viz, of the Kherson, Poltava, Bessarabia, Taurida, and Kharkov governments, and also the Don zyemstvo) gave their opinions in favor of the mechanical methods of fighting the beetle, and petitioned the Imperial Government to prohibit the use of ropes and to declare the measures obligatory for all the southern governments. The Imperial Government granted the petition, making the following tax, as a temporary measure, obligatory for the enumerated govern-

ments during a period of two years: Persons of the lower classes must appear for three days' work without compensation at a distance of 7 versts and with compensation at a greater distance, not exceeding 20 versts; upon persons of the higher classes, on the other hand, a money tax is levied, the amount of the imposition per dyessyatina (2.7 acres) depending on the value of the work performed by the persons of the lower classes. The use of the rope was prohibited by the same law. After the lapse of two years the law was not renewed, each government conducting the contest according to its discretion. The Taurida and Ekaterinoslav governments leave the fight of the weevil to the population, and allow the use of the rope. The Kharkov government has imposed a tax of 1 garnts (2.88 quarts) of weevils from each dyessyatina (2.7 acres) under rye, wheat, and barley; for each garnts not presented a fine of 12½ cents is imposed.

The means of fighting the weevil employed by the zyemstvos are almost all mechanical: (a) Collecting the weevil with the hands or with specially designed machines, and (b) frightening off the weevils by means of a rope.

(*c*) *Cecidomyia destructor* Say.—The only measure enforced by the zyemstvos in fighting the Hessian fly consists in not allowing the early sowing of winter crops.

THE TOBACCO STALK WEEVIL.

(*Trichobaris mucorea* Lec.)

By F. H. Chittenden.

In a consideration of the potato stalk weevil, *Trichobaris trinotata* Say., which was treated somewhat in detail in Bulletin No. 33, new series (pp. 9–18), it was remarked in defining the food habits of this species that tobacco and tomato appeared to be exempt from its ravages, although nearly all other Solanaceæ growing within its range were attacked. Before the bulletin in question had appeared in print we received a communication from Mr. Lawson H. Shelfer, tobacco expert of the Bureau of Soils, and located at Willis, Tex., that a related species of weevil was greatly injuring tobacco in that section. Our correspondent first wrote in regard to this species, transmitting adults, and in the following months sent much material and many valuable notes on the habits of this insect and the nature of its ravages. The remarks which follow, on the insect's life history and habits, are based mainly upon Mr. Shelfer's letters and the material received from him.

The larva of this species also, as might be expected from its close relationship to the potato stalk weevil, inhabits the stalk of tobacco and also the main ribs of leaves, sometimes completely severing them or injuring them so badly that the winds which blow almost constantly in that region break them off and thus greatly weaken the plant.

This weevil first appeared, according to the testimony of residents of that vicinity, in 1898, and has become more numerous each year. At the date of first writing, May 20, from 2 to 6 beetles were found on single plants, frequently in pairs. It was concluded, as a result of conversation with many local growers, that the tobacco crop had been attacked even earlier than the specified date, but the cause was not definitely known.

May 28 some tobacco plants showing infestation were sent to this office. It was discovered a few days before this time that nearly every plant in a four-acre field was affected. In some neighboring fields it was impossible to find a stalk that did not contain one or more larvæ, but all fields were not so badly affected.

The larva is locally known as "pith worm," from its habit of boring through the length of plants.

The beetles were also stated to be doing great damage to tobacco.

June 12, Mr. Shelfer stated that the beetles were still cutting the leaves and depositing eggs. Owing to the fact that twenty-six days had elapsed at that time since rain had fallen and many nights were without dew, the tobacco crop suffered much, and more especially when this insect was at work in the stalks. During the last week of June and first of July we received considerable material from our correspondent, the insect being present in the three stages of larva, pupa, and adult at this time. In some stalks the pupal cell was constructed 4 inches from the root system, while in others on a level with the surface of the ground. It is evident that in tobacco this insect works in a different manner from that which it employs in other plants which it may infest, the reason being the very woody condition of the lower portions of the stalks. It is evident also that the larvæ, after attaining maturity or thereabouts, turn and bore upward for the construction of their transformation cells. The lowest individuals will mature first, and those which form their cells higher will mature much later. As a consequence there will be intervals of a week or more between the time of their transformation. Thus it happens that the older individuals must wait for the younger ones to make their exit, since there is hardly space for the former to pass the latter. Some of the insects penetrate to the very tops of the stalks.

Jamestown weed, which we have record of this insect attacking, was a comparative rarity in that section of Texas, and no other solanaceous plants could be found growing wild within half a mile of the infested fields. At other points (Liberty and Woodville, Tex.) this weed was found, but no weevils, this verifying an opinion hazarded by the writer that the insect was local as well as periodical as regards injuries.

Mr. J. A. Blohm, of Willis, verified Mr. Shelfer's account as to injuries of this stalk weevil, his experience practically duplicating that of our correspondent in most essential particulars.

Attack was at first attributed to improper farming.

September 5, 1902, Mr. Shelfer called at this office and furnished the writer with some additional information on the insect's occurrence and life history. Tobacco was first set out April 8, and the beetles were observed at work the following day, as a rule in pairs, attacking the leaves, which soon after attack began to droop. After the midribs had been eaten for some time the leaves curled over, and under this protection the beetles congregated for feeding. The beetles, as well as larvæ, were still in the field the first week in September.

DESCRIPTIVE.

The tobacco-destroying species of weevil, *Trichobaris mucorea* Lec. may be readily separated from the potato species, *T. trinotata* Say, by its much larger size. The former will average one-fourth of an inch or a little longer (5–6^{mm}), while the latter does not exceed three-sixteenths of an inch, averaging about one-sixth inch or a little smaller (3–4.5^{mm}). The tobacco species is, moreover, a little more robust and of more uniform size, and is distinguished, according to Casey, "by its rather depressed upper surface and the subdentate area at the sides of the prothorax beneath." Also by the "pronotum densely and confluently punctate, sometimes longitudinally rugose, the sides more or less feebly sinuate just behind apical third; antennal club more slender and elongate, less abrupt, the outer funicular joints more transverse; pronotum with a narrow impunctate median carina."

In *T. trinotata* the pronotum is simply punctate and without an impunctate and subcarinate median line, as in *mucorea*, and the antennal club is robust and abrupt. In a large series of specimens, such as the writer has at the present writing, it is seen that there is also a difference in color. All of the specimens of *trinotata* are darker, the pubescence being darker gray than in *mucorea*. There is no observable difference in specimens collected in the field and those taken from the stalks of eggplant the first week of September. In hibernated individuals of *mucorea* the scales are very pale, nearly white, while in those which have recently issued from stalks they are dull, somewhat yellowish brown.[a] In all specimens of *mucorea* there is an apical line of yellowish pubescence on the thorax, forming a collar above the head. This collar is scarcely at all indicated in *trinotata*, and the color of the scales here are of the same uniform gray as of the entire upper surface.

INJURY IN FLORIDA BY A RELATED SPECIES.

July 14, 1902, Mr. William M. Corry, Quincy, Fla., wrote, in response to inquiry, that at various times in previous years—though not in

[a] This difference in coloration has been noted in another species of scale-covered weevil, *Ceutorhynchus rapæ* Say, Bul. 23, n. s., p. 43.

1902—he had observed affected stalks in fields of tobacco there, and when the leaves were broken off it was found that a hole was in the center, caused by a small insect known there as "the borer." The insect seemed to start at the root and make its way gradually up in the heart of the stalk, its presence being indicated by the leaves dropping and the stalk gradually withering and turning yellow.

There can be no reasonable doubt that the species in question is *Trichobaris insolita* Casey, a species rather commonly found in that portion of Florida.

DISTRIBUTION.

In defining the distribution of the potato stalk weevil it has been said that that species was rather generally distributed throughout the Carolinian and Austroriparian regions, and that it was found westward to Texas. Such a statement has previously been made by Casey and probably others, and it may be that the insect really inhabits Texas, but in a series of 34 specimens at present available Texas-labeled individuals are not in evidence.

Trichobaris mucorea is represented in the national collection and others at present under observation by upwards of 50 individuals, from which the following locality list is taken: Columbus and Willis, Tex.; Los Angeles, Kern County, and elsewhere in California (no definite locality); Tucson, Galiuro Mountains, San Rita Mountains, Catal Springs, and Oracle, Ariz. LeConte records the species from Cape San Lucas, Lower California, and there is little doubt that it occurs elsewhere in Mexico. The type specimen was found near Fort Yuma, Cal. (Proc. Acad. Nat. Sciences, Phila., 1858, p. 59.)

METHODS OF CONTROL.

In spite of the close relationship of this species to the potato stalk weevil, it is very evident that we have an entirely different problem to solve. The similarity of the insects is structural. The habits are materially different; for whereas the potato weevil has a definite time of appearance and disappearance, from April to May, and again the following year at the same time, we see no more of the insects until after they have laid their eggs and the larvæ have transformed to pupæ and thence to adults in the stalks. Here they remain during the winter. The tobacco weevil, on the contrary, evidently escapes from the stalks after the tobacco leaves have been cut, and hibernates in other places.

Paris green, Mr. Shelfer has observed, applied as a spray by means of a knapsack outfit, will kill the beetles, and he is of the opinion, in which the writer concurs, that if an arsenical is used at intervals during the season at the proper time, beginning with the time that plants are set out, the insect may be kept under control.

The following suggestions for another season are made:

After the leaves are cut the stalks should be destroyed as promptly as possible, and the entire fields should be cleaned of refuse; and this applies also to barns and other places where the tobacco is stored. If this be done systematically over the entire affected area it will leave very few insects to combat the following year.

The first appearing insects could be attracted and successfully dealt with, there is no doubt, by setting early plants as traps here and there over the area to be grown in tobacco. Their growth could be stimulated, and they could be protected from insects and the weather until ready for use, by covering them with square frames covered with cheese cloth or similar material. A few days before planting the main crop the covers should be removed and the plants thoroughly coated with a spray of some arsenical.

Before setting out the main crop the plants should be dipped in a solution of arsenate of lead, prepared at the rate of 1 pound of poison to 100 gallons of water. This would not scorch the plants, and it would be preferable to Paris green, as it remains longer, requiring more rain to wash it off. In a week or ten days, according to the growth of the plant, a second spraying should be made, and for this purpose either arsenate of lead or Paris green and Bordeaux mixture can be used.

It is suggested by way of experiment that one plat of, say, 25 or more plants be sprayed with arsenate of lead; a second with Paris green, 1 pound to 150 gallons of water; a third with Paris green at the same rate, with the addition of Bordeaux mixture used instead of lime as a diluent; and the fourth, with Bordeaux mixture alone. It is not known to what extent Bordeaux mixture would prove repellent to this weevil (possibly not greatly), but if sufficiently distasteful it would drive the insects from the plants treated with it to others which should be poisoned with Paris green alone.

THE LEAF-MINING LOCUST BEETLE, WITH NOTES ON RELATED SPECIES.

By F. H. Chittenden.

The foliage of the common, yellow or black locust tree (*Robinia pseudacacia*) is subject to the attack of a leaf-beetle, sometimes called in literature the locust Hispa (*Odontota dorsalis* Thunb.) and which we may call the leaf-mining locust beetle to distinguish it from several other forms of insects, mostly the larvæ of Tineidæ, which also mine the leaves of this tree, and from other beetles which attack the trunk and other portions of the tree. Injury by the species under discussion is due mainly to the work of the larvæ, although the beetles also assist.

Damage usually becomes manifest some time in July in the more northern States, and southward earlier, in June. In cases of severe attack the leaves turn brown as if scorched by fire. Injurious attack is not often brought to the notice of economic entomologists, which is rather remarkable considering that the locust is of great value as a timber tree, for posts, etc., though of less importance as a shade tree than elm, oak, maple, and others with which everyone is familiar. Thus it happens that although year after year this insect has done much harm to the locust, where this tree is of value, comparatively little has been published concerning the insect's ravages, its life history and habits.

Like many other insect pests, it is subject to considerable fluctuation in numbers, in some years being quite destructive while in others it attracts little notice. It is nearly always more or less troublesome to the locusts in Maryland, Virginia, and the District of Columbia, and in recent years has been reported as more or less destructive in neighboring States. Injury has been reported in West Virginia from 1890 to 1897, in New York and New Jersey in 1896, in Maryland from 1896 to 1899, in Ohio and Kentucky in 1897, in Pennsylvania and Kentucky in 1898. These reports probably do not by any means sum up the entire area infested during the past ten years. In 1898 this beetle did more than usual damage over a considerable portion of this territory.

In most seasons this beetle does little more harm to the locust than to mar its beauty as a shade tree, but in years of its greatest abundance it is probable that trees are so badly weakened by the combined ravages of this and other leaf-miners that the result is practically the same as that of defoliation and the trees are so weakened that they readily succumb to disease, to unfavorable atmospheric conditions, and to the destructive work of different species of borers, such as the painted locust borer (*Cyllene robiniæ* Forst.), which is of still more importance as an enemy of this tree.

In the vicinity of the District of Columbia the damage effected by this leaf-miner is frequently as bad as reported elsewhere, and we have observed locust groves where the injury was almost entirely due to the work of the beetle, while in others the Tineid leaf-miners were more numerous. As a rule, however, this locust beetle is more abundant about Washington than all of the leaf-mining Tineidæ, as well as other locust pests, taken together, and its importance in economic entomology is deserving of a more detailed consideration than has hitherto been given to the public.

Injury is usually most severe to young trees and to such as have low, vigorous branches, and to others growing on the edges of sunny lawns and in similar locations. There are, however, some striking exceptions. In many localities such plants suffer greatly year after year. Taller trees, on the contrary, are much less subject to injury.

In speaking of damage effected by this leaf-miner, Chambers (Amer. Ent., Vol. III, p. 61) says:

The young trees seem to suffer most, as the insect seems to prefer their foliage; and large old trees seldom exhibit the burnt appearance of the young groves. Young shoots growing up around an old trunk will sometimes have nearly all of their leaves blistered, while few, comparatively, on the old tree will be injured.

DESCRIPTIVE.

Few species among our native Coleoptera exhibit more striking coloration than *Odontota dorsalis*,[a] so that with the accompanying illustration (fig. 3, *a*) and description even an inexperienced observer can not fail to recognize it.

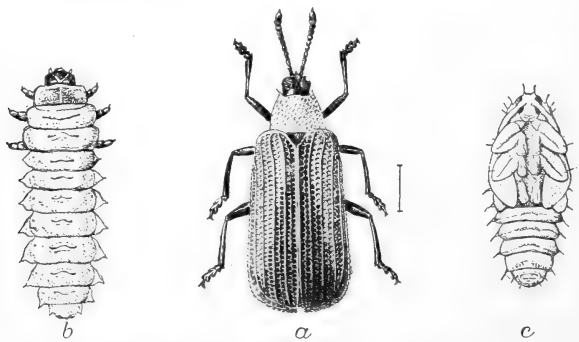


FIG. 3.—*Odontota dorsalis*: *a*, beetle; *b*, larva; *c*, pupa—5 times natura size (original).

The beetle.—It is elongate in form, moderately convex, only moderately shining, the color of the dorsal or upper side being bright orange red with the head and a vitta or stripe along the suture of the elytra or wing cases black. The ventral or under side, including the legs, is also black. The black sutural vitta occupies usually about one-third of the width of the elytra and widens behind, but sometimes it is much narrower and of equal width and still more rarely widest at the base. The structural characters which, besides the coloration, distinguish *O. dorsalis* from other species of the same genus are as follows: Form rather slender, not cuneiform; elytra of equal width, each having ten series of punctures and three of the interstices forming elevated costæ.

It measures a little less than a fourth of an inch in length (5–5.5 mm.) and is less than half that in width (2.2–2.4 mm.) at its widest part.

The egg is short, oval in outline and flattened on two sides, its color when freshly

[a] As this species has been given other names than the one here used, a word should be added in regard to nomenclature. The specific name *dorsalis* was proposed first by Thunberg in 1805 (Götting Gel. Ang., p. 282); in 1808 Olivier redescribed it as *Chrysomela scutellaris* (Ent. Hist. Nat., Coleop. Vol. VI, p. 771), and Harris also described the species as new, using the name *Hispa suturalis*, which was first introduced by the Rev. F. V. Melsheimer in his Catalogue of the Coleoptera of Pennsylvania, published in 1806 (p. 15, no. 308), and seems to be based on an erroneous identification of our species with the *Hispa suturalis* of Fabricius.

laid being milk white, with the shell extremely thin and pliable. A very fine net-like sculpture is barely visible even under a strong magnifying glass.

The larva.—The more obvious characters by which the full-grown larva (fig. 3, *b*) may be distinguished are as follows:

Body depressed (but not flattened), elongate, very little tapering posteriorly, glabrous, color yellowish white, the head, larger portions of first thoracic segment, upper side of anal segment, and the legs brownish or blackish. Head subquadrate, about half as wide as the first thoracic segment, brown, shining, impunctate, with a deeply impressed median line. First thoracic segment more than twice as wide as long, a little longer than the head, distinctly bisinuate at the anterior margin, sides strongly rounded; a large brown spot divided by a narrow median line occupies the greater portion of the upper surface, but does not reach the posterior and side margins. Second thoracic segment a little shorter, but wider than the first, sides very strongly arched but not gibbous, surface uniformly whitish; third thoracic segment equal to the second. First abdominal segment a little shorter than the last thoracic one and also a little narrower, but produced on each side into a triangular, semitransparent tubercle, capped with a more horny point which in its turn terminates in a short spine. Second, third, and fourth abdominal segments equal to the first; on the following segments (which are slightly longer than the first) the lateral tubercle is directed gradually more backward, the anal segment is unarmed, shorter and much narrower than the preceding, subtruncate at tip, its upper side being of a brown color.

The general color of the dorsal surface is not uniform, but variegated by the transparency of the skin as the fat corpuscles of the body appear on the surface as yellowish-white spots, the rest of the body being grayish white. The sculpture of the dorsal surface (excepting head and anal segments, which are smooth) consists of a very regular fine granulation and besides this of vague impressions arranged as follows: On the first thoracic segment an undulating impression each side on the disk; on the two following thoracic segments a long transverse median impression accompanied each side posteriorly by a foveiform impression; on the abdominal segments a transverse median impression and another oblique one each side, causing the spiracles to be placed upon a kind of blunt tubercle.

The ventral surface is colored like the dorsal and only the head and median portion of the first thoracic segment is brown, and the general sculpture is like that of the upper side, legs being brownish or blackish, stout, and widely separated.

There are nine pairs of rather conspicuous stigmata, all visible from above and situated as follows: One pair at the anterior angle of the second thoracic segment, one pair on each of the first seven abdominal segments, each stigma being at the base of the lateral tubercle a little before the middle of the segment; the ninth pair is situated on the dorsal side of the anal segment. The thoracic and anal stigmata are larger than the intermediate ones.[a]

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[a] It is interesting to observe that most leaf-mining larvæ of different families or even of different orders of insects exhibit a strong uniformity in general appearance, viz, a more or less depressed body, the head being much narrower than the first thoracic joint, while all joints of the body (excepting head and anal joint) are strongly arched at the sides and often tuberculate or even spinose. Thus the larvæ of our leaf-mining Buprestidæ (genera Brachys and Trachyscelus) and Rhynchophora (genus Orchestes) have an unmistakable resemblance to our Hispine larvæ, and all of these agree in shape with the numerous Tineid leaf-miners.

There can be no mistake about the number and position of the stigmata, and the account given by Chapuis & Candeze appears to be based upon a wrong interpretation of Harris's figures, entirely ignoring the correct description of that author.

The young larvæ differ from the mature ones by being more contracted, thus appearing more strongly tuberculate at the sides. Moreover, very young larvæ are entirely whitish.

The pupa (fig. 3, *c*) is at first whitish, but soon assumes a uniform rich honey color. In general shape it resembles the full-grown larva, only a little shorter and somewhat more convex. The head has become more convex and especially wider in comparison with the first thoracic segment; the second and third thoracic segments have of course changed the appearance of the wing pads, which are longitudinally striate and bent downward along the sides of the body, resting between the second and third pairs of legs and reaching with their extremities to the posterior end of the first ventral segment. The abdomen still shows the lateral tubercles so conspicuous in the larva and these tubercles are furnished each with two or three stiff bristles. The edges of the median transverse impressions on the dorsal surface of the abdominal joints of the larva are in the pupa much sharper, ridge-like, and also furnished with sparse bristles. The fourth abdominal spiracle is replaced by a long stout spine directed backward. On the ventral surface the armature of spines is even more conspicuous than on the dorsal, each segment having a sharply raised transverse line which is sinuate and more raised at the middle and there furnished with five or six setiferous tubercles. On the penultimate segment the transverse line is not sinuated and is furnished with eight tubercles, the two median ones being much less prominent than the lateral ones. The anal segment is also furnished with two obsolete transverse lines and with a few inconspicuous tubercles.

This array of bristles and tubercles enables the pupa to move rapidly forward or backward by a wriggling motion of the abdomen. The power of locomotion exhibited in this pupa is really astonishing; in fact, the pupa is much better afoot, so to speak, than the larva.[a]

The mine produced by the larva has not hitherto been described so that it may be distinguished from the mines produced by the various leaf-mining Tineidæ which are usually working in company with it. As already stated, the beetle larva consumes the whole of the parenchyma within its mine, thus causing the mine to be equally visible on both sides of the leaf, whereas in the case of the Tineidæ the larva destroys only a thin layer of the upper portion of the parenchyma, causing the mine to be invisible on the underside of the leaf. The Tineid larva very neatly separates the epidermis from the parenchyma so that not a particle of this last is left adhering to the skin-like epidermis forming the roof of the mine, and this roof is of a uniform pale buff color strongly contrasting with the green of the leaf. On the other hand, the larvæ of the beetle accomplish their work much less carefully; numerous small particles of the parenchyma are left adhering to the epidermis, and consequently the latter forms a much thicker covering to the mine than in the case of the Tineidæ. The color of the mine is a pale green slightly tinged with brown, its surface

[a] The power of locomotion in the pupa becomes still more remarkable if we take into consideration that the pupa, which always remains within the mine, has really no occasion or opportunity to make use of it, unless we except the possibility that by wriggling about in their mines the pupæ might succeed in evading parasitic or predaceous attack.

being lightly roughened and never so smooth as in the Lepidopterous mines. In outline the beetle-larva mine is neither uniformly rounded nor provided with finger-like processes, but irregularly undulated. As soon as the larva has left the mine or has changed to pupa, the affected part of the leaf dries up and assumes the dismal brown color already alluded to.

GEOGRAPHICAL DISTRIBUTION.

This species is native to North America, and apparently partial to the upper austral life zone, but its full distribution does not appear to have been clearly defined beyond published statements that it occurs in New England and the Middle, Southern, and Western States. Northward, we know of its occurrence in Massachusetts, Connecticut, and Canada, but it does not appear to have ever been taken in Michigan, a State which has been rather thoroughly collected over by Messrs. Schwarz and Hubbard. In Missouri, although numerous collectors and observers have made collections in that State, the species appears to be rare, although taken in two localities. It will thus be seen that although the southern and western range is practically limited by the States of Virginia, Kentucky, and Missouri southward, and by Missouri also westward, the precise limits of its range remain to be determined.

In his Check List of the Forest Trees of the United States (Bul. 17, Div. Forestry, U. S. Department Agr., 1898, p. 82) Mr. George B. Sudworth speaks as follows regarding the distribution of *Robinia pseudacacia:*

Range.—From Pennsylvania (on the Appalachian Mountains from Locust Ridge in Marion County) to northern Georgia. Widely naturalized through cultivation and other agencies throughout the United States east of the Rocky Mountains; possibly indigenous in parts of Arkansas (Crowleys Ridge, etc.) and eastern Indian Territory; also in the Great Smoky Mountains of eastern Tennessee (Sevier County).

From the entomological record it would seem, therefore, at least at the present writing, that this locust hispid has a more limited range of distribution than its food plant, which is not infrequently noticed among insects and which occurs also in another species of Hispidæ, viz, the trumpet-creeper leaf-miner, *Octotoma plicatula*, which will be considered later on in the present article.

The following is a list of localities from which the species has been received at this office or is known to the writer or recorded:

Massachusetts; Connecticut; Allegheny, York, Pa.; Coney Island, Rockaway Beach, Yaphank, L. I., N. Y.; New Jersey (throughout the State—Smith); Tennallytown, Washington, D. C.; Oakland, Bladensburg, Glen Echo, Cabin John, Marshall Hall, Md.; Cherrydale, Rosslyn, Va.; Monongalia, Wood, Hancock, Harrison, Upshur, Tyler, Preston, and Tucker counties, Morgantown, Kanawha, Clarksburg, W. Va.; southern Ohio, particularly Brown, Clermont, and Hamilton counties; Nazareth, Frankfort, Ky.; Cadet, Louisiana, Mo.; Indianapolis, Ind. (Blatchley).

INJURIOUS OCCURRENCES IN 1898.

Frequent inquiry has been made concerning this species and the injury committed by it, but it will be sufficient for present purposes merely to recount the occurrences of the year 1898 as an example of what is liable to happen any year.

May 10 beetles were observed in a raspberry patch at Tennallytown, D. C., feeding upon the upper surface of the leaves. July 1 we received a communication from Sister Marie, Nazareth, Ky., about injury to locust in that locality. July 22 Maj. Henry E. Alvord, of this Department, transmitted specimens of locust leaves from Fairfax County, Va., with accompanying statement that all locust trees over an area of several square miles in that county were at that time apparently dead, looking as if a fire had swept through the country, but without actually consuming the foliage. Major Alvord was interested to the extent of 300 acres, carrying a very large locust growth of considerable value. On this tract not a tree could be found, either old or young, protected or exposed, that was not in bad condition. The cause of the affection of the plants was not at first attributed to insects, but believed to have developed as a result of a recent period of exceptional dryness and heat, a remark which applies to much injury to locust that is caused by this leaf-miner. Ravages were so extensive, also, that it was practically out of the question to attempt any general remedy or means of prevention. August 1 we received from Mr. J. E. Herbert, York, Pa., specimens of leaves showing injury by this species and attributed to blight or rust. Injury was stated to be general along the Susquehanna River, in York County, where every locust tree seemed to be affected.

HISTORY AND LITERATURE OF THE SPECIES.

The natural history of the leaf-mining locust beetle was first made public in an article "Upon the Economy of Some American Species of Hispa," by Dr. Harris, printed in 1835 (Boston Journ. Nat. Hist., Vol. I, pp. 141–151), an account which, until comparatively recent years, constituted the only source of information regarding the early stages of the Hispini. It is noticeable that neither Harris nor subsequent authors of early times mentioned this species as particularly troublesome, the first instance of observed injury having been published in 1868 in an editorial answer to a correspondent of the American Entomologist (Vol. I, p. 58). The injury in question was at Frankfort, Ky., and it was stated that the beetles had eaten the leaves of black locust in that section so severely as to kill the trees in some cases, and generally to injure their growth and appearance. It was pointed out in the editorial reply that the principal damage was doubtless due to the insidious work of the larvæ in the pulpy internal sub-

stance of the leaf, rather than to the feeding of the beetles on the leaves.

The nature of the damage effected by this insect is well illustrated in an article which appeared in Volume III of the American Entomologist (pp. 59–61) by V. T. Chambers. Injury by this species is stated to have been rather general in northern Kentucky. "By the 1st of August the groves look as if a fire had swept over them: and on examining the leaves in many groves almost every leaflet will be found to contain a 'mine,' as the burrow of the larva is technically called, and many of them will contain three or four, while the imago or mature insect of *Hispa suturalis* will be found in great numbers feeding externally on the leaves."

About half of the injury was attributed to the leaf-mining locust beetle, the remainder to other species of leaf-miners.

The bibliography of this species has been brought together up to 1896 in Dr. Lintner's Twelfth Report on the Insects of the State of New York for that year (pp. 264, 265), and the subject need not be entered into here in detail. It should be mentioned, however, that the ravages of this species had assumed sufficient proportions in West Virginia to call for special investigations on the part of Dr. A. D. Hopkins, these studies having been begun in 1890, the results being published in a short article in Bulletin No. 16 (p. 87). In the Canadian Entomologist for 1896 (p. 248) the same writer mentions the destructiveness of this species in West Virginia, adding some new food plants, and in Bulletin No. 9, n. s. (p. 20), the junior author called attention for the first time to the fact that this species fed also upon herbaceous plants, and that the larvæ develop in the leaves of soy bean. Other accounts, which appeared with and since the year 1896, contain little more than mention by State entomologists of ravages made by this insect in their respective States, all of which have been briefly brought together in the introductory chapter on this species. Exceptions are Dr. Lintner's article previously cited and a column article by Prof. E. D. Sanderson on page 672 of American Gardening for September 30, 1899.

FOOD PLANTS.

This species forms a rather interesting example of an insect with a well-known favorite food plant, which will also feed, even in times when this plant is available, on numerous other forms of vegetation, both related and otherwise.

The prime, and no doubt the original, food of the larva and beetle is, of course, common locust (*Robinia pseudacacia*), but there is no doubt that larvæ could develop equally well in the leaves of other species of the same genus, and perhaps of most other trees of the same family. On the grounds of the Department of Agriculture at Washington the

insect has been found in about equal abundance on various cultivated varieties of this locust, and the larva has also been observed in the leaves of false indigo (*Amorpha fruticosa*). Beetles are not infrequently met with upon various other trees, and more especially oak, but the larva has not been found until recently on any other plants than the two above specified. In the year 1880 this species was stated by Dr. John H. Warder (American Ent., Vol. III, p. 151) to be devouring the foliage of Siberian crab apples, and rendering it quite shabby, other forms of apple of the immediate vicinity escaping attack. The *Crataegus tomentosa* and some quinces appeared eroded in the same manner, and, although the insect was not seen, the injury was probably due to this species. The same correspondent mentions the young leaves of red oak (*Quercus rubra*) and European white oak (*Q. pedunculata*) as having been attacked, while nine or ten other species of oak observed escaped injury. It seems probable that the larva does not develop in oak, or in other plants outside the order to which the locust belongs, the Leguminosæ. The leaves of *Ulmus americana*, or white elm, were also stated by Dr. Warder to have been eaten.[a] The beetles have been observed by Dr. Hopkins (Bul. 32, W. Va. Agric. Ex. Sta., 1893, p. 202) attacking beech, apple, wild cherry, and Wistaria leaves; as also birch and hawthorn (Can. Ent., Vol. XXVIII, p. 248). During the summer of 1897 the writer observed this species feeding upon the foliage of red clover, which grew under locust trees upon which the larvæ had originally fed, on the leaves of hog peanut (*Falcata comosa*) growing under locust trees, while larvæ were found and reared on the large hairy leaves of soy beans on the grounds of this Department about 200 yards from where locust trees were growing (Bul. 9, n. s., Div. Entom., pp. 22, 23).

LIFE HISTORY AND HABITS.

The beetle.—In the vicinity of Washington the beetle makes its first appearance as soon as the leaves of the locust tree have fully developed, usually about the beginning of May, and is then to be seen without interruption throughout the summer, until the first half of September,[b] being quite abundant from the first week of July to near the middle of August. During 1902 the beetles of the first new generation began to develop July 7 and had transformed for the most part by the 12th of that month.

The beetle is usually seen, apparently motionless, upon the surface of the leaves, but upon close inspection it will be found busily engaged

[a] Owing to the confusion in the scientific nomenclature of our locust Hispid, these other records are not quite reliable, and may refer either to *Odontota rubra* or to *O. nervosa*, as these species are now known.

[b] Dr. Hopkins has recorded the occurrence of *O. dorsalis* in West Virginia as late as October 3, but does not state if the beetles were feeding at this time.

in feeding. Early in the season, when the leaves are still tender, the beetle eats small oblong holes in the leaves, but later in the season it usually leaves the lower half intact and the upper portion finely skeletonized. At any rate, the damage done by the beetles, even when they are very numerous, is trifling when compared with that inflicted by the larva. The beetle is a slow walker and apparently dislikes to move about without cogent reason, but if disturbed it takes wing rapidly and is capable of sustained flight for long distances. During rainy weather, at night time, and during the act of oviposition the beetle is to be met with on the underside of the leaves.

Hibernation.—There can be no doubt that the perfect beetle alone hibernates. It seeks winter quarters rather early in the season, some time in September. During mild winter days a specimen may occasionally be found under accumulated leaves at or near the base of locust trees, but even for an experienced entomologist it is not an easy task to find them in their sheltered retreats.

Mode of oviposition.—Dr. Harris's description of the eggs of Hispini (Treatise, etc., Flint ed., p. 120) does not apply to this locust beetle, and appears to have been made from dried cabinet specimens. The fact is that in our species the eggs are not laid on the upper side of the leaf but always on the underside, and, further, that they are not laid singly but in masses, each composed of from three to five eggs, which are glued together by a sticky substance and partially covered with an excrementitious secretion. We succeeded in July in partially observing the act of oviposition, which may be described as follows: One egg was already deposited, representing a somewhat flattened, short, oval object of yellowish-pink color fastened to the leaf by its flat side. The female beetle was quietly resting with the forepart of her body much erected and the last abdominal joints covering the egg, while the tip of the elytra touched the surface of the leaf beyond the egg. After a while the tip of the abdomen was bent toward the egg and a yellowish-pink semifluid matter was excreted; then an egg appeared at the genital opening, but was several times retracted and again protruded, when finally, with a sudden effort, the beetle moved its abdomen a little backward and deposited the egg so that with its end it rested upon the leaf and with its greater portion over the first egg. Then the beetle rested for about two minutes, when the same process was repeated. The act of oviposition itself takes only a fraction of a second. When the last egg has been laid the beetle makes a sudden movement forward, sweeping with the tip of the abdomen the upper side of the egg mass and discharging at the same time a large quantity of fluid fecal matter of dirty-yellow color, which soon hardens and darkens.

From this mode of oviposition the form of an egg mass can be readily understood. Since the second and the following eggs each overlap the preceding egg, but at the same time touch with one end the surface

of the leaf, it is evident that each egg is placed somewhat more vertically than the preceding one. But as there are never more than five eggs in a single egg mass, the last of these is still placed obliquely, and the egg mass when viewed from the side slopes very gradually in the direction toward the first egg while it ends more abruptly at the last one. Owing to the glutinous and excremental coverings the individual eggs can not be distinguished from above, but on the sides and from beneath, where the glutinous covering is very thin or absent, they may be plainly distinguished. The glutinous substance appears to possess some caustic properties, for the place of an egg mass can always be seen on the upper side of the leaf as a small brown spot. It hardens very rapidly, and becomes so tough and firmly adherent to the eggs that these can not be taken out from a mass without destroying them.

The duration of the egg state appears to be very variable, most of those which were gathered (in July) when apparently quite freshly laid hatching in from six to eight days, while others of the same batch hatched nearly a week later, but in every instance all the eggs of one egg mass hatch nearly at the same time, or at least within the space of a few hours, the first-laid egg usually hatching first.

The larva and its work.—The young larvæ invariably break through the egg shell on the underside of the egg mass and at once begin to gnaw through the epidermis of the leaf without leaving the protecting egg mass. Then they proceed to eat out the inside of the leaf, leaving only the epidermis of both sides of the leaf intact, thus forming what in scientific terminology is known as a tentiform mine. There is only one entrance to the mine, that made by the first-hatched larva, the other larvæ entering the inside of the leaf by the same hole. Thus from three to five young larvæ are usually found within the same mine, which rapidly grows through their united efforts. In fact, within a few hours four young larvæ had hollowed out about one-fourth of a large leaf, and it is evident that a single leaf is not sufficient to nourish the larvæ during their life duration. Moreover, the larvæ have the habit of hollowing out not more than one-half or at most two-thirds of a leaf. Thus in from two to four days after hatching (the time varying according to the state of the weather, the number of the larvæ, and the size of the leaf) the larvæ leave their original mine, wander off along the leaf stems, often to a considerable distance and to another twig, and form new mines, but this time each larva lives by itself. There are never two separate mines on one and the same leaf, and only once were two nearly full-grown larvæ found in the same mine. In captivity this process of migration was repeated as often as the leaves began to wilt, but we did not succeed in ascertaining the number of these changes in nature, owing to the difficulty in following the individual larvæ in their migrations, which appear to take place at night. This much has been ascertained, that at least

some larvæ change their habitation three times, but whether all larvæ have the same habit, or whether they change oftener than three times, is uncertain. However that may be, it will be seen that the damage inflicted by the larvæ is greatly increased by these migrations, for every leaf attacked is doomed to destruction.

The duration of the larva state appears to be quite variable. In captivity no larva was actually carried through from the time of hatching to pupation, but from observations in the field it is pretty clear that this period, even in the height of the season, is never less than two weeks, and probably lasts on the average three weeks, being somewhat longer in the beginning of the season than in midsummer.

The pupa.—The pupa state is assumed within the mine and lasts from six and a half to ten days, after which the perfect beetle breaks its way through the brittle epidermis of the leaf.

At 11 a. m. of August 5 a larva taken from its mine was found to have transformed to pupa within two or three minutes, the change having taken place while it was being taken from one room to another and returned. August 12 the imago was found fully colored early in the morning, the pupal period having been passed in about six and a half days. Temperature, 75°–80° F.

The number of generations annually.—This is a point in the natural history of the insect which has not hitherto been clearly made out. Dr. Harris (Ins. Inj. to Veg., Flint ed., p. 121) is evidently in favor of a single generation, and we have no doubt that this will hold true for the more northern States; perhaps elsewhere. In the latitude of Washington the insect, as has been stated, appears in May, one month earlier than in Massachusetts, and is then to be found in all stages throughout the summer, until the beginning of August, when egg laying ceases. It is therefore evident that individuals produced from eggs deposited early in the season developed to the mature insect early enough to produce a second generation in the same manner, but no second generation has as yet been segregated.

NATURAL ENEMIES.

Of nonparasitic enemies we have observed at Washington the wheel bug (*Prionidus cristatus*), which appears to be particularly attracted by the presence of the Odontota.[a] The young larvæ of the wheel bug may frequently be observed slowly walking over the leaves until they have found a mine inhabited by the Odontota. This found, the wheel bug deliberately pierces with its beak the Odontota larva through the

[a] The abundance of the wheel bug on the Agricultural grounds on the trees infested by the Odontota is in striking contrast to its comparative scarcity on the elm trees infested with the imported elm leaf-beetle (*Galerucella luteola*) and which are in close proximity to the locust trees.

epidermis of the leaf. Should a beetle be met by the wheel bug it is at once lifted in the air on the tip of the bug's proboscis.

In its earlier stages the leaf-mining locust beetle appears to be well protected from the attacks of true parasites, the eggs being inclosed in an armor-like covering, and the pupa remaining out of sight in the snug retreat of the mine, but still we have reared in a single season no less than four different species of parasites, and Dr. Harris mentions and describes still another species (*Ichneumon hispæ*) which has thus far remained unknown to us. These four species of parasites are as follows:

Trichogramma odontotæ How.—Was reared quite commonly from the egg masses of this beetle. In cases of parasitism all the eggs of an egg mass were generally parasitized, and only in a few instances were two or three parasitized eggs found where the rest produced larvæ. The fly emerges usually from the underside of the egg and gnaws its way through the leaf. Dr. Howard described this and the other three species which will be mentioned below, in Volume I of Entomologica Americana (pp. 117–118).

Derostenus primus How.—A few specimens of this chalcis fly were obtained from the egg masses of the Odontota. The breeding of one of these species from the peculiar pupæ of a Eulophus would seem to indicate that it may in all cases be a secondary parasite, and that the specimens bred from the egg of the Odontota may have fed in the larva state upon the larvæ or pupæ of *Trichogramma odontotæ*.

Sympiezus uroplatæ How.—Upon opening the mines we observed in a few instances a whitish hymenopterous larva feeding externally on the Odontota larva and having already devoured the posterior half of its body. The host larva was of course dead when thus found. Whether or not this parasite in its earlier stage lives within the Odontota larva has not been ascertained. It appears to be very rare, and of the three specimens observed only one was raised to the perfect insect. It formed a naked black pupa within the mine.

Spilochalcis odontotæ How.—This parasite was observed emerging from the Odontota pupa, and no doubt lives as larva within that of the Odontota. The parasitized pupæ can be distinguished from the healthy ones by being darker and rigid. Upon opening such pupæ the parasite larva, apparently full-grown, was found to occupy the empty cavity, but the specimens thus disturbed died without changing to pupa. Only one winged parasite was obtained from a pupa which was left undisturbed in the mine.

The *Ichneumon hispæ* described by Harris was obtained by him from the pupa of *Odontota quadrata* (=*rosea*) and *O. scutellaris* (=*dorsalis*). It may belong to the Braconidæ. Harris's description was published in 1835 (Boston Journ. Nat. Hist., Vol. I, p. 150).

REMEDIES.

From what has been said in regard to the feeding habits of the leaf-mining locust beetle it is obvious that whatever of a remedial nature is employed must be directed toward the beetles, since the larvæ are completely hidden in their mines in the leaves during their short lifetime, and the eggs and pupæ are similarly protected from contact poisons. The beetles can be killed by means of the arsenicals

administered in the form of a spray[a] in the same manner as for the imported elm leaf-beetle.

The leaves of locusts are so smooth that they are apt to shed an ordinary spray of Paris green, but this can be obviated by the addition of glucose or molasses to the spraying mixture, or by the more adhesive arsenate of lead. It should be unnecessary to state that the proper time to spray is upon the first appearance of the beetles in May or June, according to the localities infested, that the beetles may be destroyed before egg-laying commences.

Small groves can be protected by jarring the beetles from the trees into sheets prepared for the purpose and saturated with kerosene in the same manner as in use against the plum curculio and other beetles which drop to the ground and feign death when disturbed. The best time for this remedy is in the early morning, while the beetles are still somewhat sluggish. This method could only be employed with benefit before the beetles have oviposited, and with the coöperation of neighbors who possess similar trees, or in localities where the locust trees are isolated, not surrounded by others growing wild. This manner of collecting the beetles, to be effective, would have to be practiced every few days so long as the beetles continue to be attracted to the trees.

Where only a few trees in yards or lawns are to be protected, even more simple mechanical methods could be employed, such as jarring the beetles into inverted umbrellas and picking off the egg masses before these hatch. The egg masses are not difficult of detection and are sufficiently conspicuous by reason of their size and color to be easily seen by looking for them from beneath the branches toward the light.

In connection with any remedy that might be employed, clean culture must always be practiced, which includes the destruction of all volunteer locust growth in the immediate vicinity of trees planted for shade and ornament, and the prompt raking up and destruction of the locust leaves and other débris about the trees in the early autumn.

The protection of extensive woody tracts in which locust predominates is practically out of the question.

THE LEAF-MINING LINDEN BEETLE.

(*Odontota rubra* Web.)

This is also one of the species observed by Harris. He states that he discovered the larvæ in 1827 and afterwards feeding upon a

[a] Instructions for the application of the arsenical poisons against the latter species are given on pages 3 and 4 of Circular No. 8 of this Division, as also on pages 10–12 of Farmers' Bulletin No. 99, and as both of these publications can readily be obtained by application to this Department, no further instructions need be given here.

parenchyma of a leaf of white oak. A description of the larva is given, with biologic notes (l. c.). Since that time this species (fig. 4) has been found to attack numerous other plants, and the writer has already expressed the opinion that the foliage of linden, or basswood (*Tilia americana*), is the favorite food tree. Larvæ and adults, the former mining the leaves and the latter feeding on the lower surface of the same, can be found in abundance at Ithaca and elsewhere in New York during the month of June, the imago occurring as late as September (Proc. Ent. Soc., Wash., Vol. II, pp. 266, 267).

Among other food plants are English filbert and orange, the imago having been found occasionally attacking the leaves of the last mentioned plant in Florida by the late H. G. Hubbard. It is more particularly, however, as an enemy to apple that this species has received mention by Harris (Ins. Inj. to Veg., 1863 ed., pp. 120, 121). Chokecherry (*Prunus virginiana*) is also recorded as the food plant by Harris, as also the shadbush or service berry (*Amelanchier canadensis*).

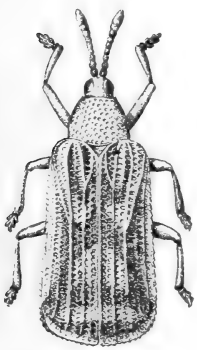

FIG. 4.—*Odontota rubra:* beetle, about seven times enlarged (original).

It has been called the rosy Hispa, from one of the Latin names (*Hispa rosea* Web.).

According to published statements the beetle makes its appearance during the latter part of May, and soon afterwards deposits its eggs on the leaves of the trees which form its larval food plants. The eggs are described as small, round, and of a blackish color, fastened to the surface of the leaf either singly or in groups of four or five.

In most respects the life history of this insect appears to resemble very closely that of the leaf-mining locust beetle. Fortunately it seldom occurs in abundance and has not often been reported, to the writer's knowledge, as having been the source of any considerable trouble. The experience of Mr. W. L. Devereaux at Clyde, N. Y., cited in the Fifth Report of the United States Entomological Commission (p. 480), that this insect is a very conspicuous pest in that vicinity, "destroying the entire foliage of every basswood in many forests except trees of great height," appears to be unique.

Concerning this species Mr. William Beutenmuller writes in 1890 that it "mines the leaves of apple and linden." The perfect insect may also be found on white birch, hornbean, cherry, Juneberry (Amelanchier), and *Pyrus arbutifolia* (Entom. Amer., Vol. VI, p. 178).

ODONTOTA NERVOSA *Panz.*

This common little species, which has also received rather frequent mention under its two synonyms, *inæqualis* Web. and *rosea* Web., is

mentioned by Chambers (Canadian Ent., Vol. IV, 1872, p. 125) as mining the leaves of *Eupatorium ageratoides*, one of the bonesets.[a] During the season of 1890 it was stated by Dr. Hopkins (Bul. 16 W. Va. Agric. Ex. Sta., p. 88) to be "found quite plentifully with the locust Hispa feeding upon the surface of the leaf [of locust]," while in Bulletin No. 32 of the same station (p. 202), the same writer states that this species is "very common on yellow locust leaves; also feeds on apple leaves," recording capture of the adults from April 30 to July 16 in Monongalia, Wood, Hancock, and Jackson counties. During 1902 the writer also observed it on locust in Maryland, and reared the beetles from mines in the leaves. There is also a Divisional record of the rearing of this leaf-beetle on a species of aster in the District of Columbia, July 29. September 1, 1899, Mr. Th. Pergande reared it also from *Cassia nictitans*.

A pale variety or race was found by Messrs. Hubbard & Schwarz feeding in great abundance on the leaves of *Robinia neomexicana* in the Santa Rita Mountains of southern Arizona during the months of May and June, but no trace of either eggs or larvæ could be seen on this plant.

Odontota bicolor *Ol.*

This species is not rare in the District of Columbia and vicinity, but the writer has frequently sought for its mines on various wild plants without success. It remained for Mr. Th. Pergande to ascertain its true habits. The larva mines the leaves of grasses, Mr. Pergande having found it in the leaves of *Panicum macrocarpon* from June 18 to 26, 1899, at Cabin John Bridge, Md. The first beetle issued July 1. The beetles have been collected by the writer in greatest number during the second and third weeks of June.

Odontota horni *Sm.*

Mr. H. W. Wenzel has found this species on *Cracca* [*Tephrosia*] *virginiana*, a papilionaceous plant commonly known as goat's-rue, at Da Costa, Atlantic County, N. J. (Ent. News, Vol. V, p. 41). It has been found also near Washington, D. C., on the same plant.

Odontota notata *Ol.*

This species was also taken by Mr. Wenzel on *Tephrosia virginiana* with *O. horni* previously mentioned.

It is common near Washington, D. C., in Virginia, and the peninsula of Florida in localities where Tephrosia is absent. Mr. Schwarz thinks that the food plant will prove to be a species of Solidago.

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[a] Mr. Beuttenmüller (Ent. Am. VI, 1890, p. 178) states that he reared this species from Eupatorium and asters.

Odontota californica *Horn.*

The larval food plant of this species, *Ceanothus integerrimus*, has been placed on record in Volume V of Insect Life (p. 269) from rearings made by Mr. Coquillett while agent for this office in California. He found it mining the leaves of this plant, and reared the adult in September.

A Chalcidid was also reared from the larvæ of this species.

Odontota scapularis *Ol.*

Nothing appears to be recorded of the food habits of this species further than it was captured on a species of hazel (Corylus) in Kansas (E. A. Popenoe, Trans. Kan. Acad. Science, Vol. V, 1877, p. 36). The beetle has also been taken on Solidago in and about the District of Columbia, but the larvæ have apparently not yet been identified.

Microrhopala vittata *Fab.*

This is one of the common species which are to be found northward, and was observed by Harris in 1833 on the leaves of *Solidago "lævigata" = semperrirens* or seaside golden-rod. The account in question includes a description and figure of the larva, as also the mature beetle. What were presumed to be the eggs were also described.

The larva, which has been observed on other species of Solidago, including *lanceolata* and *canadensis*, forms blister-like mines in the leaves much like those of other species of the same group. This insect appears to be most abundant upon plants growing near the seashore and along the river banks, and is quite abundant along the coast of Massachusetts, Long Island, and New Jersey. It is common, but not nearly so abundant along the Potomac River and its branches in and near the city of Washington.

The eggs have been found near the tips of the leaves on the lower surface. They were covered with a brown substance evidently excremental, and mixed with the hairs of the leaf.

A female was noticed which had just deposited two eggs, May 13, at Rosslyn, Va. She was at this time quietly resting, head downward with the tip of her abdomen just touching the eggs.

This species has also been found parasitized by a Chalcidid.

Microrhopala xerene *Newm.*

This attractive little species occurs in considerable abundance in the vicinity of the District of Columbia and has been given some study by the author. It appears to have a somewhat greater diversity of food habits than the innoxious species which have been previously con-

sidered, this being especially true of the larva which has been found mining the leaves of several genera of Compositæ, although different species of golden-rod appear to constitute its principal food. The plants upon which the larvæ have been observed to make their mines and from which the beetles have been reared include: *Solidago canadensis, cæsia, juncea*, et al.; *Boltonia asteroides; Sericocarpus asteroides*, or toothed white-topped aster, and several species of the true aster, or starwort. So far as observed, this species has confined its attacks to wild plants, but as the Boltonia mentioned and many asters are cultivated it will probably be found to attack some of these in time.

The beetles eat out little elliptical holes in the leaves of their food plants after the manner of the commoner *M. vittata*. Frequently three or four beetles have been observed crowded closely together upon a single leaf of golden-rod. In such cases they sometimes nearly strip the leaf attacked. What is true of the beetle is equally true of the larvæ. Unlike the locust-mining species, as many as four larvæ can develop in a single large leaf. June 24, four pupæ of normal size were found together in a leaf of *Solidago cæsia*, the mine occupying about three-fourths of the apical end of the leaf.

It would be a difficult matter to describe the mines accurately, as these are so variable and, as previously stated, sometimes occupy a very considerable portion of a leaf. The mine, at the point where the pupal cell is formed, puffs up so as to form a hard blister, more or less rounded oval in shape, usually a little over an eighth of an inch wide, which sometimes becomes as thick through, its dimensions being dependent upon the number of individuals which inhabit it.

The eggs, as might readily be inferred from the smaller size of this beetle, are not so large as those of other species which have been described. They are very closely appressed to the surface of the leaf on which they are deposited and are covered with dark, nearly black, excrement, sometimes all the eggs of a group which are placed closely together being covered with a common coating. The eggs are usually deposited on the lower side of a leaf, but in one instance a batch of five eggs were found on the upper surface. Most frequently they are placed near the edge, sometimes midway between the tip and the base of a leaf, but generally above the middle.

The larvæ possess the same power as do those of the locust-inhabiting species of passing from one leaf to another, and larvæ in confinement have been seen in the daytime crawling out of a leaf and re-entering in a fresh place. Larvæ have been noticed to forsake their mines when the leaves were not in a condition that was entirely to their liking. Such desertion of mines was observed on one occasion, June 16, all of the larvæ transforming to pupæ, and, in due time, to adults, the first imago appearing June 24.

The pupal condition was observed in three individuals during the last week of June, in hot weather, and lasted four and a half, five, and five and a half days, respectively. From finding several pupal cells as early as June 10, it was evident that the first of the new brood, or generation, of beetles begins to appear at least as early as that date.

The larvæ and pupæ resemble in a general way those of the preceding species and no detailed descriptions have been made. The larva when full grown measures from 6 to 6.5^{mm} and the pupa about 5.5^{mm}. It was noticed that the pupæ moved by elevating the abdominal segments and bringing forward the last segment, thus giving a forward impetus. The pupæ moved slowly, however, at the rate of about 1.5^{mm} at each step (if this expression can be used to describe the motion) which is as fast or faster than the pace of the larvæ. Pupæ were noticed to make as many as twenty consecutive movements.

No less than four distinct parasites have been reared from this leaf-miner about the District of Columbia. All are Chalcididæ, and the list is as follows:

Eurytoma albitarsis Ashm., from mines in Solidago.

Closterocerus tricinctus Ashm., from a mine in *Sericocarpus asteroides*.

Tetrastichus microrhopalæ Ashm.—A large series was raised from the dried larval skins, July 7–14.

Mesocrina microrhopalæ Ashm.—A single example reared July 6 from a white cocoon in a mine of this beetle.

A single example of the beautiful little *Hippocephalus multicinctus* also issued from mined leaves, but may possibly have bred from some species of Tineidæ as this Chalcidid is known to live parasitically on this order of insects and has not been observed to attack Coleoptera.

Microrhopala melsheimeri *Cr.*

Mr. Henry Ulke found a specimen of this beetle in an ant's nest at Pen Mar, Pa., but it is probable that this was an accidental capture. (Proc. Ent. Soc. Wash., Vol. I, 1890, p. 248.)

Microrhopala floridana *Schwarz.*

This species was reared by Messrs. Hubbard and Schwarz at Crescent City and Bartow Junction, Fla., from larvæ found mining in the terminal portion of the leaves of grass-leaved golden aster (*Chrysopsis graminifolia*).

Octotoma plicatula *Fab.*

The Virginia creeper, *Tecoma radicans*, has been known as the food plant of this species (fig. 5) since about 1879, but was not placed on record until 1890, when a short note was published in the Proceedings of the Entomological Society of Washington (Vol. I, p. 232). The larva makes a tentiform mine in the leaves of this plant, and the imago eats

oblong holes in the leaves. It is somewhat remarkable that the food habits of this species had been overlooked, as far as published records go, until that time, considering that the insect is widely distributed and frequently found in large numbers. The plant has a still wider distribution than the beetle, which is proved by failure to find it upon this plant in Michigan and in central and southern Florida, as well as in other localities. Even in the vicinity of the District of Columbia the species is local and not to be found wherever its food plant occurs.

FIG. 5.—*Octotoma plicatula*: beetle—about seven times natural size (original).

May 25, 1879, the habits of this species were first observed by Mr. Schwarz at Columbus, Tex. It was noticed that a pupa was always to be found in a pocket adjoining the midrib. The beetle feeds also on the plant. The mines consist of several sinuous branches starting from the midrib, these branches being of varying length and shape. At the end toward the base of the leaf there is usually an oblong, or nearly oblong, blackish spot, presumably where the egg has been deposited and where the excrements of the larvæ collect.

OCTOTOMA MARGINICOLLIS *Horn*.

The perfect beetles were found by Messrs. Hubbard and Schwarz in great numbers riddling the entire foliage of certain small ash trees in Madera Canyon, Sta. Rita Mountains, in southern Arizona, during the months of May and June. Neither eggs, larvæ, nor larval mines were seen on the trees at this season, and it would seem that the real food plant of the species is a vine or some other plant which makes its appearance only after the beginning of the rainy season toward the end of July or in August.

STENOPODIUS FLAVIDUS *Horn*.

From various structural details of this genus, Dr. Horn suspected that the habits of the only species would prove to be subaquatic. While nothing definite has been ascertained regarding the larval habits, the imagos have been found in various localities remote from any water, and under conditions which strongly suggest the larval food plant. Near Brownsville, Tex., Mr. Townsend and Mr. Schwarz found a number of specimens on a malvaceous plant which appears to belong to the genus **Abutilon.**

GENERAL NOTES.

ERRONEOUS BELIEF THAT COMMON NATIVE INSECTS ARE INTRODUCED FROM ABROAD IN SEED.

Every month or two during the warm season we receive communications from farmers in various portions of the country, more particularly in the more sparsely settled States where new crops are being cultivated, concerning the probable introduction from abroad of many common species of insects in seed furnished by the United States Department of Agriculture and experiment stations. Such a communication was received from a correspondent in Texas who had never seen the Colorado potato beetle there before, although the insect has been present in that State since about 1882, and probably earlier, with the remark that it was supposed to have been introduced with seed potatoes from Minnesota. May 27, 1902, another correspondent at Gainesville, Cook County, Tex., wrote in regard to the striped cucumber beetle, which he believed had been introduced with seed received from this Department. In response to inquiry as to particulars, he wrote, that although for twenty-five years he had had experience each year with nearly all the vegetables named in circular No. 31 as food plants of this beetle, he had never seen the insect before, and thinks it impossible for it to have been present on his plants without his having noticed it. Neither had any of his neighbors taken notice of this insect. It seems to have first appeared there in destructive numbers in 1902.

CAPTURE AND POSSIBLE INTRODUCTION OF THE NUN MOTH IN AMERICA.

On the occasion of a visit to Washington by Dr. W. J. Holland, a well-known authority on Lepidoptera, he mentioned the fact that the nun moth (*Psilura monacha* Linn.)[a] had been obtained from a collector in the vicinity of Brooklyn, N. Y. Mr. George Franck, an experienced collector of that city, was referred to as authority, and in answer to an inquiry for the particulars of the capture of this insect, he wrote substantially as follows: In looking over a small collection of a local collector during the summer of 1901, he found, among other material, five individuals of this species, identified by comparison with European specimens of which he possessed a number. The collector in question had no communication with others than Mr. Franck, from whom he obtained material in exchange. He was questioned regarding this species and its occurrence, and Mr. Franck was assured that the specimens had been captured at light in Brooklyn. No other person who had been consulted in regard to this species knew anything of its occur-

[a] Also frequently mentioned in literature as *Liparis monacha*, and recently placed by Meyrick in the same genus as the gypsy moth, **Ocneria.**

rence in that vicinity, and it was put down as an accidental importation, which is probably the truth. The collector resides in a district where there are numerous lumber yards, and shipping is carried on to a great extent. The exact location is described as being around North Second street and Metropolitan avenue, near a creek which adjoins that portion of the bay running through the eastern part of Brooklyn.

As only five of the insects were captured it does not necessarily imply that the species has been introduced, but we may have here a parallel case to that of the gypsy moth, which was known to have been actually introduced in this country twenty-five years before it attracted the attention of economic entomologists. As the two species are related and have similar habits, there is reason to believe that if the nun moth does become permanently located in the vicinity of New York, it will prove a national calamity, and more troublesome even than the gypsy moth, as it will be difficult to deal with the pest in such a locality. The gypsy moth is established inland, while the nun moth, if it has obtained permanent foothold (which may not be ascertained for a number of years), will probably have spread to the immediate vicinity of waterways on either side. It is a matter that should be made public at once, that all persons interested in entomology and in agriculture may be warned to keep a sharp lookout for this species during the coming years. The Division of Entomology should be notified of captures of anything suspicious, and any insect suspected of being the nun moth should accompany the letters.

ESTIMATED LOSS OCCASIONED BY THE VARIEGATED CUTWORM IN 1900.

In looking over accounts of injuries recently occasioned by various well-known species of noxious insects, the writer noticed the lack of reliable estimates of money losses sustained. The question of the extent of the damage due to the ravages of the variegated cutworm (*Peridroma saucia*) in 1900 was entirely lost sight of, by the writer as well as by others who published in regard to injuries.

Occasion was therefore taken, in writing Dr. James Fletcher, Dominion entomologist of Canada, to make inquiry in regard to injuries in the Dominion. Through him we obtained information from Mr. J. R. Anderson, deputy minister of agriculture for the province of British Columbia, as follows: "Replying to Mr. Chittenden's inquiry as to the loss from the variegated cutworm last year—from all the information obtainable and making an addition for unreported districts, the losses foot up to $168,000."

Next, Prof. C. V. Piper was written to in regard to damage inflicted by this cutworm in the State of Washington, and he obtained from Mr. David A. Brodie an estimate of $1,012,500 in western Washington, this being based upon the estimate of damage in British Columbia. In commenting on this, Professor Piper stated that he could well believe

the loss in Washington to be ten times as great as that in British Columbia, that is, $1,680,000.

In Oregon, Prof. A. B. Cordley, entomologist of the experiment station at Corvallis, placed injuries at the modest estimate of $50,000.

If to the estimated damage in British Columbia we add the injury which was accomplished in the Provinces of Ontario and Manitoba, there will be no difficulty in raising the figures for the Dominion to $200,000. Then it must be remembered that isolated instances of injury were also reported in various States, for instance, in California, Texas, Missouri, Kansas, West Virginia, Illinois, Maryland, Virginia, and the District of Columbia. Taking all data into consideration, accounting for many localities from which no reports were received, admitting that this species was undoubtedly responsible for much injury merely attributed to cutworms in general and not reported to any official entomologist, also that it is cosmopolitan and practically omnivorous, it would seem that an estimate of $2,500,000 would not be too high as the total cash value of crops injured in the United States during the single season of 1900.—F. H. C.

OCCURRENCE OF THE MEDITERRANEAN FLOUR MOTH IN MINNESOTA, WISCONSIN, AND MICHIGAN.

During the past two years several complaints have been made to this office of trouble occasioned by the presence of the Mediterranean flour moth (*Ephestia kuehniella* Zell.) in flouring establishments and warehouses in Milwaukee, Wis.; in Minneapolis, and neighboring cities in Minnesota; and quite recently in Detroit, Mich. Through other sources of information we have knowledge of the insect spreading to neighboring States and being further disseminated in other States where it has already been established for some time; in fact, it is apparent that it is now only a matter of a few years when this insect will become permanently established in most portions of the Union where milling is an important industry. All communications were accompanied by specimens, usually with all stages of the insect in infested flour webbed up in the manner characteristic of this species.

February 23, 1901, Mr. George W. Peckham wrote of the injurious occurrence of the pest at Milwaukee, Wis., transmitting material received from a gentleman largely interested in flour mills in that vicinity who had experienced a great deal of trouble with it. April 20 Mr. Harry D. Cushman, Minneapolis, Minn., stated that although he was not aware that mills in that city were badly infested with this moth, he understood that some mills in Superior had to close because of infestation. The modern system of keeping the mills scrupulously clean, not permitting dust or dirt to accumulate, and the turning of the stock of grain and its products every few days had eliminated to a

great extent the trouble that had previously been experienced. Our correspondent believed that this statement would apply to the larger mills, at least, of his locality. November 20, a correspondent at Balls Ferry, Shasta County, Cal., reported this flour pest in that vicinity. This appears to be a new locality in California, although the species is rather more widely distributed there than in any other State of the Union.

January 28, 1902, the president of a flour company at San Francisco, Cal., wrote in regard to the Mediterranean flour moth in that city. In putting up breakfast cereals his firm had been seriously annoyed by the eggs and larvæ of the moth developing several weeks from the time of packing. He said that the food material in question could be exposed to a temperature of 212° F. or thereabouts without serious damage. June 30 a merchant miller, of Detroit, Mich., sent this species in flour from a mill in that city. He was anxious to obtain information in regard to the use of hydrocyanic-acid gas, as the insurance companies refused to grant permission for the use of bisulphid of carbon as a fumigant. Two years earlier it was reported that one mill in Detroit was infested by this insect, and it was surmised that the present invasion was due to the introduction of wheat or secondhand bags from the Northwest, with little doubt from Milwaukee and Minneapolis, where this species as just reported is now known to be present in great numbers. It is now said that nearly all the mills in those two cities are completely overrun with this pest.

THE ANGOUMOIS GRAIN MOTH IN 1901.

In spite of the employment of precautionary as well as remedial measures that have been generally used against the Angoumois grain moth (*Sitotroga cerealella* Zell.) in the more northern States in which it is found, it continues to be injurious year by year, and it seems to be as troublesome now as ever, if, indeed, not more so. The following notes are extracts from correspondence during the year 1901. In nearly every instance specimens of the insect accompanied the letters.

February 8 we received word from the Larrowe Milling Company, New York City, that this species was a general pest throughout New Jersey and eastern Pennsylvania.

On the 27th of the same month Mr. James R. Kirby, Smiths Grove, Ky., wrote that the farmers of that vicinity were seriously troubled by this species.

March 4 Mr. William J. Haverly, Los Angeles, Cal., complained of injury to the seeds of field corn.

September 28 Mr. Horace L. Dilworth reported this species as doing great damage to wheat in the neighborhood of Centerville, Del.

October 17 Mr. Walter Geist, Shawan, Md., who runs a thrashing

machine, stated that in some places in that vicinity grain was very badly infested.

November 13, 1901, Mr. C. S. Scofield, of the Bureau of Plant Industry, exhibited specimens of wheat badly infested by the Angoumois grain moth, received from Mr. Charles Dunwoody, Philadelphia, Pa., who stated that his firm had handled through its warehouse about 30,000 bushels of this year's crop which showed the work of this insect. It was noticed that the insect had been gradually working a little farther west each year. Early threshing had been the principal remedy employed. All varieties of winter wheat and rye appeared to be infested alike. The ravages of this insect had first been noticed about four or five years previous to the date of writing, and had been increasing from year to year since. Mr. Dunwoody stated that the greatest damage was at that time reported from the counties of Delaware, Chester, and Montgomery, in Pennsylvania; as well as in some sections of western New Jersey. Nearly two-thirds of the grain in the regions mentioned appeared to be infested, and it was estimated that the damage was about 20 per cent of the value of infested lots. Mr. Dunwoody asserted that field-threshed grain is seldom infested, but that nearly all grain which goes through the "sweat" in barns is more or less affected.

From Rev. J. F. Sheppard, Conshohocken, Pa., we received information, under date of November 29, that this insect was ravaging granaries in that vicinity.

December 19 Mr. Theodore C. Search, Philadelphia, Pa., reported that this species was very destructive to the wheat crop of Bucks County, Pa. In a badly infested sample from Chester County, Pa., he stated that the wheat weighed only 38 pounds to the bushel, and was worth for feeding purposes 60 cents per bushel of 60 pounds on our present market. This same variety of wheat, if sound and in good condition for milling purposes, would bring 78 cents. Later he wrote that one reason why the Angoumois grain moth is so destructive in certain portions of Pennsylvania is the fact that in the vicinity of Philadelphia the farmers *prefer to thresh their grain during the winter season at odd times.*

In one sample of wheat from Pennsylvania infested by this moth many specimens of a parasite occurred; in fact, in this lot the moths were almost completely killed off, only one breeding out in the course of three weeks, the parasites occurring in the proportion of something like 50 to 1. The parasite having a somewhat novel appearance, it was referred to Mr. W. H. Ashmead, of the National Museum, who states that it is undescribed. It is a species of Catolaccus.

RECENT INJURY BY THE CIGARETTE BEETLE.

More complaints were received of injury by the cigarette beetle (*Lasioderma serricorne* Fab.) during the seasons of 1901 and 1902 than

ever before in its history; judging by correspondence, this insect is rapidly widening its range, and unless radical measures are taken by the individuals whose products suffer from its attack, the insect will undoubtedly continue to increase and spread and will soon become a species of the highest economic importance. Complaints of injury were received from different firms, mostly tobacconists, wholesale and retail, in New York City; Baltimore, Md.; District of Columbia; Danville, Va.; Cincinnati, Ohio; Detroit, Mich.; Porto Rico; and Kingston, Jamaica. The insect was the subject of considerable correspondence from the localities mentioned. In most cases destruction was to tobacco, but certain other products were affected.

During February we received complaint from one of Cincinnati's largest department stores of injury to cigarette tobacco. September 21 a manufacturer and importer of cigars in New York City complained of this species, stating that the beetles were in every can of tobacco received from a certain firm. They were eating through the wrappers of cigars. October 10 complaint was made of considerable injury by this insect to upholstered furniture in department stores at Detroit, Mich. The insects were stated to be infesting the very best furniture in one house. In the latter days of October Mr. Frank D. Gardner, agent in charge of the experiment station at Porto Rico, stated that cigar dealers in San Juan had considerable trouble in keeping their stock for any length of time on account of the cigarette beetle boring holes in the cigars and practically ruining them. November 13 a cigar dealer at Baltimore, Md., stated that his firm had lost about 700 of their best cigars through the attacks of this insect.

During July, 1901, complaint was made by a large wholesale and retail tobacco establishment in the city of Washington of injury by this beetle, and an opportunity was afforded for disinfecting the establishment infested by means of bisulphid of carbon. This work was undertaken by Mr. W. E. Hinds, temporary assistant in this Division. The results of these experiments, which were eminently satisfactory, were published in Bulletin No. 30, new series, (pp. 78–82). This led to a further study of carbon bisulphid as an insecticide and to the treatment of this topic in a general manner. The results of further study and investigation have found expression in Farmers' Bulletin 145, prepared by Mr. Hinds with the cooperation of Mr. E. E. Ewell, assistant chemist of this Department. The cigarette beetle was also found by Mr. J. Kotinsky, of this office, in a pharmacy at Washington, D. C., affecting American saffron.

January 23, 1902, complaint was received from a prominent cigar manufacturer of New York City of injuries by this insect. April 9 Mr. H. H. Cousins, island chemist, of Kingston, Jamaica, requested information on dealing with the cigarette beetle, which he stated threatened the tobacco trade of Jamaica.

In practically all of the instances of attack that have been mentioned letters of complaint were accompanied by specimens of the insects at work in tobacco or other products affected.

INJURIOUS OCCURRENCE OF AN EXOTIC DERMESTID IN THE UNITED STATES.

Among the beetles of the genus Dermestes, treated by Dr. Horace F. Jayne in his paper entitled "A revision of the Dermestidæ of the United States" (Proceedings American Philosophical Society, Vol. XX, 1883, p. 353), *D. cadaverinus* Fab. is included, Florida being given as its only locality. Correspondence during September, 1901, shows not alone that this species is apparently established in this country in New York City, but that it is probably an exotic form, perhaps originating in China.

September 6, 1901, the Clifton Silk Mills, town of Union, N. J., sent specimens of this species, with accompanying information that the beetles and their larvæ were found in bales of dried China silkworm cocoons imported from Shanghai for reeling. Many of the beetles were noticed at this time wandering about among the cocoons, and a lesser number of larvæ. A friend of our correspondents having a silk-reeling establishment in France said that this (or perhaps a related) species emerged from the cocoons when the latter were kept in moist places. Another friend interested in silk culture stated that he found the larvæ or "worms" in bales of reel silk, and that they cut the silk as with a knife, establishing themselves generally beside the cords which tie the bundles, and working their way along the grooves made by the cords, cutting the skeins as they go. He recollected that larvæ had been occasionally found in Italian silk.

Our correspondents stated that the beetles made short flights, but were disinclined to use their wings.

September 14 our correspondents called attention to the small clean holes made by the insects in the cocoons, in contrast to that made by the silkworm moth, which in emerging makes a ragged hole, stained brown for some distance in from the edges. It was further stated that in France, where this species is found in reeling establishments in raw silk, that when the packing of the silk was done near where the cocoons were stored infestation was noticed. By removing the packing department to a distance from the cocoons this trouble was averted.

September 25, 1901, the Payne Spring Tanning Company, Cumberland, Md., sent specimens of this beetle with sample of leather received from a tanner in New York City, showing holes through which the beetles had bored. Our correspondents stated that the leather was rolled in bundles of 12 and 24 sides each, and upon opening the same they found that the leather had numerous holes in it about the size

that would be made by large shot. According to their description, the beetle or its larva would start on one side and cut a hole through an entire bundle of leather. An attempt to disinfect the leather with carbolic acid had no apparent effect.

Writing again September 28, this company stated that there was little doubt that the leather became infested in a hide house in New York City where it had been stored for some time, and where large quantities of foreign hides are handled. Damage of the nature mentioned was common in foreign dry hides, but our correspondents had never known of domestic tanned leather being attacked in this manner before.

All of the material received from the New Jersey and Maryland correspondents from silkworm cocoons and leather, respectively, was referred to Mr. E. A. Schwarz, who pronounced the species *Dermestes cadaverinus* Fab. This species is comparatively rare in the United States, as Dr. Jayne's note on its distribution "merely occurs in Florida" would indicate; but it is one of the many species which affect stored material, and which are thus destined in time to become cosmopolitan.

REMEDIES.

The best remedy for these insects, when they occur in leather and similar substances, is undoubtedly the bisulphid of carbon, and this should be freely used where the insects are most abundant. Where it is possible to remove leather to tight rooms, it can be disinfected in the usual manner; but where this cannot be conveniently done it is more advisable to disinfect entire rooms in the storehouse infested. Silk and cocoons can be even more readily reached by the use of bisulphid of carbon, and this applies to the fumigation of entire rooms; but the hydrocyanic-acid gas treatment can also be employed. This latter is useful where insurance companies object to the use of bisulphid of carbon on account of its inflammability. Directions for the use of bisulphid of carbon are given in Farmers' Bulletin 145, and for fumigation with hydrocyanic-acid gas in Circular 46 (second series), both of which publications can be obtained by application to this office.—F. H. C.

SOME BLISTER BEETLES INJURIOUS TO FRUIT TREES.

For many years past blister beetles of three or four species have been reported at intervals as doing more or less destruction to the foliage of various fruit trees in different portions of our country. The insects in question are quite different from the common species of blister beetles found in potato patches and in fields and gardens generally. They are strictly arboreal, while the latter are terrestrial. Some accounts of recent injury may be of interest, together with the accompanying illustration of one of our best-known forms. All of these insects are handsome creatures of graceful form, and in color different shades of green or olive with yellow or yellow and black legs.

SAY'S BLISTER BEETLE (*Pomphopœa sayi* Lec., fig. 6).—April 29, 1901, Mr. R. J. Black, Bremen, Ohio, sent specimens, as did the other correspondents who will presently be mentioned in connection with this and other species, stating that the beetles were found in great numbers devouring blossoms of Japan plum. The species had not been noticed in previous years, and other varieties of plum, cherry, and peach were not affected. May 13, Mr. C. W. Nash, Toronto, Canada, also reported this species on plum doing great damage to the blossoms.

The PEAR-TREE BLISTER BEETLE (*Pomphopœa ænea* Say).—May 1, 1901, Mr. Joseph Hampson, jr., reported this species to be destroying the petals, stamens, and pistils of pear blossoms at Pen Mar, Pa. An invasion of this species on pear was recorded as occurring in central eastern Ohio in 1894 (Ins. Life, Vol. VII, p. 204). In 1898 and 1899 it was reported to be destroying the blossoms of young plum at Wooster, Ohio, and Tazewell, Tenn.

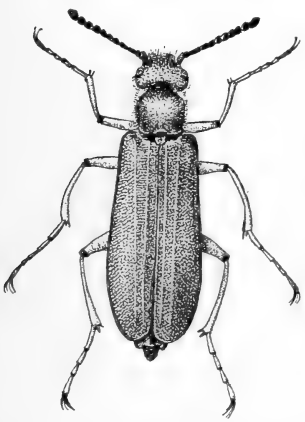

FIG. 6.—*Pomphopœa sayi:* beetle, 2½ times natural size (original).

The TEXAS PLUM BLISTER BEETLE (*Pomphopœa texana* Lec.).—March 18, 1902, Mr. David Hunter, San Antonio, Tex., wrote of the occurrence of this blister beetle on plum in that vicinity. Six years earlier our correspondent had noticed this beetle feeding on Chickasaw plum in Blanco County of the same State.

The PEACH BLISTER BEETLE (*Pomphopœa ungularis* Lec.).—April 8, 1902, Mr. Franklin Sherman, jr., wrote of the occurrence of this blister beetle at Blowing Rock, N. C., on wild mountain laurel, devouring both blossoms and leaves. It occurred there literally by thousands, attacking also peach trees, eating those which had previously been attacked by leaf curl. The beetles also affected cultivated roses to such an extent that one owner had to resort to spraying to save them. In Volume VI of Insect Life (p. 36) we recorded the occurrence of this species in immense numbers at Whitesides, N. C., where they denuded the locust, *Robinia viscosa*, of foliage. This was at an elevation of 5,000 feet above sea level, and occurred in 1893.

Remedies.—All of these blister beetles undoubtedly feed, in nature, on the blossoms of wild fruits, such as plum, mountain laurel, and the like. On low trees it is not difficult to control them by hand-picking. On higher trees they can be destroyed by means of a spray of Paris green applied in the usual manner. On peach, however, arsenate of lead is best, owing to the danger of scorching the tender foliage of

that tree. Another manner of holding them in check is by jarring them upon curculio-catchers, which can be constructed by means of a sheet stretched and held taut on a frame. If this catcher is saturated with kerosene such insects as come in contact with it will die. As to the success of these remedies, Mr. Hunter, writing of the Texas species, states that it was easily destroyed by hand-picking, as the beetles were not readily disturbed, while Mr. Nash, writing of Say's blister beetle, states that arsenicals could not be applied owing to the danger of killing bees.—F. H. C.

NOTES ON VINE-CHAFERS.

Recent years have witnessed considerable injury locally and, as usual, periodically to grapevine and the foliage and blossoms of various fruit trees by some species of beetles of the genus Anomala. Of the dozen described forms of this genus, four are known to affect the grape; hence the name of vine-chafer, which is rather commonly bestowed on them.

Anomala undulata Mels.—This, one of the commonest species, has been reported during the last two years at Gadsden, Ala., and Tazewell, Tenn. In the first locality the beetles were first noticed by Mr. C. W. Ewing, April 10 at sunset, flying in great numbers from a valley below and settling on peach trees, where they ate both blossoms and leaves. In the latter locality, Mr. H. Y. Hughes observed the beetles destroying buds, bloom, and young fruit of cherry. In earlier years we have recorded the occurrence of this species as injurious to the blossoms of grape, apple, and pear at Grand Bay, Ala., and to grape at Greenville, S. C.

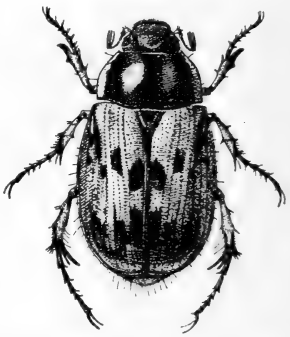

FIG. 7.—*Anomala undulata:* beetle, four times natural size (original).

The life history of this species is in some respects like that of the common rose chafer, which is treated in Circular No. 11 of this Division. The beetle, however, is quite different in appearance. It is shown in fig. 7. The color is shining pale yellow, with the thorax mostly black, and the elytra or wing covers spotted with black, much as illustrated, the pattern, however, being quite variable.

Anomala marginata Fab.—This, the margined vine-chafer has been quite destructive recently at Carterton, Va. Dr. E. K. Harding reports that it occurred in June, 1900, about the middle of the month, and did considerable damage to cherry and Japan walnut, but did not trouble the vine. Many holes were found in the earth under the trees, and when the beetles were shaken off they disappeared into the ground, an occurrence which led our correspondent to infer that eggs might be deposited in the earth from which the larvæ would hatch. This is

probably true. The beetles, like the rose chafer, were seen in copulation at any hour during the day. Subsequent observations showed that these beetles also occurred in abundance on sycamore and that they even relished the acrid foliage on black walnut.

The beetles also resembled the rose chafer in their sudden appearance, their time of activity (about one month), and their equally sudden disappearance at the end of that time.

Anomala minuta Burm.—The black form of this species was received May 2, 1901, from Mr. B. H. Frazier, Fruitdale, Ala., where it was observed working on young peach and plum trees set out that spring. The beetles burrowed in the ground around the trees to a depth of 1 to 3 inches into the moist earth. They ate only the young, tender leaves. It was also noticed that they seemed to be most numerous in the drier and sandier soil of that vicinity, which suggests that the larvæ probably fed on grasses grown in such locations.

While writing of the habits of these vine chafers it may be well to add that on one occasion *A. undulata* was observed affecting growing wheat, in another case attacking petunias, and in still another affecting grape. *A. marginata* is most commonly found on the vine, as is also *minuta*. *A. lucicola* is also a grape-feeding species, and *binotata* has been found on the grape as well as on strawberry and locust.

Remedies.—In the treatment of these vine chafers we have practically the same problem, in many cases, as in dealing with the rose chafer. The beetles frequently occur in such numbers and devour the leaves of young and tender fruit trees so rapidly that Paris green does not produce the desired effects. In ordinary cases, however, an arsenical spray is sufficient for their destruction. Dr. Harding has met with good success both with spraying and with shaking the beetles off and burning them, in much the same manner as described in connection with the blister beetles which affect fruit trees.—F. H. C.

THE COLORADO POTATO BEETLE IN THE SOUTH.

We have recently received information from many correspondents in Southern localities furnishing evidence that the Colorado potato beetle (*Doryphora 10-lineata* Say) has been making a general effort to extend its range southward. Such migration has been noticed for a number of years past, but has never been so noticeable as during the season of 1901. The species will doubtless continue to spread southward until it is overcome by natural enemies or perhaps killed out by the weather. It has been noticed that this species has been destroyed in great numbers during severe dry spells, such as was experienced during the summer of 1900, the larvæ being literally dried up on their food plants.

Our first information in regard to recent spread by this species was from Mr. N. L. Willet, of Augusta, Ga. For the first time in his remembrance, that section was being devastated. He wrote, May 12,

1900, that within a radius of about 100 miles the country was being devastated, his drug firm receiving daily orders from railroads radiating from the city for Paris green, more of this insecticide being sold in the previous week than in the preceding four years. The opinion was expressed that in future the inhabitants of that region might have to count upon this beetle as one of the expected annual arrivals in spring. The country round about appeared to be alive with them.

May 14, 1901, Maj. Harry Hammond wrote of this species and its destruction of potatoes in the vicinity of Beech Island, S. C. May 24 Mr. John Conner, Ripley, Tenn., wrote of injury in Lauderdale County. The insects were first noticed about the middle of May, and by the end of the month early potatoes were entirely stripped of their leaves. A similar report of injury was received from Mr. Albert E. Seddon, Atlanta, Ga., May 25.

Mr. J. P. Rudulph, Pleasant Hill, Ala., wrote May 27 that the Colorado potato beetle made its first appearance in that locality that year, but the timely application of Paris green checked its ravages.

June 4 we received a communication from Mr. J. C. Russell, Clarksville, Tex., in regard to the occurrence of the insect in that vicinity.

It should be remarked that Mr. H. E. Weed, when entomologist of the Mississippi Agricultural College Experiment Station, writing of this species in 1897, published a map showing that in 1896 it had occupied the northern two-thirds of Mississippi, the prediction being made at that time that owing to the large increase in the acreage devoted to Irish potato in that State and throughout the South it was probable that the insect would continue its southward spread to the Gulf of Mexico (Bul. 41, Miss. Agr. Exp. Sta., Mar., 1897, pp. 186, 187).

THE RICE WEEVIL AN IMPORTANT FACTOR IN THE FAILURE OF GERMINATION OF CORN IN THE SOUTH.

In the course of investigations conducted by Mr. E. A. Schwarz, of this office, in Texas, to place the hibernation of the Mexican cotton-boll weevil, it was ascertained that not only the boll weevil but the rice weevil (*Calandra oryza* Linn.) or so-called corn weevil, as it is better known in that portion of the South, made use of cornstalks for winter quarters. Only a few of the boll weevil were observed in comparison to thousands of the rice weevil that habitually hibernate in this manner. The latter beetle also sometimes passes the winter in cotton bolls and in other plants, but cornstalks, owing to the greater degree of moisture which they contain in the pith, form a favorite winter home of this insect. Thus it happens that the careless farmer has to contend not only with the weevils that are present in his corn when planted, but with others which come out of the cornstalks on the approach of warm weather and undoubtedly dig down into the soil to the kernels.

Frequent complaint has been made of the failure of corn to grow in the South, and this explains the reason to a very considerable extent. Most of Mr. Schwarz's observations were made in the vicinity of Victoria, and he related having seen long, uninterrupted rows of these beetles on fences when warm weather tempted them from their places of concealment. Mr. Schwarz brought with him specimens of corn seed that had been planted showing the holes made by the ravages of this insect, which ate out the germ, leaving the remainder practically intact. The farmers usually attributed this failure of germination to crows and other birds, and the truth has never been ascertained hitherto.

The necessity of selecting good seed for planting has been pointed out in Farmers' Bulletin 45, on insects affecting stored grains, as well as in a pamphlet entitled "Insects Injurious to Beans and Peas." It is now in order to advise cleaner culture, consisting of the destruction of cornstalks before the insects which have hibernated in them issue. This is a measure of the greatest value not only in controlling the rice weevil, but many other granary insects which lead a more or less outdoor existence in the South, such as the grain beetles, Silvanus and Cathartus, and the flour beetles, Tribolium, etc., and some other species.

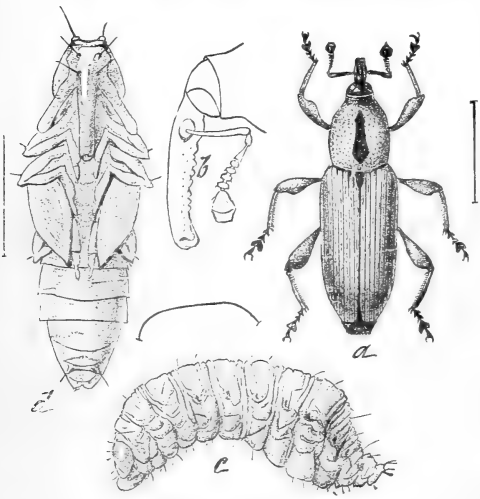

FIG. 8.—*Sphenophorus obscurus*: *a*, adult, enlarged; *b*, head of adult, from side, still more enlarged; *c*, full-grown larva, from side; *d*, pupa, ventral view, both enlarged (from Insect Life).

THE SANDWICH ISLAND SUGAR-CANE BORER AGAIN.

It may be remembered by our older correspondents that we published in Volume I of Insect Life, on pages 185–189, an illustrated account of *Sphenophorus obscurus* Boisd., which we may call the Sandwich Island sugar-cane borer. We have several times received this species from different sources, and some articles and shorter notes have been published in regard to it, most of which are referred to in the article cited. February 18, 1902, Mr. Jared G. Smith, special agent of this Department in charge of the Hawaii Experimental Station at Honolulu, Hawaiian Islands, wrote us from Spreckelsville, Maui, in regard to severe injuries by this insect. As some of our

present readers may not have access to the volume of Insect Life to which we have referred, the illustrations there presented are reproduced (figs. 8 and 9). Mr. Smith writes substantially as follows:

I am sending you herewith specimens of the cane-borer which infests the sugar-cane plant throughout the rainy districts of Hawaii. It is quite rare in the dry districts or in dry years, but is terribly destructive in wet years or on plantations in regions with abundant rainfall. On one plantation on Maui the loss last year from the cane-borer was estimated at between 1,000 and 1,500 tons of sugar—20 per cent of the crop. At an average price for sugar of $70 per ton it is not difficult to figure up a pretty stiff bill against the cane-borer.

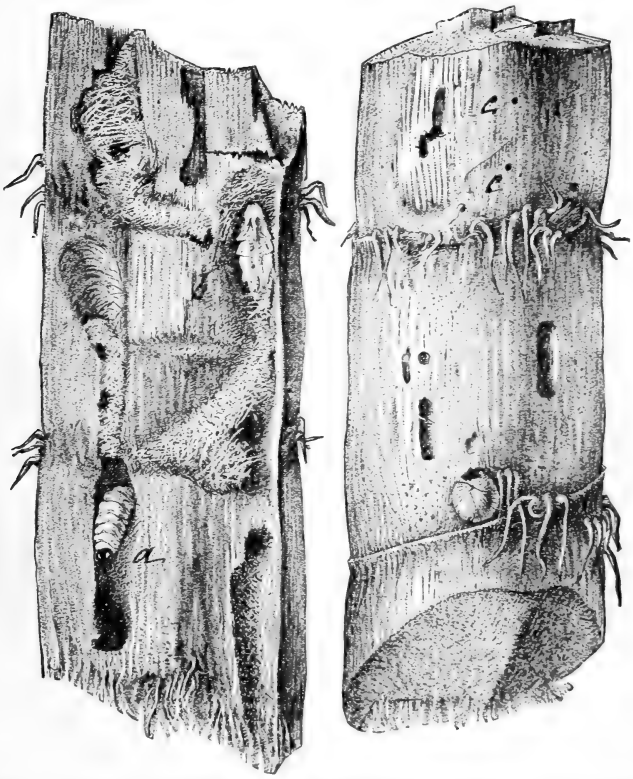

FIG. 9.—Sections of sugar cane showing work of *Sphenophorus obscurus: a*, larva; *b*, pupa, *in situ; c*, probably points of oviposition, somewhat reduced (from Insect Life).

From its habits I judge there is no hope of trapping, poisoning, or otherwise destroying it, and it looks as though we would have to find a natural enemy for it. The toad has been tried, but the mongoose is too fond of toad for breakfast.

The eggs are apparently laid in the sheath of the old leaves of the cane a little above its junction with the node. The egg hatches out in the sheath and the young grub eats its way into the cane just above the node. The hole where it enters is very small and hardly visible. Once inside the grub grows rapidly and channels back and forth, rapidly converting the lower internodes into a mass of fœces. The grub pupates in the cane and only emerges from the stalk as a beetle to copulate, and do it all over again. Several of those which I send were caught in the act. The

imagos are found inside the sheaths of the dead leaves on the lower part of the stalk during the daytime, and apparently only fly at night.

Not being an entomologist, I don't know what other information would be of value to you. The grub is found only in the mature basal joints of the cane stalk—the portion of the stalk which is richest in sugar. I do not think that the imago is attracted by light; anyway it would be dangerous to have a light in a cane field on account of the danger of fire.

Ten tons of cane per acre are sometimes destroyed by the borer.

Since writing the above I have talked with Mr. A. Koebele. He says the borer is probably a native of Tahiti, or at least that it was introduced here from there, but that it also occurs in Samoa, Fiji, New Guinea, and other southern Pacific island groups. Also that it infests the banana, wine palm (*Caryota urens*) and other palms, the papaya (*Carica papaya*), and a good many other tropical crops.

Hon. H. P. Baldwin, who gave me most of the preceding information, says that the cane borer is the worst insect pest in Hawaii, and that a conservative estimate of the amount of damage done by it would be at least $500,000 per annum.

UMBRELLA ANTS IN CUBA.

During the first week of June we received two communications in regard to an ant native to Cuba and designated by the natives as "bibijagua." Mr. Thomas R. Towns, Quiebra Hacha, province of Pinar del Rio, wrote May 27 that this insect, which is probably *Atta insularis* or a related species, is as industrious as any animal alive, working as late as 12 o'clock at night, when the dew puts a stop to its work. At 10 next day it is out again. The ants stripped a nursery of every leaf of orange, showing a preference for the tender leaves. They are described as taking a row of young stock about an eighth of a mile long, tree by tree, never missing one nor leaving a leaf. When this row is finished they take the next. Our correspondent stated that he "ran them out" by tarring a rope with pine tar and laying this around the plot attacked.

Mr. E. T. Fries, Santa Fé, Isle of Pines, complained of the same species and its injury to orange. He had noticed its habit of living in colonies in immense hills of earth, with galleries, chambers and tunnels, and with well-beaten paths in many directions leading to the hill. Along these the ants traveled, each carrying a bit of leaf often several times as large as the ant itself. The ants are officered by one of larger size.

THE GAGE BUG.

During the time that this Division issued the periodical publication, Insect Life, which reached an edition of seven volumes and has now been discontinued, we had frequent occasion to mention the popular names of our common insects. Such notes as we published frequently elicited interesting correspondence.

January 30, 1902, Mr. James Riley, of New Dorchester, Mass., wrote in regard to popular names, giving an account of the "Gage

bug," which we reproduce below in its entirety. There is little doubt, from the description of the insect, as chunky and not flying, that he has reference to the common squash bug, a well-known enemy of pumpkin and squash vines. It is probable that General Gage did not have a very extensive knowledge of entomology, and judged this insect to be more destructive than it really was, owing to its somewhat disgusting appearance and still more displeasing odor. The following is in reference to one of the Entomologist's lectures delivered at the Lowell Institute during the month of January:

In common with all your auditors I have been pleased and instructed with your heart and head talks on insect life. I was waiting all the time to hear of one of my old enemies, the Gage bugs. You may have mentioned them in your second lecture, which I missed. They may have been the Hessian fly, but if my memory serves they came with them, but were more chunky, and did not fly. I was reminded of them when in your first lecture you said that people often named pests after what they disliked, as the French weed in English-speaking Canada and the Abe Lincoln bug in Georgia. So too with the Gage bug. The old man who brought me up was an Alden but five generations from the historic John. He used to tell me in hoeing time (in the late 50's and early 60's of the century that was) that General Gage after the battle of Bunker Hill, finding he could not "whip us," went up on the hill the next day and, opening his snuff box, let out the bugs that we were then killing on our pumpkin and squash vines. He would describe most lucidly the battle before telling the story, and so I never stooped to "squash" a Gage bug in those days without seeing a general in red on a high hill, snuff box in hand, out of which issued a living line of pestilence as the bugs swarmed in perspective down the thirteen colonies. Such was a lesson in natural and political history of an old-time Yankee to an Irish boy forty years ago.

THE PROBABILITY OF THE OCCURRENCE OF THE MEXICAN COTTON-BOLL WEEVIL IN BRAZIL.

We have received information leading toward the conclusion that the cotton-boll weevil (*Anthonomus grandis* Boh.), or an insect of very similar habits, has been present for some years in the cotton regions of Brazil, notably in the State of Bahia. Professor d'Utra, director of the State agricultural station of São Paulo, has written a rather extensive article upon this subject, in which he considers that there is no doubt that the insect is *Anthonomus grandis* (Boletin de Agricultura, 2d ser., No. 4, pp. 211–229, 1901). In our efforts to obtain specimens we have been favored by Prof. Adolph Hempel, of the same station, with the information that, although there may be some uncertainty about the identification, the fact remains that in the State of Bahia there occurs a small beetle that lives in the cotton bolls, especially within the seeds. This describes exactly the method of work of the boll weevil in southern Mexico and Central America, as noted by Townsend, though in Texas it never occurs within the seeds.

In the absence of specimens only speculations regarding this matter are to be indulged in. There is, however, an authentic record of

the occurrence of this insect in Cuba in 1871. Nevertheless, it is practically certain that in 1882, at the time of the visit of Branner and Koebele to Brazil, *Anthonomus grandis* did not exist as an enemy of cotton in the State of Bahia or elsewhere in that country. Moreover, none of the principal works dealing with the Coleoptera of that portion of South America mentions the species. Although this by no means demonstrates that *Anthonomus grandis* may not now be found there, it certainly tends to indicate that if the species has made its way into Brazil, it has, in less than twenty years, increased its range remarkably.—W. D. H.

THE ST. ANDREW'S COTTON STAINER.

Mr. J. J. de Barril, the proprietor of a cotton plantation in the interior of Cuba, has given us interesting details concerning *Dysdercus andreæ* L. This species, like *D. suturellus* H.-S. of the southeastern United States, is a cotton stainer. It sometimes occurs in such numbers that if cotton culture is again engaged in extensively in the West Indies it may become considerably more important there than its congener in this country, which has for many years ranked as a pest of only secondary importance.

Some years ago this insect was the subject of one of Prof. T. D. A. Cockerell's stylographic notes (Institute of Jamaica, Notes from the Museum, No. 9, Feb. 24, 1892). The common name we have used was suggested by Professor Cockerell, and is in allusion to the white cross formed by the markings on the hemelytra which Linnæus also referred to in the Latin name he gave the species. In the adults this coloration is quite striking. More than a century ago Sloane, a traveler in Jamaica, referred to the insect as "a Cimex of a scarlet colour with a white St. Andrew's cross on its back. This is one-third of an inch in length. It is very often to be met with amongst flowers."

Our correspondent states that on his plantation, where until last year no cotton had been planted for nearly half a century, the cotton bolls were frequently so covered that nothing but a mass of red and black insects was visible. This happened in January and February, before the fruit opened, and no effect upon the plant, except that of dwarfing the bolls, was observed. Toward the end of March, however, when all of the bolls had burst open and most of the staple had been gathered, the pests fell upon what remained, and then the staining of the fiber became most noticeable. The color of the stain was yellowish brown or ferruginous. Another observation suggests a probable effective method of destroying the pests. All the hollows of stumps or trees in the cotton fields were noticed to be filled by millions of the immature insects. These did not eat the leaves of the cotton plant, but were found crawling over the grass and tobacco

plants which were planted in the vicinity of the cotton. In these situations it would be an easy matter to destroy the pests by means of hot water, or kerosene emulsion, or a mechanical mixture of kerosene and water.

The species is generally distributed in the West Indies. It has been reported from San Domingo, Jamaica, and St. John, and Mr. O. Heidemann's collection contains specimens from Cuba and Montserrat. It did not appear, however, in the extensive Smith collection of Hemiptera from Granada, W. I., and likewise seems to be unknown in Mexico and Central America.—W. D. H.

STOPPAGE OF ELECTRIC LIGHTS BY INSECTS.

The Electrical World and Engineer of August 9, 1901, says that recently at St. Paul, Minn., the electric lights were stopped by an accumulation of shad flies, 18 inches from wire to wire, shutting off the current of 25,000 volts. The shut down by a short circuit between the wires lasted an hour, and it was found necessary to station an attendant to remove the constantly accumulating insects with a hoe. The figure illustrating the article represented a Bibio, but the text says that the creatures were shad flies.

A VARIETY OF WHEAT SAID TO BE IMMUNE FROM HESSIAN FLY.

Maj. William R. King, ex-chief of the seed division, Department of Agriculture, returning from Buffalo, and having interviewed several New York wheat growers, reports that he is authoritatively informed that the only variety of wheat which practically escaped the great damage which the Hessian fly did in that part of the State during the season of 1901 is Dawson's Golden Chaff. The peculiarity in the wheat is that the straw is very stiff and tillers abundantly. It originated at Guelph, Ontario, Canada, at the Dominion Experimental Farms. It has been extensively planted in Canada, also in western Michigan, not only at the Agricultural College, but in the vicinity of Grand Rapids.

A WESTERN CRICKET IN OREGON.

July 30, 1901, Mr. R. J. Hollis sent specimens of one of the so-called western crickets (*Anabrus purpurascens* Uhl.) from Andrews, Harney County, Oreg. Our correspondent had never seen this species in California or elsewhere, but knew that it was a yearly visitor in the vicinity from which he wrote, staying about six weeks, after which it either died or disappeared in some unexplained manner. It was noticed that it was migratory. In some places there were millions of them, and they ate everything from garden truck to leather and canvas, and even each other. They appeared to be sensitive to heat and cold, and were described as herding together like hogs during the

night, while in the hottest part of the day they got under cover out of the sun. It was an interesting sight to see so many of them jumping and hopping like frogs. They were so large and ravenous that it took much vegetation to appease their appetites. They soon cleaned out a garden. The species appears to be peculiar to arid regions.

NOTES FROM CORRESPONDENCE.

Tobacco for mushroom fumigation.—John T. Cochran, Claymont, Del., writes that tobacco fumigation has been practiced with some success for mushrooms. It did not entirely remove the insects, but killed many of them. Our correspondent believes that a mild fumigation, as suggested by us, with tobacco stems at frequent intervals before the crop begins to show, will keep down insect pests.

Insect injury in Texas.—Mr. John Nagle, a Texas correspondent, of Gainesville, Cook County, writes under date of July 4, 1902, that every year the State loses 25 per cent of all crops through insect depredations, not including losses from other causes, the latter modifying clause being added because the year 1902 at that time gave promise of being one of great deprivation, as many farmers would suffer for the bare necessities of life in that portion of the State at least, where people were going 10 miles for water for use on their farms.

The apple twig-borer (*Amphicerus bicaudatus* Say) **injuring honey locust.**—This species, which is also called grape cane-borer and which is known to attack a variety of fruit, forest, and shade trees as well as shrubs, was received May 24, 1902, from Mr. W. S. Robb, Lacrosse, Kans., who reported that it was feeding on honey locust. As in the case of attack to apple, the beetles perforate the bark near a bud, thorn, or branch, generally above, and work directly toward the heart.

The pear-blight beetle in the Pacific region.—May 23, 1902, Mr. Harry G. Smith, Vancouver, Wash., sent twigs of Italian prune injured by this species, known also as the shot-hole borer (*Xyleborus dispar* Fab.), with the information that considerable injury was done in that region. Mr. Smith stated that the proportion of trees killed in his young orchard was about 10 to 75. June 12 we received a package of specimens from Ely, Oreg., containing beetles and a score or so of bits of twigs showing injury by this insect. These are the first instances of injury to our knowledge that have been recorded for this species in the far West. It would be interesting to learn how general the attack is, and whether the insects were introduced from our Eastern States, where the species has been present for half a century or more, or from Asia, where it occurs in Siberia.

Peculiar larval habits of a leaf-beetle affecting prickly ash.—During 1901 and 1902 Mr. J. D. Mitchell, Victoria, Tex., sent specimens of *Trirhabda brevicollis*, stating under date of May 4 of the former year that the larvæ burrow into the ground where it is slightly raised, making runs or galleries, from which they crawl out and about day and night, but never more than a few inches from the colony home. The following year he reported that he had found a large colony tunneling into a small hillock and crawling around on the surface of the ground, and had observed also that the pupal stage was passed in the ground, the mature insects issuing about ten days from the time that the larvæ disappeared. May 7, 1902, he noted that a large colony of the beetles, which are not unlike the common elm leaf-beetle (*Galerucella luteola*) in appearance, had about ten days later completely defoliated a large prickly ash (*Xanthoxylum americanum*). As with other species of this genus, the beetles are very sluggish, seldom flying, and dropping to the ground when touched or disturbed, and crawling slowly. Mr. E. A. Schwarz, of this office, has observed the same species at Victoria, Tex., often entirely defoliating the brush-like trees of this worthless plant. What is considered to be the same species which occurs in Michigan and all over the Eastern States wherever this plant occurs.

Blister beetles attracted to lights.—Mr. Otto Holstein, Cline, Tex., wrote during August, 1901, that he succeeded in getting rid of blister beetles as well as other insects by placing a lighted lamp in a basin of water; the insects flying about the light invariably fell into the water and drowned, a little oil upon the surface rendering it impossible for them to escape. This is an old-time remedy against a number of insects, and it is well known that blister beetles are frequently attracted to lights in considerable numbers. The trouble with this remedy, however, is that it is apt to destroy also many beneficial insects.

Parasites of the tent caterpillar (*Clisiocampa americana* Harr.).—Writing June 17, 1902, Mr. F. E. Brooks, Frenchcreek, W. Va., sent specimens of parasites of this species, with report that out of 43 cocoons collected on apple trees 9 yielded moths and 8 the tachina fly (*Frontina frenchii* Will.), while all the remainder gave 201 individuals of the ichneumon (*Pimpla maura* Cr.). Later, our correspondent sent two chalcis fly parasites (*Miotropis clisiocampæ* Ashm. and *Dibrachys boucheanus* Ratz.), as well as a species of Compoplegine from the same host.

Parasites of the plum curculio.—Mr. Brooks also sends us from the same locality a Braconid parasite of the plum curculio (*Conotrachelus nenuphar*), viz: *Bracon mellitor* Say; and a chalcis fly, a species of Eurytoma, also a parasite of the curculio.

Note on Pogonomyrmex barbatus, one of the agricultural ants of Texas.—Mr. G. M. Dodge has recently sent specimens of this ant, together with samples of seeds on which he observed it feeding at Ingram, Kerr County, Tex. These seeds have been identified by Mr. A. J. Pieters, of the Bureau of Plant Industry of this Department, as Texan grama (*Bouteloua texana*), sand bur (*Cenchrus tribuloides*), and lance-leaved sage (*Salvia lanceolata*). Our correspondent stated that he had seen the ants harvesting these seeds.

A Cimbex in British Burma.—Mr. George Field, of Washington, an importer of orchids, found attached to the roots of *Dendrobium wardianum*, an orchid from British Burma, a rough, brown silken cocoon from which issued May 17, 1902, in the insectary of this Department, a new species of sawfly of the genus Cimbex. This fact is of very considerable interest, since it seems that no species of this genus has ever been taken in Farther India.

Note on the ox warble in Mississippi.—March 27, 1902, Mr. Lawrence C. Johnson, geologist, Pachuta, Miss., wrote in regard to this species, which is also called the ox bot or heel fly (*Hypoderma lineata* Vill.), stating that about two weeks prior to the date of writing, with the first spring-like weather, this species had appeared in large numbers and had proved a great torment to cattle. The insect did not confine itself to attack on the heel, this, according to popular belief, being because the cattle stamped so much.

Christian Science for Cattle.—Mr. Franklin, formerly district attorney at San Antonio, Tex., vouches for the fact that two cattle owners at Llano, Tex., treat their cows for screw worms by Christian Science.

Scavenger flies as a creamery pest.—A correspondent at Garrison, Mo., writing May 16, 1902, transmitted specimens of the fly *Calliphora viridescens* Desv., with the report that these insects were new, and that they were troublesome in a room where milk was kept. They laid eggs in the cream when it was nearly sweet and beginning to turn. They did not appear to infest the butter, but tried to get into the sweet milk.

Notes on kissing bugs.—June 28, 1902, we received a specimen of *Reduvius personatus* Linn., from Mr. W. T. Hubbell, Philo, Ohio, with the information that it was caught in the night within the folds of a lady's nightdress after twice stinging her. The lady described the sensation as like the sting of a wasp, causing sickness and something like a chill, symptoms which, however, might have been due to nervousness, as the lady was not very strong.

July 28, 1902, Mr. J. C. M. Johnston, New Wilmington, Pa., sent a minute larva of a lace-winged fly (*Chrysopa* sp.), with report that it had bitten him on the hand,

and the sensation which followed was similar to that due to the bite of a mosquito, but no inflammation took place.

Tobacco as a remedy for grape leaf-hoppers.—Mr. Fred W. Card, Kingston, R. I., writes October 19, 1901, that a Mr. Saunders found tobacco stems on the floor of his grapery an effective remedy against grape "thrips" or leaf-hoppers (Typhlocyba). Mr. Card also suggested that after thoroughly clearing out the leaves and refuse during the fall the vines and houses should be thoroughly sprayed with kerosene emulsion.

The use of harvest spiders in medicine.—A correspondent from South Carolina sends us specimens of *Liobunum formosum* Wood, with the legs removed and the bodies packed carefully in gelatine capsules, with the remark that he has found them a sure cure for malarial fevers.

Negro superstition in regard to stinging ants.—The negroes of Louisiana have a superstition, an animistic belief in the little ant, which we call the bulldog ant (Mutillid) for the reason that it is always running around hunting other insects, that if they cook this in a piece of corn bread or mush and feed it to a young pup that it will make a good hunting dog out of the pup. As a general thing, this has to be done by some old hoodoo doctor. I went to work and did the thing myself, and the results were not satisfactory. So I told him it didn't pan out, and he said: "Well, that is because you didn't send for me. Give him to me, and I'll fix that dog up."—*E. S. Hallock, Washington, D. C.*

Successful infection of a wireworm with Cordyceps fungus.—July 6, 1902, Mr. C. W. Nash, Toronto, Canada, wrote that he had been successful in infecting the larva of an Elaterid beetle with a fungus disease, a species of Cordyceps. Somewhat prior to the date of writing, larvæ were noticed affected by this disease, and the spores were confined with other larvæ received from a distance, with the result that several of these larvæ were taken with the disease. Writing later, July 21, our correspondent sent a specimen of infected wireworm which Mr. E. A. Schwarz has identified as a species of Drasterius, and with little doubt *dorsalis*. This specimen had the fungus growing from the side of the head. The fungus was described as growing straight up until it reached the top of the jar in which it was confined. The specimen sent measured between 4 and 4½ inches.

Cutworm injury to ginseng.—Mr. George Adams, Detroit, Mich., writes in regard to injury done by cutworms to 2,000 valuable ginseng plants (*Aralia quinquefolium*). He states that they were all gnawed off at night, and that the plants were vigorous and healthy until cut down. In Pulaski County, Mich., he states that ginseng seed is selling at from $5 an ounce to $120 a pound, and that he had lost his entire crop of seed for the year.

The unicorn worm in a new role.—Under date of July 29, 1902, Mr. C. P. Crowell, Rochester, N. Y., sent a specimen of the larvæ of *Schizura unicornis* S. & A., with report that it was devouring the leaves of plum in that vicinity, literally eating everything as it went, leaves and plant-lice included. This insect, as is well known, is a rather general feeder on deciduous woody plants, but its habit of feeding on Aphides has not been recorded to our knowledge.

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