EIGHTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF

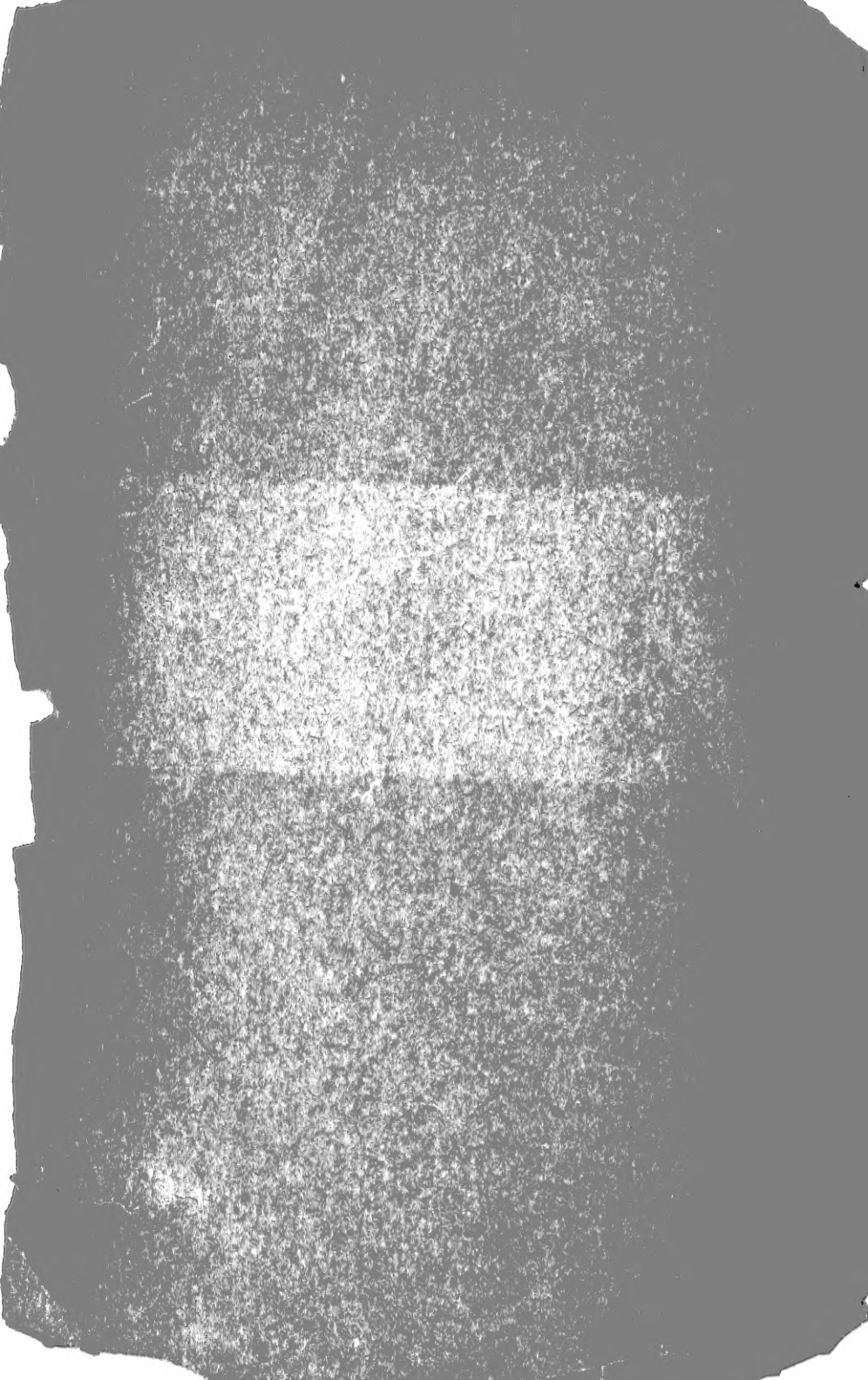
MINNESOTA

TO THE GOVERNOR

FOR THE YEAR 1903.

SECOND ANNUAL REPORT OF F. L. WASHBURN.

AGRICULTURAL EXPERIMENT STATION,
ST. ANTHONY PARK, MINN.
DECEMBER, 1903.



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LETTER OF TRANSMITTAL.

STATE EXPERIMENT STATION,
ST. ANTHONY PARK, MINN.
December 31, 1903.

To His Excellency, S. R. VAN SANT:

I take pleasure in presenting you herewith my second Annual Report, the eighth of the series.

With the exception of a serious loss over a limited area occasioned by an unusual number of Chinch Bugs, the year has been characterized by exemption from marked insect injury. This is evidently due in a great measure to the peculiar climatic conditions which prevailed in different parts of the state during last spring and summer, and in part to the growing appreciation of modern methods of farming among our citizens. I believe, as time goes on, and the farmers of the state become more conversant with the life history and habits of our leading pests, such as the Chinch Bug, they will learn to adopt remedies and methods of prevention of injury which are suggested and will be able to largely control the attacks upon their crops. Naturally, emergencies will arise from time to time, unforseen because it is impossible to predict them, when appeal must be made by farmers to some authority on economic entomology, whose resources may be taxed to the utmost in coping with some unexpected and unprecedented insect attack. It is for these emergencies that this department of the Experiment Station, in addition to its regular routine work, must ever stand prepared, and I wish to assure you, sir, that it will always be our aim to be of practical aid to those interested in agricultural pursuits.

During June, July, August and September about 600 letters were written, largely in reply to inquiries about insects, either identifying and advising in regard to some specimen sent, or giving remedies for some pest known to the correspondent. Some of the principal inquiries in this line are listed elsewhere

in this report. All correspondence received from farmers regarding insects is carefully filed.

About 1,000 eggs have been procured from silk worms raised in the laboratory, for distribution to public schools where nature study is taught.

In May, Press Bulletin No. 16, on the "Criddle Mixture," was issued. This contained a description of a cheap poisoned bait for Grasshoppers, which has been found very effective in Canada.

Numerous articles have been written for the press from time to time and several addresses made in different agricultural communities. In the latter connection, I will add, that the Entomologist has offered to hold practical talks during the fall and winter in localities which have been infested with any special pest or pests, such as the Chinch Bug, Grasshopper or Hessian Fly, and this offer has been accepted already by a number of farming districts; others will undoubtedly follow the example during the winter. The form of notice used is here given:

> The State Entomologist is preparing to hold a series of practical talks on Minnesota insects in different localities during the fall and winter to discuss with farmers the best means of combating any pest or pests, such as Chinch Bug, Hessian Fly, etc., with which those localities are troubled. These talks will be illustrated with specimens or pictures, or both. Farmers desiring a meeting of this kind are invited to correspond with the Entomologist of the Experiment Station at St. Anthony Park.

The Entomologist has also established a correspondence department, following the example of many other state entomologists, whereby he is kept in touch with insect conditions in different parts of the state during the spring and summer and will present a summary of those conditions in the form of original letters in the Annual Report. Observers are chosen from the ranks of those who have shown themselves proficient in this line of work. At present nine counties are represented from which reports are received once a month. As the number of efficient observers increase more counties will be represented.

We were obliged to chronicle last year a serious injury from native Grasshoppers in the Hill River District near McIntosh in Polk county. I am pleased to say that this has not been the case this year. Farmers in that vicinity have been induced to plow their stubble fields and are thus annually reducing the evil. In this connection I will state that the legislature last winter, ever ready to promote the agricultural interests of Minnesota, passed a "Grasshopper Law," which makes it obligatory upon the owner or lessee of land which is declared, by an expert, to be infested with Grasshopper eggs, to plow said land. This law has, I am confident, already proven of value in keeping this dread pest within bounds. Another law passed at the last session of the legislature in the interests of horticulturists and nurserymen, as well as for the benefit of their patrons and the state at large, is known as the "Horticultural Inspection Law." Both of these laws, while not as stringent as those which exist in some states, and not as strict as we should like to see them, are certainly steps in the right direction, and can be amended from time to time if public sentiment and the interests of the state demand. Each law is given in full in its proper place in this report.

On June 23d the following card was mailed quite generally to those counties of the state infested with Hessian Fly:

> This department of the Experiment Station is desirous of obtaining all data possible upon this insect. The number of broods in Minnesota is not known with certainty. The undersigned is doing field work on this subject and would be very grateful to farmers if they would advise him of the first appearance of any injury to wheat and send him specimens. Specimens of the first appearing "flax seeds" on this year's wheat are much desired.

As intimated in that card, special work has been done this year to determine the number of broods of Hessian Fly in Minnesota. Contrary to the belief of my predecessor, Dr. Lugger, who thought there was but one brood of this fly in the state, we have, I think, put the occurrence of at least two broods beyond question. This is fully discussed in the article upon Hessian Fly in this volume.

I wish to call especial attention to the results of the work on Paris Green, as given in this report. It is an observed fact that different packages of the same brand of Paris Green on the Minnesota market, although used in same proportions, give different results, frequently burning foliage to a marked extent. In other words some of the Paris Green is adulterated with free arsenic and other compounds, and different amounts of free arsenic being used in different cases, different results as to burning foliage naturally follows. It was to expose this practice and to defend farmers of the state from fraud that this department in connection with the chemical department of the station has instituted a series of analyses of samples purchased in different towns of the state. The results are shown in the article on "Poor Paris Green," on page 33.

Laws regulating the compositions of Paris Green exist in New York, Texas, Louisiana and California. It is evident from what our work brings out that some such law is necessary here.

I am obliged to refer to the extremely crowded quarters afforded the Entomologist at the Experiment Station, a state of affairs which causes great inconvenience. This unfortunate condition it is promised to relieve two years from now at which time the new state building will be completed and the Entomologist has been assigned an abundance of room therein. A better plan, if it were possible, would be for the university authorities to allow the department a building by itself, which, with the necessary equipment, insectary, etc., could be completed for $18,000 or less.

The routine work of the department is increasing marvelously. As the Entomologist becomes more familiar with the agricultural conditions of the state and enlarges his acquaintance among the farmers and fruit growers, new lines of work present themselves so rapidly and so many new and varied relations with the citizens are being continually entered upon, that the office work takes altogether too much time of the Entomologist and he is deprived of the opportunity for much of the research work which would seem to be desirable. The correspondence alone is quite an item, the mail of this office

having more than trebled in the past year and a half. The need of more assistance is imperative.

During the year the department has extended courtesies in the way of the use of its cuts to various parties; zinc etchings have been loaned to Mr. Oestlund of the University at Minneapolis, to Professor Pammel of Iowa; and permission was granted Professor Kellogg of California to have made from cuts in our possession a large number of electrotypes to be used in his forthcoming work. The same privilege was accorded Professor Blatchley of Indiana for his work on Orthoptera.

I have again to acknowledge courtesies received in behalf of the year's work from different sources. The members of the station staff and employes of the institution generally are in every respect obliging and courteous. The press, our best means of disseminating information quickly, has always been ready to serve in this work. While according to the general press all due praise for efficient aid in disseminating information, in fact, as has been stated, the press is one of our best means of getting facts before the people, the Entomologist cannot condemn too emphatically the practice of the Associated Press in sending out, notably from Washington, D. C., the most lurid reports which are calculated either to raise our constituents upon a pinnacle of hope from which they are later destined to be dashed, or to fill them with constant alarm. For instance, our citizens may learn, from what appears to be an authentic report, that Dr. Howard has discovered a fungus that will kill all the Grasshoppers in the country; and that another member of the staff is breeding, by countless millions, parasitic mites which will lay low the festive mosquito and that these parasites will be sent out in tubes to suffering humanity. Hardly have we stopped rejoicing over this news, when we are plunged into the depths of despair by startling statements spread broadcast over the country, amongst farmers and others, that a new kissing bug has been discovered; that a new worm has been found which contains in the bite of one individual enough poison to kill thirteen persons and so on, and so on. We do not believe that this office is the only one which receives, as a result of

these false reports, inquiries from their constituents showing that farmers accept these published statements as facts, in fact, conversation with other entomologists shows this to be the case. This is deplorable and the writer understands that as far as the Department of Agriculture is concerned the evil has been in a measure stopped. My thanks are also due to the Chicago Great Western, Northern Pacific, Great Northern, Chicago, St, Paul, Minneapolis & Omaha, Minneapolis & St. Louis, Duluth & Iron Range and Minneapolis, St. Paul & Sault Ste. Marie railroads, which roads have been of material assistance in furnishing transportation when occasion required.

The Minneapolis office of the U. S. Weather Bureau has kindly furnished complete weather reports for the spring and summer. These are made use of in the body of this report.

We are annually indebted to the Division of Entomology, U. S. Department of Agriculture at Washington, D. C., for many courtesies.

Before our last report went to press we engaged Mr. A. G. Ruggles of Cornell University as assistant. I am pleased to say that the assurances contained in the recommendations from leading entomologists accompanying his application have been more than fulfilled, Mr. Ruggles proving himself efficient and willing; the department owes much this year to his enthusiasm and faithfulness, as well as to that of the other members of the office force.

Thanking you for the kind interest you have always taken in the work, believe me,

Respectfully yours,

F. L. WASHBURN,

State Entomologist.

FINANCIAL STATEMENT.

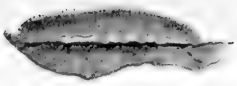
1902.		Amount.	Requisition No.
Nov. 24.	H. G. Todd	$39.23	....
Nov. 11.	McClure, Phillips & Co	1.63	2005
Nov. 10.	Bausch & Lomb Optical Co	29.56	1986
Nov. 10.	Art Engraving Co	69.65	1986
Oct. 31.	Southern Printers' Supply Co	1.00	1986
Nov. 29.	A. G. Ruggles	83.33	....
Oct. 24.	Lyman-Eliel Drug Co	.83	1986
Nov. 18.	American Entomological Society	45.00	2001
Nov. 10.	Doubleday, Page & Co	3.00	2005
Nov. 5.	W. K. Morison & Co	1.65	1986
Oct. 24.	O. H. Peck Co	4.73	1986
Oct. 28.	M. M. Cheney	7.50	1986
Nov. 26.	F. L. Washburn (traveling expenses, Norman Co.)	12.29	....
Nov. 20.	Entomological News	1.70	2005
Nov. 20.	Express	12.78	....
Nov. 20.	Southern Printers' Co	.60	1986
Dec. 12.	Gendron & Vaudrin (oil)	1.89	....
Dec. 10.	J. A. Schlener & Co	2.25	1986
Nov. 14.	Entomological Society of Ontario	4.20	2005
Nov. 28.	Harrison & Smith	6.25	1986
Nov. 24.	Julius Bien & Co. (plates for report)	380.00	2002
Dec. 18.	J. A. Schlener & Co	5.00	1986
Dec. 31.	A. G. Ruggles	83.33	....
Dec. 23.	H. G. Todd	30.00	....
Dec. 22.	Western Union Telegraph Co	4.55	....
Dec. 11.	Expressage	1.50	....
Dec. 10.	O. F. Stafford	5.00	1986
1903.			
Jan. 24.	Edwin R. Williams	4.65	{ 2407 / 2408
Jan. 22.	J. A. Schlener & Co	4.25	2407
Jan. 13.	R. S. Mackintosh	2.85	2408
1902.			
Dec. 3.	New York Entomological Society	6.40	2005
Dec. 1.	A. S. Froshaug (oil)	12.00	....
Dec. 22.	Bausch & Lomb Optical Co	3.90	1986
Oct. 26.	Harrison & Smith	3.00	1986
Nov. 25.	Harrison & Smith	6.00	1986

1903.		Amount.	Requisition No.
Jan. 20.	Childs, Edgerton & Wickwire (preparing grasshopper bill)	25.00	2407
Jan. 28.	Alma Dahl (stenographer)	16.25	....
Jan. 26.	A. G. Ruggles	4.00	2408
Jan. 30.	A. G. Ruggles	83.33	....
Jan. 20.	Webb Publishing Co. (publishing report 1902)	557.80	2403 2408
Jan. 28.	F. L. Washburn (traveling expenses)	98.85	2605
Jan. 16.	J. A. Vye	20.00	....
1902.			
Aug. 7.	Bausch & Lomb Optical Co	9.00	1986
1903.			
Jan. 7.	J. A. Schlener & Co	.98	1986
1902.			
Aug. 1.	Bausch & Lomb Optical Co	.80	1986
1903.			
Feb. 6.	Freight	7.65	2005
Jan. 28.	Harrison & Smith Co	6.00	1986
Feb. 7.	Wendell & Green	4.00	1986
Feb. 27.	Alma Dahl (stenographer)	15.75	....
Feb. 26.	J. A. Vye	10.00	....
Jan. 00.	Twin City Telephone Co	3.00	....
Jan. 9.	Tice & Lynch (zoölogical record)	74.00	2005
Jan. 20.	Boutell Bros	4.00	2407
Jan. 29.	Country Gentleman	3.00	2407
Mar. 2.	H. G. Todd	10.35	....
Mar. 2.	A. G. Ruggles	83.33	....
Mar. 28.	Zimmerman Bros	3.00	1986
Feb. 28.	Western Union Telegraph Co	3.23	....
Mar. 25.	Kny-Scheerer Co	3.44	2407
Mar. 25.	J. A. Schlener & Co	7.33	1986
Jan. 30.	W. K. Morison & Co	1.84	2407
Feb. 1.	Library Filing Cabinet Co	7.50	2407
Mar. 12.	Wyckoff, Seamans & Benedict	.60	....
April 1.	Edith Reed (drawings for report)	5.00	2409
April 1.	H. G. Todd	21.85	....
April 1.	A. G. Ruggles	83.33	....
April 1.	F. L. Washburn (expenses)	7.09	....
April 16.	Cornell Co-operative Society	.90	1986
April 2.	John Hopkins Press	5.00	2409
April 20.	W. K. Morison & Co	3.09	2409
1902.			
Nov. 3.	Lyman-Eliel Drug Co	.25	1986
1903.			
Feb. 2.	Lyman-Eliel Drug Co	.40	1986
April 4.	Lyman-Eliel Drug Co	.67	1986

1903.		Amount.	Requisition No.
April 29.	Harrison & Smith	14.75	1986
Feb. 1.	Twin City Telephone Co	3.00	....
Feb. 2.	Bausch & Lomb	.64	1986
April 8.	Jessie Polley (drawings for report)	2.00	2409
April 7.	A. W. Spencer (drawings for report)	2.00	2409
April 30.	Edith Reed (drawings for report)	7.00	2409
April 30.	H. G. Todd	18.40	....
May 1.	A. G. Ruggles	83.33	....
May 1.	A. G. Ruggles (traveling expenses, Polk Co.)	22.00	....
Mar. 16.	Western Union Telegraph Co	1.71	....
April 1.	Edward S. Field (entomological reference card)	36.25	1986
May 14.	Pioneer Press Co. (press bulletin)	15.55	2412
May 15.	O. H. Peck Co	8.50	2412
May 9.	Kennedy Bros	19.00	2407
May 5.	Bausch & Lomb	6.00	1986
April 30.	H. H. Wilson Co	.65	2409
April 28.	Zoölogical Record	11.87	2404
May 8.	J. A. Schlener & Co	13.90	2412
April 20.	Henry Heil Chemical Co	4.80	2409
April 29.	E. R. Williams	6.05	2409
April 23.	J. A. Schlener	3.60	2412
April 30.	J. A. Schlener & Co	9.60	2409
May 27.	Lyman-Eliel Drug Co	3.00	2412
May 30.	H. G. Todd	23.00	....
May 30.	Express	2.05	....
June 1.	A. G. Ruggles	83.33	....
June 3.	Dorothea Moxness (Paris green analyses)	30.00	....
June 3.	F. L. Washburn (investigation of insects affecting timber)	35.40	....
June 9.	Stamps	20.00	....
May 12.	Brooks Bros	1.80	1986
June 2.	O. H. Peck Co	28.10	2412
June 3.	Harrison & Smith Co	4.00	1986
June 8.	J. A. Schlener & Co	2.50	1986
June 1.	Twin City Telephone Co	3.00	....
June 30.	Edith Reed (drawings for report)	16.50	2409
June 29.	F. A. Mathieu (oil)	8.10	....
July 1.	Interstate Clipping Bureau	10.00	2001
July 1.	H. G. Todd	30.50	....
July 1.	F. L. Washburn (traveling expenses, Douglas and Itasca counties)	18.25	....
July 1.	Dorothea Moxness (Paris green analyses)	30.00	....
July 2.	A. G. Ruggles	83.33	....

1903.		Amount.	Requisition No.
July 2.	A. G. Ruggles (traveling expenses, Wright Co.)	2.84	....
July 2.	A. G. Ruggles (traveling expenses, Washington, Chisago and Clay counties)	20.18	....
July 28.	Harrison & Smith	16.00	2414
July 6.	F. A. Mathieu (oil)	7.80	....
July 6.	A. I. Root Co	13.00	2412
July 28.	W. G. Johnson (insect cabinet)	24.04	2414
July 16.	Harrison & Smith	8.00	1986
June 9.	Deming Co. (spraying machinery)	36.61	1986
July 30.	Edith Reed (drawings for report)	23.75	2409
July 23.	F. L. Washburn (Rice, Steele, Freeborn, Faribault, Noble and Rock counties)	23.40	....
July 30.	A. G. Ruggles (Rice, Hennepin and McLeod counties)	20.13	....
July 31.	A. G. Ruggles	83.33	....
July 31.	H. G. Todd	30.00	....
July 25.	Yawman & Erbe (office furniture)	60.00	2414
July 14.	E. B. Meyrowitz	20.00	1986
July 29.	J. A. Schlener	15.35	1986
June 30.	Western Union Telegraph Co	.95	....
July 25.	Eimer & Amend (apparatus, glassware, etc.)	209.72	2412
June 2.	Adam Deckèr & Co	1.25	2006
July 31.	Western Union Telegraph Co	.77	....
Aug. 1.	O. H. Peck Co	1.50	2412
Aug. 1.	J. A. Schlener & Co	1.80	1986
Aug. 1.	Andrus & Church (bulletin files)	10.00	2414
Aug. 21.	F. A. Mathieu (oil)	4.50	....
Aug. 22.	American Entomological Co	25.05	2414
Aug. 18.	Yawman & Erbe	1.44	2414
Aug. 8.	Dust Sprayer Manufacturing Co. (spraying machinery)	22.50	2412 1986
Aug. 20.	Yawman & Erbe	.75	2409
Aug. 25.	Harrison & Smith	10.50	1986
Aug. 27.	W. G. Johnson	22.25	2415 2416
Aug. 29.	E. R. Williams	4.50	2409
Aug. 31.	Edith Reed (drawings for report)	12.50	2409
Sept. 1.	F. L. Washburn (Stearns, Meeker and Chisago counties)	39.51	....
Sept. 1.	H. G. Todd	31.00	....
Sept. 1.	A. G. Ruggles	83.33	....
Sept. 1.	A. G. Ruggles (Clay, Marshall and Polk counties)	21.51	....
Aug. 15.	Pittsburgh Plate Glass Co	20.00	2415 2416

1903.		Amount.	Requisition No.
Sept. 1.	Twin City Telephone Co.	3.00	....
Sept. 3.	American Entomological Co.	2.15	2414
Sept. 9.	A. I. Root Co.	5.35	2412
Aug. 1.	W. R. Ansell.	22.00	2415, 2416
Sept. 14.	Pioneer Press Co.	8.50	2412
Sept. 15.	Experiment Station.	3.12	....
Sept. 30.	Ruth Holmberg (field work).	4.00	....
Sept. 30.	O. W. Moore (field work).	4.50	....
Sept. 30.	R. Lindquist (field work).	5.00	....
Sept. 30.	G. R. Mills (field work).	4.00	....
Sept. 30.	Oluf Foss (field work).	4.00	....
Sept. 30.	S. Z. Roach (field work).	4.00	....
Sept. 30.	F. L. Washburn (traveling expenses, Winona, Wabasha, Otter Tail, Douglas, Clay and Polk counties).	29.55	....
Sept. 30.	J. A. Vye.	9.31	....
Oct. 5.	A. G. Ruggles.	83.33	....
Oct. 5.	A. G. Ruggles (Washington county).	1.20	....
Oct. 5.	H. G. Todd.	30.00	....
Sept. 1.	Interstate Clipping Bureau.	10.65	2414
Sept. 26.	Pioneer Press Co. (paper and envelopes).	30.00	....
Sept. 30.	H. D. Harrison (field work).	2.50	....
Oct. 30.	Express	5.15	....
Sept. 30.	Western Union Telegraph Co.	4.28	....
Oct. 9.	W. J. Gerhard.	5.00	2417
Oct. 15.	E. T. Cresson.	1.50	2417
Oct. 27.	Edith Reed (drawings for report).	8.85	2409
Oct. 31.	A. G. Ruggles (Clay and Marshall counties)	15.85	....
Oct. 31.	A. G. Ruggles.	83.33	....
Oct. 31.	H. G. Todd.	30.00	....
Total		$4.146.45	....



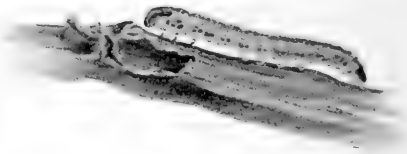
14
Cabbage Worm

12
Orange Striped Oak Worm

13
Lime Inch Worm

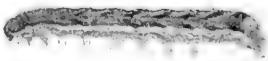
9
White-marked Tussock Moth

11
Forest Tent Caterpillar



10
Stalk Borer

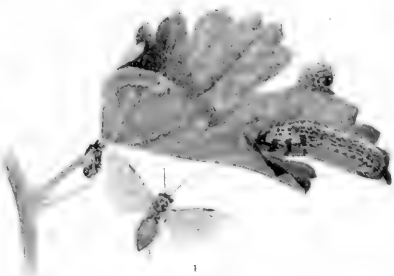
8
Mourning Cloak



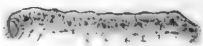
6
Spotted Cut-Worm

7
Eight Spotted Forester

4
Yellow Spotted Willow Slug



1
Imported Currant Worm



5
Zebra Caterpillar

1
Cecropia Larva

2
Blind Eyed Sphinx

SOME CATERPILLARS OF MINNESOTA

EXPLANATION OF COLORED PLATE.

These colored drawings, made from life by Miss Edith Reed, artist, and remarkably true to nature, will give an excellent idea of some of our more common caterpillars, though by no means all. It is to be noted that two of the figures, Nos. 4 and 5, are not really caterpillars. They turn into four-winged flies, known as Saw Flies, and not into moths or butterflies, but barring the difference in the number of prolegs they resemble caterpillars superficially, and having the same food habits are included here. All figures are life size except Fig. 1, which is half life size.

Fig. 1. Cecropia larva; *Attacus cecropia*, Linn. These caterpillars feed on almost all fruit and shade trees and small fruits. Their number is never large, and for this reason, and because they are so conspicuous, they can be removed by hand-picking. They are preyed upon by parasites, some birds, and other animals. Emerge from their silken cocoons (see Fig. 109 on p. 172) in May or June as large moths, similar to the one pictured on page 172.

Fig. 2. Blind-Eyed Sphinx, *Paonias excaecatus*, S. and A. Infests apple and other trees. Caterpillar enters the ground to undergo transformation, and moth (see Fig. 110, p. 173) emerges in May, June or July. This caterpillar, not uncommon in this state, is figured as a type of the Sphinx Caterpillar. Should they ever become sufficiently numerous to be markedly injurious they could be controlled with arsenical poisons.

Fig. 3. Zebra Caterpillar, *Mamestra picta*, Harris. This beautiful cut-worm, although really a cabbage insect, has been known to eat the leaves of the apple. The caterpillar forms a cell in the ground, turns into a pupa and the brownish moth (Fig. 111, p. 173) emerges in the spring.

Fig. 4. Imported Currant Worm, *Nematus ribesii*. Appeared in this country in 1858. Not a true caterpillar. Feeds upon leaves of currant and gooseberry. When full grown it spins a cocoon in the rubbish under the bushes or on

the stems or leaves of the bush upon which it was feeding. The perfect fly, also shown, emerges in June or July.

REMEDIES: Spray or sprinkle bushes with one tablespoonful of Paris Green in pail of water, keeping liquid constantly stirred. This is to be applied only when fruit is green. When later treatment is necessary use Hellebore dry when leaves are moist, or in water, 1 oz. to each pailful.

Hand-picking while the insects are young is helpful.

Fig. 5. YELLOW-SPOTTED WILLOW SLUG, *Nematus ventralis*, Say. Feeds on willow and poplar. Eggs are laid in puncture in the leaf.

REMEDIES: Can be controlled by Paris Green spray, as recommended for currant worm. Like the currant worm, not a true caterpillar, turning into a small four-winged fly.

Fig. 6. SPOTTED CUT-WORM, *Noctua c-nigrum*. A very common species and figured here as being typical of the cut-worm family. The individual from which this drawing was made was, with its fellows, feeding upon clover and a neighboring field of onions. See Fig. 119, p. 178.

REMEDIES: Fall plowing; avoid as far as possible using land which was in sod the previous year. See page 161 for remedies in more detail.

Fig. 7. EIGHT SPOTTED FORESTER, *Alypia octo-maculata*. This beautiful caterpillar feeds upon grape and woodbine. It passes its pupal stage just beneath the surface of the ground, emerging as a beautiful blue-black moth with two pale yellow spots on each wing, making eight in all. See Fig. 112, p. 174.

REMEDIES: Hand-picking, or Paris Green, or Hellebore, when necessary.

Fig. 8. MOURNING CLOAK, *Euvanessa antiopa*. This caterpillar feeds in colonies on the elm, poplar, willow and other trees. It is of wide distribution. The specimen from which the accompanying figure was made was with its fellows stripping the leaves from an elm in St. Anthony Park. This species hibernates as a butterfly, and is sometimes seen on the wing on warm winter days. The writer has seen them on the wing in Minnesota in March. See Fig. 113.

Remedies: Cutting off and burning small branches when first observed to be infested. Dislodging by vigorous shaking and then destroying the worms. Spraying with Paris Green.

Fig. 9. White Marked Tussock Moth, *Orgyia leucostigma*, S. and A. This beautiful caterpillar feeds upon the foliage of maple, poplar, cottonwood, etc. It is not as yet abundant enough here to call for any special remedies.

Fig. 10. Stalk Borer, *Hydroecia* (*Papaipema*) *nitela*, Gn. This troublesome pest attacks tomato vines, potato plants, aster, dahlia, golden glow, hollyhocks and other plants with soft centers. Even wheat has suffered in Minnesota. A sudden wilting of the plant or parts of plant indicates presence of caterpillar in the stem. It turns into a brownish moth.

Remedies: This caterpillar has been killed in its burrow by injecting about one teaspoonful of chloroform through the opening with a medicine dropper and then plugging the hole with cotton. The writer believes that bisulphide of carbon will do the work equally well and more cheaply, but has had no opportunity to try the same.

Fig. 11. Forest Tent Caterpillar, *Clisiocampa distria*, Hub. Very common in Minnesota. Feeds upon plum, apple, maple, oak, ash, basswood, etc. See Figs. 114 and 115, p. 175.

Remedies: Cutting off egg masses before leaves appear and destroying same. Crushing young worms with the hand when still small and in clusters. When leaves are being badly eaten trees may be sprayed with Paris Green, 1 lb. to 160 gals. of water. Add 2 to 4 lbs. of fresh lime to this amount of liquid to guard against burning foliage. Keep mixture constantly stirred.

Fig. 12. Orange-Striped Oakworm, *Anisota senatoria*, Hbn. Sometimes very destructive to oak trees, but also attacks raspberry and blackberry. See Fig. 116 for illustration of moth.

Remedies: Paris Green sprays are useful against all leaf-eating insects.

Fig. 13. Lime Inch Worm, *Hybernia tiliaria*, Harris. This "measuring worm" feeds upon the basswood or linden, also on elm, hickory, etc., and sometimes on the apple. The

female moth is wingless. For illustrations of the male and female moths, which produce the caterpillar, see Fig. 117, p. 176.

REMEDIES: Same as for other leaf-eating species when such remedies are practical.

Fig. 14. IMPORTED CABBAGE WORM, *Pieris rapae*. This very common caterpillar is well known to every farmer and gardener. They are known to feed upon plants other than those included in garden crops, i. e., shepherd's purse, pepper grass, cress, nasturtiums, Russian thistle, wild mustard, etc. The beautiful white butterfly which produces this caterpillar is shown on page 177, Fig. 118.

REMEDIES: Employ children to catch with nets all they can of the butterflies in the spring before they have laid their eggs. Hand-picking of the worms. Spray plants with Paris Green solution (see No. 41, p. 116), or use Paris Green and flour early in season, and later, when heads are formed, use Hellebore (see No. 27, p. 110). Flour alone sprinkled over the head and leaves is said to be useful.

INJURIOUS INSECTS OF 1903.

BY F. L. WASHBURN, State Entomologist.

THE HESSIAN FLY.

A glance at the accompanying map will reveal the very general distribution of the Hessian Fly in Minnesota as indicated by reports for the seasons 1902 and 1903. A line drawn from the northern boundary of Kittson county and passing due south, east

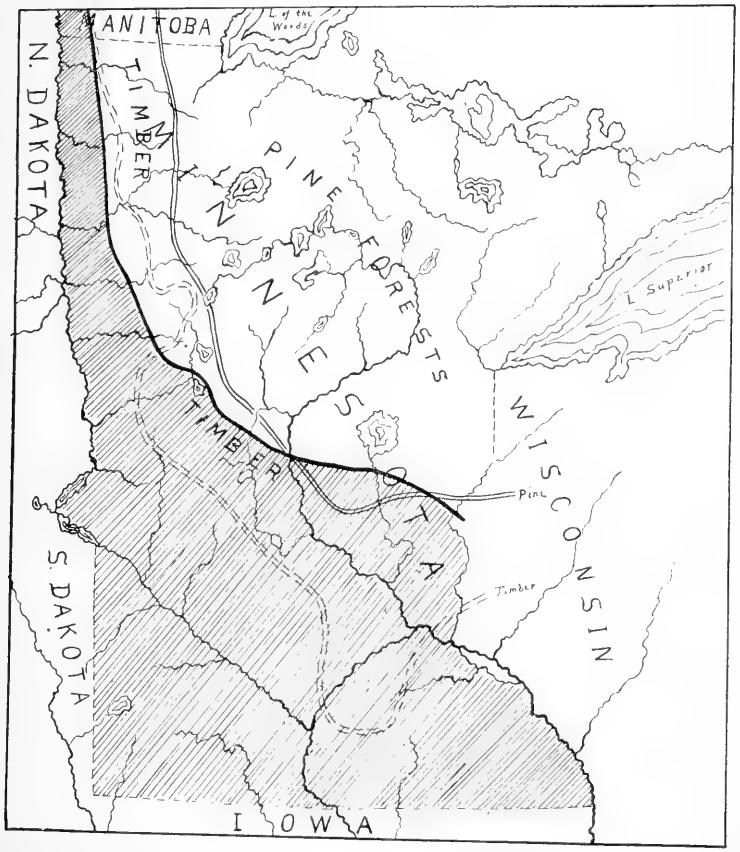


Fig. 1.—Map of Minnesota, the shaded area showing present distribution of the Hessian Fly.

of Hallock, thence through McIntosh in Polk county; thence southeast through Norman, Becker and Morrison counties to Little Falls; thence southeast through Mora to State Line, would represent very nearly the eastern and northern boundary of the affected portion of our state. In other words, the chief part of our agricultural district is in the grasp of this minute, yet destructive, insect. It is not to be understood that every county situated in the shaded portion of the map is infested, but a very large proportion of these counties are sufferers, as shown by the reports of the last two years, namely, Otter Tail, Kanabec, Polk, Clay, Becker, Douglas, Meeker, Marshall, Rock, Isanti, Lyon, Swift, Stearns, Chisago, Washington, Dodge, Wilkins, Kittson, Morrison, Lac qui Parle, Yellow Medicine, Rice, Kandiyohi, McLeod, Chippewa, Stevens, Brown, Nicollet, Grant and Goodhue. There are doubtless other infested counties which have not been reported.. Old maps published in Government Reports, showing only south part of Minnesota to be infested, must be altered to include all of wheat-raising portion of the state.

The first report of injury this year came with specimens from Lac qui Parle county.

The fly has been no worse than, and in portions of the state not so bad as, last year. Counties in the south and counties south of west central portions are heavier sufferers than the Red River country from Clay northward. There is no question but that parasites are largely responsible for keeping this pest in check, but the general freedom enjoyed this year by the northern counties in the Red River Valley, in contrast to the conditions which prevailed in southern portions of the state, is directly in accord with the meteorological conditions prevailing in these two portions. Through the courtesy of the Minneapolis office of the U. S. Weather Bureau I have been furnished with a complete record of weather conditions prevailing during April, May, June, July, August and September in counties in north, south, southwest and southeast portions of Minnesota. Following is a tabulated statement of the conditions at these various stations:

TABLE NO. 1.

1903.	Stations. Counties.	Mean Temp.	Total Precip.	Rainy Days.	Clear Days.
May.	Albert Lea, Freeborn	59.8	7.99	14	12
June.	Albert Lea, Freeborn	64.0	3.25	9	20
July.	Albert Lea, Freeborn	69.6	3.21	8	15
August.	Albert Lea, Freeborn	65.6	6.42	11	13
September.	Albert Lea, Freeborn	57.4	6.20	9	13
	Total	63.2	20.87	51	83
May.	Faribault, Rice	58.2	7.74	14	9
June.	Faribault, Rice	62.6	0.85	5	21
July.	Faribault, Rice	67.8	8.26	9	19
August.	Faribault, Rice	64.6	3.67	13	15
September.	Faribault, Rice	58.2	5.90	11	17
	Total	62.2	26.42	52	91
May.	Hallock, Kittson	54.6	2.30	9	21
June.	Hallock, Kittson	61.8	2.55	9	21
July.	Hallock, Kittson	65.3	2.20	8	20
August.	Hallock, Kittson	61.6	3.81	13	18
September.	Hallock, Kittson	51.0	4.17	5	16
	Total	62.8	15.03	44	96
May.	Lynd, Lyon	57.0	6.73	12	19
June.	Lynd, Lyon	62.7	3.49	8	21
July.	Lynd, Lyon	67.4	5.05	10	21
August.	Lynd, Lyon	65.6	5.16	10	15
September.	Lynd, Lyon	57.9	5.20	12	12
	Total	62.6	25.63	52	88
May.	Moorhead, Clay	56.0	3.36	10	13
June.	Moorhead, Clay	63.0	0.80	7	17
July.	Moorhead, Clay	67.0	2.86	10	13
August.	Moorhead, Clay	63.7	5.58	13	11
September.	Moorhead, Clay	53.4	5.60	12	8
	Total	60.6	18.20	52	62

TABLE NO. 1—Continued.

May.	St. Cloud, Stearns	59.0	5.28	13	9
June.	St. Cloud, Stearns	64.2	1.28	4	22
July.	St. Cloud, Stearns	67.8	10.50	6	13
August.	St. Cloud, Stearns	63.6	2.64	8	10
September.	St. Cloud, Stearns	56.1	5.20	9	16
	Total	62.7	24.90	40	70
May.	St. Paul, Ramsey	59.4	5.28	13	9
June.	St. Paul, Ramsey	65.4	1.16	7	16
July.	St. Paul, Ramsey	69.6	5.61	8	12
August.	St. Paul, Ramsey	65.9	4.90	13	11
September.	St. Paul, Ramsey	58.7	7.84	11	13
	Total	63.8	24.79	52	61

It is well known that the Hessian Fly, unlike the Chinch Bug, needs cool, moist weather for its development. Many warm, dry days while it is in the immature stage are fatal. It will be seen by looking at the above table that Kittson county, for example, had less rain and more sun than the southern counties. We would therefore expect that the fly would be less numerous and less destructive there than in the south, which was the fact. An assistant visiting Warren on August 5th reported "flax seeds" in small numbers, and the per cent of grain down, both at Warren and McIntosh, from this cause to be very small. Working south, he found "flax seeds" much more numerous in Clay county.

By far the most interesting fact discovered this year in regard to this pest is the very evident proof that there is more than one brood in Minnesota. My esteemed predecessor, Dr. Lugger, declared there was only one brood here. He is quoted as saying: "Not one fly issued from stalks gathered as soon as injury became visible. * * * This assuredly seems to indicate that the flies do not issue during the autumn as they do farther south, but remain in the culm until spring." He further *found no larvae or puparia in volunteer wheat plants growing near fields which had been badly infested.*

It has seemed to the writer that the flax seeds found in the stubble in the autumn would hardly account for the immense injury done the crop of the succeeding year, unless the fly was more than one brooded, and hence special attention has been given during the season to determine this point. From the following facts it is believed that the occurrence of more than one brood is placed beyond the shadow of a doubt. For a better understanding of the following the reader should be told that the

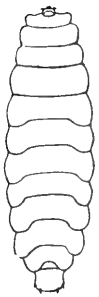


Fig. 2.—Larva of Hessian Fly in first stage. Enlarged 50 times. Original.

Fig. 3.—Larva of Hessian Fly in second stage. Enlarged four times. Original.

so-called "flax seed" is a puparium formed by a hardening of the skin of the maggot.

On June 25th larvae in the second stage were found on stalk just above first joint in Panola township, Chisago county, brought to laboratory and placed in breeding jar where they shortly formed puparia. On July 1st more maggots were found in second stage in Clay county; in one case four individuals being discovered on one stalk just above second joint. These were placed in breeding jar, and July 8th changed to puparia, or

"flax seeds." See drawing on page 7. On same date one specimen was found in first larval stage. See drawing. The latter did not live.

On July 19th a female emerged from one of the "flax seeds" formed by maggot of second stage which we secured June 25th in breeding jar. This female died on the 21st, having previously laid between 80 and 90 eggs on green shoot of wheat which had sprung from the root and on dried stalk of plant against which "flax seeds" were lodged. The stalk was green, of course, when placed in breeding jar. The eggs were laid singly, in clusters

Fig. 4.—Female Hessian Fly on wheat stalk, about eight times natural size. Original.

and in short strings. She was laying, of course, under abnormal conditions. They were for the most part slightly curved, though some were spindle-shaped. The egg pictured was 1-60 of an inch long and 1-250 of an inch wide in center, just visible to naked eye.

From the larvae in second stage, brought in July 1st and placed in breeding jar, forming puparia on July 8th, one female resulted, issuing from "flax seed" on August 16th. She died August 18th, without ovipositing. These facts were duly published in the Canadian Entomologist for November, 1903.

From the foregoing observations one would naturally conclude that probably the fly would be found in an immature stage upon wheat which had volunteered in the stubble field, and such proved to be the case, both "flax seed" and maggots (second stage) being found on volunteer wheat growing in stubble in Clay county October 18th.

This last finding is significant, showing that winter wheat

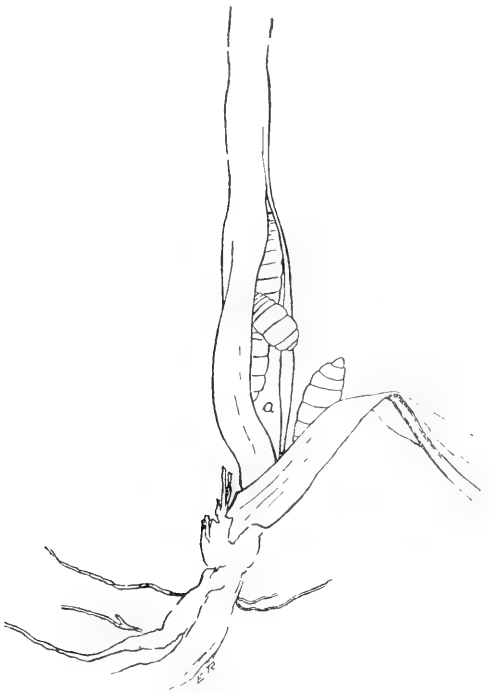


Fig. 5.—Four Hessian Fly larvae on one stalk, just changed to "flax seed" stage. Enlarged four times. Original.

would be affected if raised in Minnesota and also showing an additional source of infection when the volunteer is not turned under; in other words, the "flax seeds" seen in the stubble might not account for the injury to the crop in the early part of the following season, but these, plus those in the volunteer which we have not hitherto considered, might easily be responsible for the quite extensive injury caused by the first generation the fol-

lowing spring. Volunteer in plowed land adjoining infested fields, and undisturbed volunteer along the edges of fields, may both furnished their quota of flies the following season. Of course the freezing down of these volunteer plants during the winter would not kill the contained "flax seeds" any more than the cold would affect those in the stubble. While we can say with confidence, from our discoveries this season, that there is more than one brood in Minnesota, too hasty conclusions must not be drawn as to the actual number of broods, since the weather may have a marked effect in this direction.

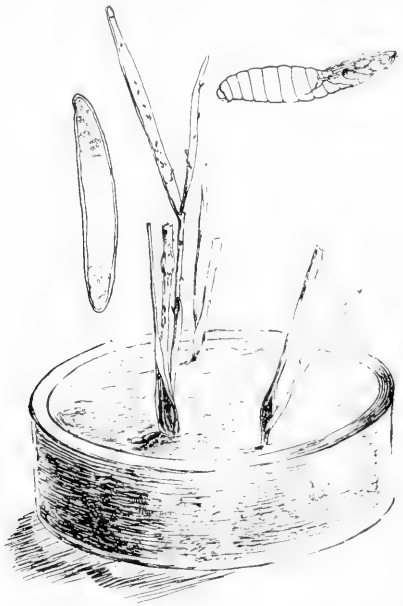


Fig. 6.—Wheat Plant used in breeding jar, showing eggs on leaf; one egg in outline, enlarged about 70 times, and pupal skin protruding from puparium four times enlarged. Original.

One farmer declares that fall plowing will not kill the fly, stating that he kept wheat off his fields for two years and summer-fallowed the year preceding wheat, yet his next planting was very seriously affected. In response to my query about his neighbors, he said there might have been neglected stubble one-third of a mile away, but no nearer. The explanation of this infection can be found in the fact that the fly may have been

carried by the wind or actually flown from the neighboring farm, even though a third of a mile away, or they may have possibly come from flax seeds on volunteer stuff overlooked on the edges of the field. It is more than probable that the first explanation is correct, illustrating very forcibly the need of co-operation.

The life history of this pest has been thoroughly discussed in previous reports from this office, notably that of last year, and need not be repeated here. The same might be said of remedies and methods of prevention, but in order that this information may be as widespread as possible among our farmers, the latter are repeated here. To these I will add a suggestion, that varieties of wheat which produce a stiff straw be planted as far as possible, or that the land be so handled that it will grow strong straw, capable of standing up in spite of the ravages of the fly. The Fifes may fill these requirements, supposing the soil is in proper condition. One must clearly distinguish between the two terms "strong straw" and rank growth," the latter being undesirable, since it results in weak straw. Conditions of the soil which produce a "rank growth" of straw, therefore, are to be avoided.

REMEDIES AND MEANS OF PREVENTION.

1. Burn the stubble when, from any reason, shallow plowing is unavoidable, or when plowing is to be delayed in the spring until after emergence of flies. If the stubble is left long it will burn easier. Some farmers are willing to go to the trouble of spreading straw from threshing over the stubble, thus insuring the burning and at the same time getting rid of some "flax seeds" which may have lodged on the surface of the straw pile at the time of threshing. It is well, however, to remember that repeated burnings, from the standpoint of our chemists, are not good for the soil.

2. Fall plowing of the stubble in such a way that the straw is completely turned under. In this connection we should not overlook the fact, made evident from the findings of 1903, that volunteer wheat, wherever found in the fall, may contain flax seeds.

3. All screenings and litter about the threshing machine should be cleaned up and either fed immediately or burned, leaving no litter from the threshing on the field. There is no absolute need of burning the straw pile. The flies emerging from "flax seeds" in the center of the pile will never reach the surface.

4. Since the fly lays its eggs as a rule near the locality where it emerges from the "flax seed," it is best not to plant wheat on

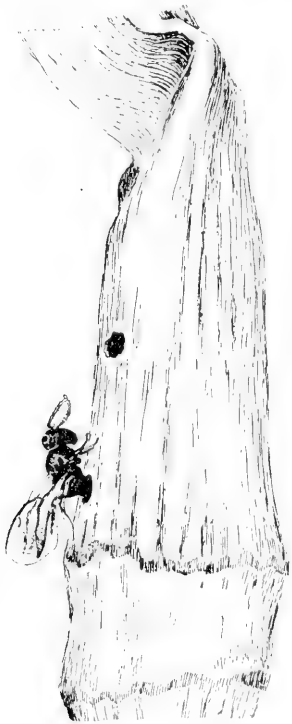


Fig. 7.—Merisus, a parasite of Hessian Fly, emerging from a "flax seed" through base of leaf. Original.

the same ground two years in succession where rotation is possible. Varieties of wheat that produce a stout stalk are the least affected by this pest, and varieties of wheat should be selected and the soil handled to that end, remembering that a rank growth does not mean strong straw, but the contrary.

5. Co-operation is absolutely necessary, for, however careful one man may be, if his neighbor is not equally so the latter's

fields will afford a supply of this pest for the former. Since this pest issues from the "flax seed" early in May, a stubble field left for corn land and not plowed up to the 10th of May or later has probably discharged its quota of flies, ready for mischief, before plowing.

As stated elsewhere, this pest will increase and decrease at regular intervals, due to the increase and decrease of its many parasites, which in turn are due to the abundance or the contrary of the fly.

An assistant, Mr. Ruggles, visiting farms in the neighborhood of Faribault, Rice county, on July 24th, at which place Chinch Bug and Hessian Fly were both abundant, made the following observation, viz.: That he could almost invariably tell where to look for "flax seeds" from the fact that where the heads of wheat were entirely shriveled the plant was badly infested with Chinch Bugs, while plants with but few kernels whitened almost invariably contained "flax seeds." This is interesting and might be of some value to a farmer endeavoring to estimate which pest was doing him the most harm before the ripening of the grain. When the grain is about ripe and afterward, the fallen heads tell the story.

The food plants of the Hessian Fly are too well known to need comment, viz., wheat, barley and rye. Assurances have been made the Entomologist by a few farmers that "flax seeds" have been found by them upon oats, but the most careful search by this office has failed to reveal them, and we are forced to conclude that these observers were mistaken, yet there is no *a priori* reason why the traditional food habits of this pest might not change in some sections, and oats be included in their bill of fare.

CHINCH BUG.

While the extremely wet weather prevailing in some portions of the state during last spring and summer kept this pest in check in favored localities, other portions less wet or where sandy soil and good drainage prevailed, suffered most seriously. It was a banner year for Stearns and adjoining coun-

ties in this respect, Stearns being particularly afflicted. On the farm of Mr. Chris. Block, near Maine Prairie, where previously by good farming method the land had yielded twenty-five bushels per acre or over, I found a most serious condition of affairs, the grain being badly shriveled. "This wheat is unsalable," said Mr. Block, "and I shall use it for my hogs; it will barely pay for the binding twine and labor of threshing. I shall not raise wheat or barley next year."

Approximately the same condition prevailed in many sections of Stearns county; while some fields were not touched by the bug, others suffered a loss of from 30 per cent to 50 per cent, and some wheat was not deemed worth cutting. Heavily manured portions, which was the case in Mr. Block's

Fig. 8.—An ideal place, seen upon almost every farm, for the Chinch Bug to pass the winter in.

land, were the worst affected, the surface dressing applied in the autumn forming a favorable place for the bug to pass the winter. In this county, Stearns, timothy was damaged to some extent.

In driving from St. Cloud to Maine Prairie through Luxemburg on August 25th I noted that six out of every ten corn fields were badly infested with Chinch Bugs for several rows deep. On some of the least affected it was evident that the ears would mature, weather conditions allowing, but in the majority of cases the entire plant was doomed.

In some infested portions of the state I found this pest the worst on land which had been in corn the year previous, the corn stubble being allowed to remain and the wheat disked in. The bugs being on the corn when it came time to hibernate remained about the stubble, and in the spring found wheat plants upon which to lay their eggs growing at the very door of their winter quarters.

The different expressions called forth by the ravages of this pest are worthy of repetition as showing the different views taken by different citizens; many farmers are utterly discouraged, others say they "will not raise any more wheat for several years." Still others exclaim: "It is a good thing, we are raising too much wheat; this will force us into more diversified farming and lead us to raise more live stock." Still another man says: "The Chinch Bug is a good thing; tell our farmers that they must stop raising wheat; they cannot compete with the large western farmers, and they might as well stop trying," etc. Manifestly it does not lie within the province of the entomologist to give any such advice.

Whatever different views different farmers may hold regarding this pest, it is evident that keeping it in check is one of the most serious problems which confront us at this time. Though not of such general distribution as the Hessian Fly, it creates greater havoc locally, and is all the more to be dreaded because, as happened this year, it may, when climatic conditions are favorable, suddenly destroy from one-half to an entire crop in a locality which has been practically immune for a number of years. Further, the very methods of farming which we like to encourage, namely, a generous treatment of the land as regards manuring, and clean cultivation of the corn field, may be the most encouraging causes of its increase. To give an idea of its prevalence during the year just passed I list the localities from which reports of injury have come: Corvuso, Princeton, Minden, West Ripley, Royalton, Roseville, Grove City, St. Nicholas, Thomastown, Kimball, Lake Henry, Little Sauk, Hutchinson, Ledoux, Culdrum, Pierz, Manamal, Acton, Motley, Litchfield, North Kingston, Pulaski, Central North Prairie, Upsalon, Belleview, Elysian, Melrose, Foley, Osakis, Irving, Long Prairie, Spring Hill, Willmar,

Round Prairie, St. Cloud, Ringville, Maine Prairie, Richland, Watkins, Brownsville, Litchfield, South Haven, Fair Haven, Foreston, Belgrade, Pillager, Burtrum, Granite Lake, Central Collingwood, Rich Valley, Sauk Center, Forest City, Maple Lake, Georgeville, Forest Lake, Milaca, Faribault, Glenwood,

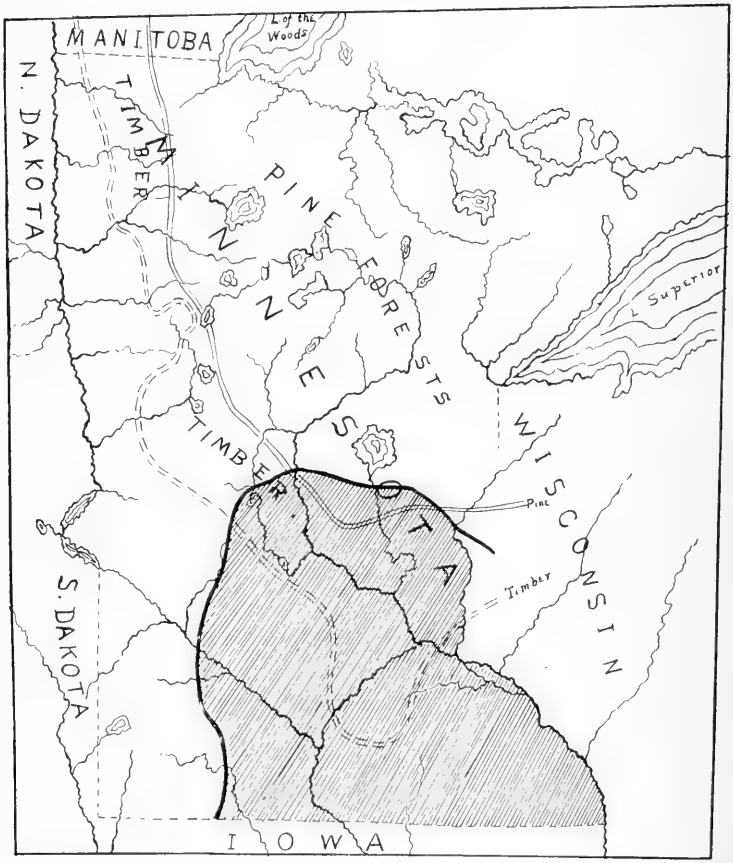


Fig. 9.—Map of Minnesota, the shaded portion showing the distribution of the Chinch Bug in 1902 and 1903.

Alden, Lincoln, Avon, Little Falls, Maple Plain, Harrison, Wabasha, Paynesville, Clear Lake, Brownton, Panola and Marine; representing the following counties: Meeker, Mille Lacs, Benton, Dodge, Morrison, Kandiyohi, Stearns, Todd,

McLeod, Redwood, Le Sueur, Douglas, Rice, Cass, Wright, Dakota, Ramsey, Hennepin, Washington, Pope, Freeborn, Anoka, Wabasha, Sherburne, Houston, Jackson and Chisago. In the accompanying map the shaded portion represents the area of the state infested in 1902 and 1903. This area is bounded on the north and west approximately by a line running northwest from the vicinity of Rush City to Little Falls in Morrison county; thence southwest to Osakis in Douglas; thence south through Redwood Falls to State Line. As in the case of the Hessian Fly not all the counties included within that area were infested, but all counties infested lie within shaded area. Dodge county, which had much rain this season, had few or no Chinch Bugs, according to report, and no reports of injury came this year from Lyon (which has not been included in shaded area), Isanti, Kanabec, Nicollet, Watonwan or Waseca.

As intimated above, Stearns takes the prize as being the worst sufferer last summer; Meeker is a close second, then comes Morrison, Kandiyohi and Wright in relative amounts of injury, followed by Pope, Benton and Sherburne. The writer found one or two Chinch Bugs near Alexandria, Douglas county, this season, while studying the Hessian Fly, and a report reached us of its occurrence in Osakis, same county. Farmers in this county report its presence in small numbers in different districts, but not as yet numerous enough to cause injury.

Consulting reports of this department for the last nine or ten years, it will be seen that the above map gives a very good idea of that portion of the state usually visited by the Chinch Bug. In 1887 it was reported as occurring somewhat farther north in the central and eastern portions, and I have heard this year from Lindsay P. O., Polk county, to the effect that they occur there every year to some extent. I have not been able to secure specimens from there, however, and doubt the correctness of the report; my correspondent must be mistaken.

On the Experiment Station farm on April 17th I found Chinch Bugs crawling actively about under a little rubbish which had afforded them a winter retreat. They were ob-

served mating from May 28th as late as June 26th. On May 27th they were extremely abundant on the farm; still more so on June 4th. On June 25th their numbers had very materially decreased, being much less numerous than they were three weeks previous.

In accordance with a plan made the previous year, a strip of millet the width of the seeder was planted as an experiment about a wheat field April 22d, the same date at which the wheat was sown. This millet did not come up, and a second sowing was necessary, which brought the millet up so late that it was no protection to the wheat; it was so far behind that it did not serve as a catch crop, the bugs preferring the succulent grain in the center of the field. In view of the fact that only in exceptional conditions can millet be made to grow when planted at the same date that wheat is planted, it is evident this, as was anticipated, is not a practical thing for the farmer.

What shall be done, then, to combat this evil? Practically all entomologists have abandoned the use of bugs infected with fungus, "diseased bugs," as they are called, because it has been found to be not practical. We have then at present no successful means of combating them when spread through a large field of grain. We must turn our attention, therefore, to methods of farm practice which, supposing we are troubled one year, will lessen the danger for the following year, and to certain means of procedure to save our corn.

1. **A thorough cleaning up of all rubbish in the late autumn is desirable, in order to do away with all places favorable for hibernation, and as far as possible to destroy the hibernating adults.**

2. **If the bugs remain on weeds in stubble in great numbers, after wheat is cut, and if no grass crop is growing thereon, plowing the stubble deep immediately after cutting would probably destroy very many of the pests.** Whether such action is desirable or necessary must be left to the individual farmer, who best knows the conditions he has to meet.

It is an observed fact that corn neglected as to cultivation has escaped injury, although in close proximity to infected wheat fields. In other words, where pigeon grass has been

allowed to grow among the outer rows of corn, the bugs, greatly preferring that, attack it, leaving the corn practically untouched. This is an important fact, for it offers a remedy within the reach of every one, costing nothing, albeit it may seem to encourage laziness.

As our farmers are doubtless aware, Chinch Bugs are also very fond of millet, and Mr. James Hanna of Forest City, one of the most energetic farmers of Meeker county, tells me he intends planting a strip of millet about his corn next year, expecting it to hold the bugs until the corn gets beyond them, and possibly attempting to destroy the pests while on the millet. In view of these observed facts, I also suggest for use where this pest seriously affects corn:

3. **Stop cultivating a few of the outer rows of corn early enough to allow pigeon grass and succulent weeds to grow therein.** It is with reluctance that I make any such suggestion, the undesirability of raising weeds whose seeds will be disseminated is very evident, yet there is no question but that the presence of such weeds saves the corn.

4. **Better still, plant a strip of millet the width of the seeder about the corn field at such a time that it will be 8 or 10 inches high when the wheat is ready to cut and the bugs are migrating to corn.**

In order to lessen the number of Chinch Bugs for the following year they should be killed while in the millet. This might be done in various ways. Plowing it under deeply would undoubtedly do away with many of them, but I suspect some would work their way up through the loose soil, if it were not compacted by several harrowings. Or, they might be destroyed by sprinkling the millet most thoroughly with strong kerosene emulsion,* or even with a mechanical mixture of water and kerosene, three parts of the former to one of the

*Recipe for Kerosene Emulsion: Dissolve ½ pound of soft or hard soap in 1 gallon of water, boiling it thoroughly. When the soap is dissolved, remove the liquid from the fire and, when boiling hot, add two gallons of kerosene. This should now be mixed thoroughly by pumping it vigorously through a force pump or spray pump. This may take five minutes. It should be, when properly mixed, like thick cream or clabbered milk.

latter. This is hardly practicable; it would be somewhat expensive, as the millet would have to be drenched in order to make the process effective. If straw were strewn over the millet plants in sufficient quantity and then burned, the bugs would undoubtedly perish. It will be noted that I do not emphasize any of these methods of killing bugs on the millet. As far as known it has not been tried, and hence we cannot speak from experience; but it will certainly be tried at the Experiment Station farm next summer. I regard it as an important point, for, *having next year's interests in view, the farmer should not be content with merely saving his present corn crop when apparently such a good opportunity is at hand to kill off the pest by the wholesale.*

One farmer in Meeker county suggests putting straw along the edge of the corn after the wheat is ripe, claiming that the bugs will gather upon it and through it in large numbers when they are moving to the corn and can be burned with the straw. It is doubtful whether the straw will stop them.

5. It would seem desirable, when wheat follows corn, to plow the corn land in the fall and not leave the corn stubble and corn shocks standing, excellent places for wintering Chinch Bugs, until spring.

6. Corn should be planted as far away as possible from wheat or barley.

In order to place all the information possible before the wheat grower and corn raiser, I insert below the remedies suggested in the Report for 1902 verbatim. In doing so I desire to emphasize one or two points mentioned in the text.

In the first place, in making a furrow about the corn field, one should be sure to throw the furrow *away* from the corn. Secondly, in the wet weather which prevailed last summer it was practically impossible to keep a furrow dusty, hence the means was not as effective as it might otherwise have been. Tar is somewhat expensive, and some farmers who have used it report lack of success. This may be due to the fact of its not being renewed or not enough used. The first application generally sinks into soil.

Remedies and Means of Prevention (as given in Report for 1902):

We do not know of any practicable means of killing the Chinch Bugs in the grain at present. In this connection we will say that the sending out of diseased Chinch Bugs has been abandoned, it having been found that the results were not sufficiently practical. The insects, however, may be trapped and killed without much labor after they leave the grain and start to attack the corn. Plow a furrow around your corn in such a way that the steeper side is towards the corn; drag a small log back and forth in this furrow until it becomes very dusty; it must be kept dusty. With a post auger bore holes ten or twelve inches deep, or even less, along the bottom of this furrow at intervals of about a rod. If the furrow is well made the bugs cannot cross it, and finally collect in the post holes, where they may be killed by kerosene or hot water. In wet weather a dust furrow is impossible. At such times the bugs may be stopped by means of a tar line.

Tar can be purchased of the Minneapolis Gas Company for $4.50 per barrel, barrel included; for $3.75 per barrel without container. Pour tar to the width of two or three inches next your corn field or upon the side of the field attacked by the bugs. While this tar line remains sticky, bugs will not cross it. The first tar applied will sink into the ground, probably, and the line will have to be renewed occasionally; that is, it will have to be kept sticky. Bore post holes at the side of the tar line away from the corn and the bugs traveling along the line to find a means of crossing will fall into these holes, where they may be killed. Even if the bugs have reached the outer rows of corn they may be stopped by the dust furrow or tar line between these outer rows and the remaining corn. The bugs on the outer rows may be killed with kerosene emulsion, one part emulsion to ten parts of water. Pure kerosene may also be used if one does not care to save the corn. It is certainly desirable to kill these bugs on the outer rows, thus lessening the bug crop the following year. One party states that he has had success in filling a furrow with freshly cut corn on the edge of the corn field, at the time when bugs are going to corn, and when this cut corn is covered with them, pouring kerosene thereon.

The heavy rains which prevailed in southern and central part of the state between the 1st and 15th of September and previously should do much toward reducing the Chinch Bug evil next year; in fact, on Sept. 9th I obtained from the farm many Chinch Bugs dead and covered with a mould. Nevertheless we will undoubtedly have this pest with us in some locality or localities and to a greater or less extent every year. This department assures the farmers of the state that it will do all in its power to discover some method of reducing the evil to its lowest terms, and the Entomologist ventures to express the hope that the suggestions made herein will be of service.

GRASSHOPPERS.

The finding by the writer of a specimen of Grouse Locust, which had hibernated, *Tettix granulata*, on April 22d at St. Anthony Park, served as a reminder that the grasshopper season would shortly open, hence an assistant was dispatched to Polk county, the seat of considerable injury in 1902 on the part of a native grasshopper, the Lesser Migratory or White Mountain Locust, *Melanoplus atlanis*, which resembles in size, shape, color and food habits the much dreaded Rocky Mountain Locust so closely as not to be distinguished from it by the average observer.

My assistant reported fields for the most part clear of grasshopper eggs in the vicinity of Lindsay P. O., but found them abundant in a few places, namely, three quarter sections belonging to Mr. Syverson, two quarter sections belonging to Widow Distad and one quarter section belonging to Mr. Christianson. At Gentilly, near Crookston, but few eggs were found where grasshoppers were bad in 1902. Eggs brought back from Polk county at this time hatched in the laboratory May 22d. Eggs from the Red Legged Locust taken at St. Anthony Park hatched May 21st.

During the past year the following "Grasshopper Bill" was passed in the State Legislature:

STATE OF MINNESOTA.

THIRTY-THIRD SESSION.

H. F. No. 357.

A BILL

FOR AN ACT TO PREVENT THE DESTRUCTION OF GRASSES, GRAINS AND OTHER CROPS BY GRASSHOPPERS.

Be It Enacted by the Legislature of the State of Minnesota.

Section 1. Every tract or parcel of land in this state so infested in any year with the eggs of grasshoppers as to be so eminently dangerous to grasses, grains or other crops growing, or to grow, in or upon lands

situate in the vicinity of the tract or parcel so infested as to threaten the destruction of a great part of any of such grasses, grains or other crops, shall from and after the date when it becomes the duty of the owner or lessee thereof to plow the same as provided in this act, and so long as the same remains unplowed and so infested, be deemed a public nuisance.

Sec. 2. The Board of County Commissioners in any county in this state is hereby authorized at any regular or special session thereof to hear and consider complaints relative to any tract or parcel of land claimed to be infested with the eggs of grasshoppers, and to fully investigate the facts in any such case. The certificate of the state entomologist to the effect that he had made examination of any such infested tract or parcel, or any portion thereof, described by him, and that in his opinion such tract or parcel, or any portion thereof so described, is or is not so infested with the eggs of grasshoppers as to be greatly dangerous to grasses, grains or other crops growing, or to grow, on lands situate in the vicinity of the tract or parcel so infested as to threaten the destruction of a great part of any thereof, shall be prima facie evidence of the facts therein stated at any such hearing of said board, or in any civil action authorized by, or arising from anything done pursuant to, this act. The person complaining shall cause notice to be served upon the owner of such tract, or his lessee, at least 10 days prior to the day of such hearing, describing therein the tract complained of, the nature of the complaint, and the session of the board when application will be made for such hearing, naming the first day of such session, whereupon the hearing may be had on said day, or upon such future day as the board shall then appoint therefor. Such notice may be served in the manner as provided in section 3 of this act for the service of a copy of the order therein authorized.

Sec. 3. If the Board of County Commissioners shall, after the hearing and investigation authorized by the preceding section, be of the opinion that any tract or parcel of land, or any portion thereof, is so infested with the eggs of grasshoppers to the extent contemplated by section one (1) of this act, it shall make and file its order to that effect, directing therein that the owner or lessee of such tract or parcel plow the same within the time therein stated, and cause a copy of such order to be served upon such owner, or his agent, or lessee, within such time as the board shall direct, not less than 20 days from the date of said order. Such copy shall be served upon such owner or lessee, if he be a resident of the county, in the same manner that a summons is served in a civil action; and, if such owner or lessee resides in another county, service thereof may be made upon the agent of such owner, or lessee, if any, residing in the county; and, if the owner is not a resident of this state, or his residence is unknown, and he has no known agent or lessee in the county, then service may be made by publication for two consecutive weeks in a legal newspaper printed at the county seat of such county, the last of which publications shall be made not less than 10 days prior

to the date when the plowing of any such tract or parcel is required to be commenced.

The order of the said board authorized by this section may be in substantially the following form:

Whereas, At a meeting of the Board of County Commissioners of ..... county, held on the ..... day of .....19...., the said board did duly hear and investigate relative to a complaint that the tracts or parcels of land hereinafter described are so infested with the eggs of grasshoppers as to be greatly dangerous to grasses, grains or other crops growing, or to grow, on the lands situate in the vicinity of such tracts, as to threaten the destruction of a great part of such grasses, grains or other crops; and,

Whereas, The said board is of the opinion that such danger exists, the said tracts being described as follows:

(Here Insert Description.)

It is hereby ordered and described that the owner (or his lessee) of said tract or parcel of land shall, not later than the ..... day of ..... 190...., begin, and with reasonable dispatch continue, the plowing of said tract or parcel, and all thereof, and complete such plowing prior to the ..... day of ..... 190....

(Or, if all the lands complained of are not so infested, then describe the portions thereof found to be so infested and required to be plowed.)

The county auditor is hereby required to cause a copy of this order to be served upon the owner of the lands hereby required to be plowed, or his agent (or lessee), in the manner required by law for the service thereof.

.....,
Chairman Board of County Commissioners
..... County.

Attest:

.....,
County Auditor.

Dated .....

Sec. 4. If the owner, or his lessee, of any tract or parcel of land described in any order made pursuant to section 3 of this act, upon whom service of a copy of such order has been duly made, shall fail or neglect to substantially comply therewith, he shall be deemed to maintain a public nuisance within the meaning of this act, and to consent that the said tract or parcel of land may be plowed by the county, and the Board of County Commissioners, when informed of such failure or neglect, shall cause the land found by it to be so infected to be plowed, under the direction of the chairman of said board, and the expenses incurred

by reason of such plowing shall be paid out of the county treasury, upon the warrant of the county auditor, in favor of the person entitled to the same.

Sec. 5. Whenever any tract of land shall have been plowed by the county, pursuant to the provisions of this act, and the plowing thereof shall be of value to the owner, or his lessee thereof, in the raising of any crops thereon during the season immediately following such plowing, such owner, or lessee, shall be liable to the county to the value of such plowing. Whenever the Board of County Commissioners is of the opinion that any such liability has arisen by reason of such plowing, it shall determine the sum for which the owner or lessee is so liable, and direct the county auditor to demand the immediate payment thereof into the county treasury; and, if the same is not paid upon such demand, it is hereby made the duty of the county attorney to bring a civil action in the name of such board against the party so in default, for the recovery of the same, and interest thereon from the date of such demand, provided that the amount so determined by the Board of County Commissioners shall be prima facie evidence of the value of such plowing.

Sec. 6. For the purposes of this act, the Entomologist employed by the regents of the University of Minnesota, at the State Experiment Station, located at the capital of the state, shall be deemed the State Entomologist.

Sec. 7. This act shall take effect and be in force from and after its passage.

This bill met with some criticism on the part of some of the residents in grasshopper districts in Polk county, on the ground that it was not severe enough; they claimed that the owner of the infested land should stand the expense of plowing and not the county, a few going so far as to say that it looked as though the law had been made in the interest of speculators, etc. This criticism is unjust and has, I understand, been withdrawn. The bill was framed after much study by General Childs, of St. Paul, who gave out as a result of his deliberations that if the owner were made responsible the law would not be effective. In discussing the matter with the writer, General Childs said: "The presence of these eggs is a misfortune, a visitation, not due to any neglect on the part of the owner of the land. Plowing accomplishes something for the general good, and hence expense should be borne by counties, *unless* the *individual is directly benefited in the way of raising crops, in which case he should pay. It is to be viewed in the light of a public calamity.*"

The writer is happy to say that a very general plowing of large tracts of land in the vicinity of Lindsay P. O. has been accomplished since the above bill became a law. This plowing was done voluntarily on the part of the various owners. To the plowing we believe the general immunity from this pest this season in a district previously badly infested is largely due. An assistant visiting this locality in August heard that they had been numerous on a few farms earlier in the season, and in each case the outbreak could be traced to failure to plow, the law not being effective in time to be used. We have every reason to believe that if fall plowing is persevered in in that section the grasshopper pest which has proven so serious hitherto will be practically stamped out.

Canadian authorities have made use of a cheap mixture apparently first introduced by Norman Criddle and called "The Criddle Mixture." This department was so much impressed with the unqualified praise which this poison received from all in Canada who used it that on May 12, 1903, Press Bulletin No. 16 was issued on this subject. The text of the Bulletin is here given:

THE CRIDDLE MIXTURE.

The difference between this poisoned bait and others consists in the substitution of horse manure for the bran so commonly used hitherto, on the ground that it costs nothing, is generally handy on a farm and is quite as effective as bran, if not more so.

At a meeting of entomologists at Washington, D. C., the past winter, Dr. Fletcher, the Government Entomologist of Canada, gave unstinted praise to the use of this compound, and, both at that meeting and in a printed report upon the subject, cited many instances of great success following its application. (See Report of Experimental Farms for 1901, page 226.) "It has entirely replaced the cumbersome and inadequate hopper-dozer," said Mr. Fletcher.

COMPOSITION OF CRIDDLE MIXTURE.

One part Paris Green, two parts salt, 40 parts horse manure, by measure. Add enough water to make soft without being sloppy. Scatter it about the fields well, in quantity according to number of grasshoppers. They will be attracted for 40 feet. It is most effective when fresh, but will do excellent work when several weeks old, even after being washed by rain.

A correspondent of Dr. Fletcher's, in speaking of the use of the Criddle Mixture, says: "In this section all used poison, and only a few acres of crop were destroyed. I am convinced that, had we begun the fight earlier, hardly a bushel of grain would have been lost. It is no exaggeration to say that dead locusts could be gathered up in wagon loads, and at times be smelt for half a mile." The same writer states, further, that two men "with horse and rig, kept the locusts from about 600 acres during the entire season." Another correspondent wrote as follows: "For a space of 50 yards from the edge of this crop (wheat), where the remedy had been only once applied two weeks before, the ground was literally strewn with dead grasshoppers, and all along the edge of the headland, where they had gathered during the wet weather, the dead insects were lying in such numbers as to resemble a winrow; on one spot 117 were counted in 18 inches square."

The Minnesota Entomologist has not had, of course, an opportunity, since learning of this mixture, to test it here, but there is no question but that, if it is so successful in Manitoba, it would be equally successful here. It certainly is less expensive, and, according to Dr. Fletcher, much more effective, than hopper-dozers, the use of which has been practically abandoned in that section.

This question probably occurs to the careful farmer: "Will not turkeys and chickens, wandering about the fields, be poisoned by such bait?"

It has already been definitely settled that it is extremely difficult to poison poultry with arsenic. To bring the matter nearer home to the Minnesota farmer, this department of the station has recently made a most severe test, using a full-grown turkey and full-grown and two-thirds grown chickens with most satisfactory results. The conditions were much more severe in this test—which was with confined fowls, lasting over two weeks, and using meal into which some grain was introduced, instead of horse manure—than could possibly exist in the use of the Criddle Mixture, the fowls being obliged to pick their food from this poisoned mess or go without. I do not hesitate to say, then, that the Criddle Mixture is perfectly safe in this connection as far as full-grown fowls are concerned. While we have not, as yet, had an opportunity of determining whether or not greedy young turkeys and chickens would succumb, it is fair to conclude that the use of the Criddle Mixture is also perfectly safe with them, for it must be borne in mind that it is simply the particles of undigested grain which fowls seek in horse droppings, and it must be further remembered that in the majority of cases this mixture would be used in the fields far from the house, and consequently not in situations frequented by young chicks. In response to my question, "How about turkeys and chickens eating the dead grasshoppers?" Dr. Fletcher replied that either these were not eaten, or, if they were, no ill effect followed, because no complaint of this kind had been made. I have no hesitation, therefore, in recommending this method to Minnesota farmers.

OTHER METHODS OF KILLING GRASSHOPPERS.

Hopper-Dozers. Although the Entomologist can furnish oil in limited quantities during the coming summer to farmers who own hopper-dozers, and there is no doubt but that they are useful in emergencies, I am convinced, from work done with dozers last year in Polk county, that the use of the Criddle Mixture will supersede the hopper-dozer, because of the cheapness of the method and ease with which the poison can be prepared and distributed.

The method to be followed in securing the oil is as follows: Obtain from your county commissioner an order for oil upon some dealer in your neighborhood. Orders in blank form were issued from this office to the commissioners a year ago. Upon presentation of this order at the store, oil will be furnished you, the dealer keeping your receipt and the order to serve as a voucher when he sends his bill to the Entomologist. All bills for oil must be presented before December 1st of the year in which the oil is sold. Firms furnishing oil free to farmers without a signed order from a county commissioner do so at their own risk. Hopper-dozers can be used to best advantage when the day is bright and warm. A little water placed in the hopper-dozer with the oil does not impair its value as an insecticide and will enable it to go farther. When grasshoppers have obtained their wings the hopper-dozer is almost useless.

Sowing a strip of rye around the edge of a wheat field is claimed to be a simple way to keep grasshoppers at the edge of the field. The rye grows more rapidly than the wheat, and will stand a lot of "eating down." This keeps the locusts in a comparatively narrow area, where they can be easily handled. (From Canadian Report.)

Plowing a strip of land between a crop and an advancing army of quite young hoppers will sometimes turn their march and prevent loss.

To prevent crickets and grasshoppers from eating binder twine in the field: Soak balls of twine in solution of two pounds bluestone dissolved in 12 gallons of water, for half an hour, and then dry thoroughly. (H. Vane, in Canadian Report.)

It must be remembered that it is hard to dissolve bluestone; it should, therefore, be placed in the water quite a long time before the liquid is to be used.

A farmer here suggests soaking balls of twine in kerosene. This might be effective.

THE NEW GRASSHOPPER LAW.

It is manifestly discouraging to any farmer living in a grasshopper district to have locusts, hatched in neighboring neglected stubble owned by speculators or parties who are indifferent to community interests, pour in upon his well-tilled fields and destroy in a few days the result of many weeks of hard work. Some law has long been sought which

will compel the property owners to plow stubble land so infested with grasshopper eggs as to be declared a menace to surrounding crops.

A bill leading to such a law was carefully framed by a prominent St. Paul lawyer this last winter, declared constitutional by the attorney general of the state and passed both houses without apparent opposition. Every point of the law was carefully considered by its framer, and no question exists as to enforcing its provisions. Space cannot be given in a bulletin of this nature to print the law in full; it will be published, however, in the next annual report.

Complaint of infested land should be made to the State Entomologist or to the Board of County Commissioners, or both, accompanied by specimens of eggs. The Entomologist examines the land, and, if the conditions justify it, he reports to that effect to the Board of County Commissioners, who, after consideration of the matter at a regular or special meeting, cause a notice to be served upon the holder or lessee of the infested land, requesting him to plow within a certain time. If he fails to do this, the county plows his land, and, if said plowing benefits him in raising of crops immediately after, sues him to recover moneys expended.

Inasmuch as grasshopper eggs hatch, in ordinary seasons, early in May, and since nearly three weeks must elapse, in accordance with this law, from the time of making the complaint to the time when the order to plow can be issued, it would seem best to make complaints in the fall, after grasshoppers have finished laying.

Mr. Ruggles, an assistant in this department, was in the field in Polk county in latter part of April in response to a complaint from that section, and found many eggs in some localities; hence, it is safe to predict that people in that neighborhood will have some trouble from grasshoppers this season.

Eggs brought to St. Anthony Park from Polk county hatched May 22d, in the laboratory, probably several days earlier than they would have hatched if left in the field.

It is with the hope that some of the suggestions made herein will be timely and useful that this publication is issued as a press bulletin.

A copy of this bulletin will be sent to any citizen requesting the same.

A few who have used the Criddle Mixture here report success, others the contrary; personally we have not given it sufficient trial to speak of it from experience. We used it quite late in the fall at the very end of the season, when the hoppers were eating but little, and did not meet with any success. From our observations and the experience of others it is evident it should be used when grasshoppers are young and most voracious. It is claimed that the mixture is much more effect-

ive if spread during hot, sunny weather, and it is further stated that salt may be unnecessary, possibly, if the mixture is made with fresh droppings. If used take two pounds salt for every half barrel, dissolving it in water before adding. The Paris Green should be mixed with water first and then added. This mixture should be drawn to the field in a cart or half barrel, and then broadcasted by means of a trowel or wooden paddle.

On June 24th Mr. Criddle wrote me as follows:

AWEME, MANITOBA, June 24, 1903.

Prof. F. L. Washburn, Agricultural Experiment Station, Minnesota.

Dear Sir: I beg to thank you for copies of Press Bulletin No. 16 (on the Criddle Mixture), just to hand. Since Dr. Fletcher's Report of 1901 much improvement has been made in the mixture referred to. It is now made as follows: One part, by measurement, of Paris Green to 120 parts horse droppings, preferably fresh, or about one pound of Paris Green to half a coal oil barrel of barn droppings. One pound of salt should be added when the droppings are not fresh. This mixture has taken the place of all other remedies, here, after the locusts have once got too large for the plow, *and has so far proved an unqualified success.* It is with great pleasure that I see you have taken it up.

Thanking you again for the bulletin, I am,

Yours truly,

NORMAN CRIDDLE.

It would seem from the above letter that the mixture can be used with much less poison in proportion to the manure, i. e., 1 part Paris Green may be added to 100 parts horse manure or even to a larger quantity with good results. Mr. Criddle states that a good way to keep locusts on edge of field is to sow a strip of rye around it. By this means the insects are temporarily held where they can best be poisoned. The user should bear in mind that arsenic in composition or by itself is the toxic principle in Paris Green and is a slow poison. He should not therefore expect the 'hoppers to die immediately.

In looking up the "grasshopper history" of Minnesota we find that the first mention of grasshoppers (Rocky Mountain Locusts) in Minnesota is in Neil's History of Minnesota, which states that in 1818 and 1819 vast hordes appeared in this state, eating everything in their course. They were reported again present in more or less destructive numbers in 1830, 1842 and in 1849; in 1855, 1856 and 1857; in 1863, 1864, 1865, 1866, 1867,

1869, 1870, 1871, 1872, 1873 and 1874, 1876 and 1877. In 1874 Minnesota lost $3,034,000.00 on wheat, oats, corn and other crops through the agency of grasshoppers. I am indebted to the State Historical Society for the following description of a "Grasshopper War" in 1874, occuring in an address of Gen. J. W. Bishop before that society in April, 1902. It is interesting as showing what a scourge they were in Iowa and Minnesota at that time and what methods were employed to combat them.

In early June of 1874 the fields that had been devastated by the grasshoppers in the previous summer had been generally cultivated and reseeded, and were promising a generous return to the anxious owners. But now the eggs were hatching, and in a few days the little hoppers outnumbered the wheat plants five to one. A few more days and the fields were eaten bare again. Whole counties in southwestern Minnesota and northwestern Iowa were in this condition, and a panic ensued at once. I spent a day in personal inspection of the devastated fields, and in interviewing the demoralized settlers, and, returning that night to St. Paul, reported the situation next morning to our Directors at a special meeting. The outlook was very discouraging, but it would become a great deal worse if something were not done at once to check the impending stampede of the disheartened settlers, and to restore and establish confidence.

I suggested a plan, and it was adopted, and the next day I was at the front again putting it into operation.

I had proposed to join with five others in the purchase from the company, at its regular published prices, of all the railroad lands in two townships located in the heart of the grasshopper district, and to immediately commence breaking the sod, employing the settlers to do the work in small tracts. Messrs. Horace Thompson, A. H. Wilder and John L. Merriam of St. Paul, and Adrian Iselin and Geo. I. Seney of New York, who were consulted, and approved by telegraph, formed, with myself, the party who were facetiously dubbed the "Grasshopper Syndicate."

The lands were selected near Sheldon, Iowa, and I telegraphed to John L. Kenny, who had been quartermaster in my regiment ten years before, and who knew how to manage men and teams, to meet me there next morning.

While he proceeded to mark off a square mile of land into twenty-acre tracts, I "intercepted" the migrating settlers as they came in sight on their way to Dakota, or to anywhere beyond the grasshoppers, and before night I had captured twelve of them, each with a contract to break twenty acres at $2.50 per acre. The wagon bed was lifted off, and the wife and children commenced housekeeping in it, while the man unlimbered his breaking plow and started in. The news spread over the coun-

try like a prairie fire in November, and within six weeks I had over 2,000 acres turned over. A good many of these men, after completing their contracts, returned to their abandoned homesteads and broke twenty acres or more, each, for themselves. Then came the fall plowing, and the panic gradually quieted down. Meantime the "hoppers" had devoured the crops, had grown to maturity, filled the ground with eggs again, and departed. Evidently there was more trouble to come. With 2,000 acres of newly broken land to be utilized, we built a farm house, with barn, sheds, granary, etc. Next spring it was all put in crops, including corn, oats, flax, barley, etc., and one square mile field in wheat.

About the first of June the growing grain was something to be proud of as we looked it over, but a close inspection revealed the ground alive with 'hoppers again. I would not weary this audience with any more grasshopper war stories, but we have recently heard that they filled the ground with eggs last fall in certain northwestern counties of the state, and our experience may be helpful to those interested there.

I telegraphed to St. Paul for barrels of coal tar and for plates of sheet iron about eight feet long by four feet wide, and we undertook to save that square mile of wheat in this way. The sheet iron plates were bent up a little at the front edge, and at the rear edge a strip was turned up six or eight inches wide. These plates were laid along the south line of the field at the southeast corner, with a space of eight or nine feet between them, end to end. A horse was placed in front of, and between, each pair of plates, his whiffletree attached by wires about nine feet long to the nearest corners of the two plates behind him, so that when ready to advance, the "line of battle," as the boys called it, extended about as many rods as there were plates. Then the plates were brushed over with coal tar, and the line advanced northward. The 'hoppers in front of the horse would jump to the right and left, and another and final jump would land them in the tar. At first a man was required to manage each horse, but as they became used to the work, their heads were connected by lines, so that a man at each end, and one to spare, could guide a line of eight or nine horses and clean about sixteen acres at every trip across the field. Each pan would accumulate a load of several bushels of 'hoppers in crossing the field, and at the end of the trip the pans were cleaned with shovels, rebrushed with tar, readjusted in line, and a return trip was made in like manner over the adjacent ground.

While all this did not work smoothly and perfectly at first, it did after a few hours' practice, and we thus covered the entire square mile in five days.

The next week we went over the ground in like manner from east to west, and found we had effectually cleaned up the little pests without appreciable injury to the growing grain, and then our other fields were treated in like manner. These operations were watched with great interest by neighboring farmers, and many of them saved their crops by similar efforts.

A week later a new danger threatened this particular field. A quarter section cornering on it had been sown also to wheat, and had been abandoned by the owner to the 'hoppers hatched therein. They had eaten it bare, and now, being half grown, had begun to migrate over to our field. They were not old enough to fly, and travelled in short leaps, and there were millions of them, all hungry.

Fortunately they were discovered when the movement commenced, and it was met by commencing a ditch at the corner, and extending it as rapidly as possible to the north and east. We found that a ditch two feet wide and one and a half feet deep was sufficient to stop them; very few were able to cross it—the grand army went into it, and were utterly unable to rise out of it. In a couple of days they had nearly filled it, and the raid was over.

A good many fields were abandoned to the pests that summer, to be totally destroyed, but some were saved, to yield a fair harvest. Our square mile of wheat gave us 11,298 bushels, which was sold at 80c.; the total expense of fighting the hoppers was between 30 and 40 cents per acre.

This year (1875) the grasshoppers, at maturity, generally left the country without depositing eggs, and there has been no serious trouble from them since; those appearing in later years were less in numbers, easily handled, and created no panic.

Fig. 10.—One of Nature's Hopper-Dozers.

DIFFERENCE BETWEEN ATLANIS AND SPRETUS.

Mention has been made of the great difficulty of distinction between the native pest, the Lesser Migratory or White Mountain Locust, *Melanoplus atlanis*, and the more dreaded visitor from the west, the Rocky Mountain Locust, *M. spretus*. The best way for the farmer to know what he is dealing with is to send specimens to the Entomologist at the Experiment Station. Any description of the two species necessarily involves the use of so many technical terms as to make it unintelligible to the general reader, nevertheless we append herewith a partial comparison of the two species, using as few scientific terms as possible, in the hope that some reader entomologically inclined may be helped thereby.

ATLANIS.	SPRETUS.
Head—	
Head a little prominent.	Head somewhat prominent.
Eyes moderate, rather prominent in male.	Eyes not very large or very prominent.
Subgenital plate—	
Two lobes forming notch on top of last segment of the abdomen of the male, not so prominent as in *spretus*.	
Anal joint of male tapers more suddenly than in *spretus*.	
Spine—	
The short spine (called prosternal spine) between the base of the front legs, variable, usually short, conical.	Prosternal spine rather long, shorter in female than in male.
Tegmina—	
(The narrow brown fore wings) usually surpassing considerably the hind thighs, occasionally, and especially in the female, only a little longer than the hind thighs; slender, feebly tapering. Veins of wings a yellowish brown.	Tegmina, or fore wings, exceptionally long, much longer than the hind thighs, not very narrow.
	Veins of wings mostly dark brown.

ATLANIS.	SPRETUS.
Fore and Middle femora—	
The thighs (first long joint on leg next the body) of fore and middle legs of male somewhat swollen.	Front and middle thighs of male only slightly swollen.
Hind tibiæ.	
Hind tibiæ (next long joint after the thighs) may be red, or pale or pale green, or pale yellow or dark blue; spines of hind tibiæ black beyond the base; 9 to 12 spines in the outer row.	Hind tibiæ bright red, spines black almost to the base, 10-11 spines, rarely 12, in the outer row.

POOR PARIS GREEN.

Reports reach the Entomologist that different samples of Paris Green of the same brand give widely different results, one party stating that although carefully used in the proportions recommended it killed foliage as well as the insects, and another that the insects treated do not appear to be affected. Especially is this true of its use against potato beetles, many complaining of its burning the foliage badly and giving generally unsatisfactory results. From these observed facts it is evident that there is much Paris Green on the Minnesota market, which, instead of having a constant amount of arsenic in its composition in combination with copper, has a varying amount of free arsenic, in other words, is adulterated with arsenic, and as analysis has shown with other, to the farmer, useless substances. Some of the leading brands of Paris Green, which are largely used in Minnesota, are made in New York State. In that state the original law required that there should be at least 50 per cent of arsenic in all Paris Green or products analogous to it, manufactured therein. Some of the manufacturers followed the letter of the law, but, in some cases, to put a charitable construction on the case, through

the carelessness of employes, let us say, that per cent was attained from free arsenic which was not properly combined with the copper. Previous to this year many analyses by different chemists, including the government force at Washington and the chemists employed by these manufacturing firms, gave only the total arsenic in the samples, thus not disclosing this evil which means so much to the farmer and fruit grower, the report *showing there was 50 per cent or over of arsenic, but not all the reports showing in what condition it existed.*

To correct this the New York law was amended in 1900, it now reading "Paris Green shall contain arsenic in combination with copper equal to not less than 50 per cent arsenious oxide. It shall not contain arsenic in water soluble forms to more than 3½ per cent."

It was to show to Minnesota farmers and orchardists how they were not securing a good grade of Paris Green that this department has purchased different samples of that material in different parts of the state during the year just passed, and in conjunction with the chemical department of the station has determined the nature of the samples purchased.

The California Experiment Station has brought out this year in a bulletin recently issued, No. 151, the very point we wish to illustrate here; in justice to ourselves it should be stated that our results were obtained before the publication of the Pacific Coast bulletin, though not published until now. As is evident from the nature of it, the bulk of this work has naturally fallen to the chemist, and to him the most credit is due, this department obtaining the samples, submitting them to one or two simple tests, one of which at least is in the hands of the farmer, illustrating the appearance of some of the adulterated samples, and bearing the main portion of the expense involved in the analyses.

The tests employed by the Entomological Department were (a) the microscope test by which the adulterations were made evident; the microscope unfortunately is not in the hands of many farmers or fruit growers; and (b) the ammonia test, which, though it is not as complete as might be desired, does afford an inexpensive and handy means of determining whether Paris Green is badly adulterated with other substances than arsenic or not. Its limitations are discussed below.

(a) **The Microscope Test:** A very little of the sample is taken on a knife blade, deposited on a glass slide and the slide inclined and tapped, until the green is spread out in a long, thin sheet. The color of this thin sheet should be bright green; if pale green or white to the naked eye it is undoubtedly adulterated, certainly so if it is white. This is then placed under the microscope. If the Paris Green is of good quality it will look like Fig. 13, in which the round grains of the pure article can be seen unmixed with any adulterating material. If adulterated, the adulteration appears under the microscope as many small granules amongst the large more or less spherical grains of Paris Green.

(b) **The Ammonia Test:** Consists in adding Paris Green to ammonia. We used 25 cc of ammonia (one wine glassful), and added one gram of Paris Green (about one-fourth teaspoonful). The ammonia turns blue. If, upon thorough stirring, sediment settles in the bottom of the glass, one may rest assured that the sample is adulterated. Silica, calcic carbon-

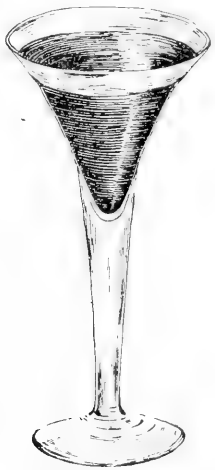


Fig. 11.

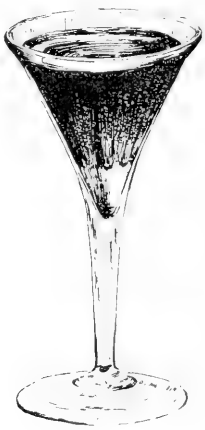


Fig. 12.

Fig. 11.—Ammonia in which all the "Paris Green" was dissolved.
Fig. 12.—Sample showing insoluble adulterations.

ate, barium sulphate and sodium sulphate, sometimes used to adulterate Paris Green, are insoluble in ammonia. *It must be borne in mind, however, that some adulterants of Paris Green, notably arsenic, are frequently soluble in ammonia, hence this is but a negative test.* A very good rule to follow would be to *avoid using any Paris Green which was not completely soluble in the above test.*

The following table shows retail source of Paris Green, purchaser's name and date of purchase, character of package

No.	Character of Package.	Retail Source.	Manufacturer.	Ammonia Test.	Microscopic Test.
1	20 lb. keg..	Lyman Eliel Co., Minneapolis....	Ansbacher & Co., N. Y. & Chicago	No sediment....	Fairly good.....
2	5 lb. box...	Found at station, open	Ansbacher & Co., N. Y. & Chicago	Slight sediment..	Apparently adulterated,.....
3	1 lb. tin....	Found at station, open	(Put on market by F. Force P. Co.)	A little sediment	Poor.....
4	1 lb. tin....	Found at station, open	(Put on market by F. Force P. Co.)	No sediment.....	Very good .....
5	½ lb. seal'd	Farwell, Ozmun. Kirk & Co., St. Paul.....	Fred Lavanburg, New York.....	Fairly good, some sediment.....	
6	1 lb. sealed	Scofield Bros., Cannon Falls...	A. B. Ansbacher, N. Y. & Chicago	No sediment.....	Some adulterant evident .....
7	1 lb. sealed	Northrup, King & Co., Minn'pls.	Fred Lavanburg, New York.....	A little sediment	Badly adulterated .....
8	1 lb. sealed	Larson & Bergquist, Lafayette	A. B. Ansbacher, N. Y. & Chicago	No sediment.....	Good, a few minute particles....
9	Bulk.....	E. B. Rollins, Vesta	.....	Practically no sediment.....	Apparently good, few minute particles
10	Bulk.....	R. S. Patchen, Belview	.....	Practically no sediment.....	Evidently badly adulterated....
11	Bulk.....	H. A. Strath, Dawson	.....	Slight sediment..	Badly adulterated.....
12	½ lb. seal'd	J. H. Onstad, Dawson.....	A. B. Ansbacher & Co., N. Y. & Chicago	Slight sediment..	Apparently badly adulterated....
13	Bulk.....	Netz & Vinton, Owatonna.....	.....	Considerable white sediment	Adulterated. ...
14	Bulk.....	Zambonie Bros., Owatonna.....	Holbone, St Louis	Considerable white sediment	Badly adult., like silica .....
15	1 lb. sealed	H. M. Hitchcock, Redwood Falls	A. B. Ansbacher, N. Y. & Chicago	Considerable white sediment	Evidently adulterated.....
16	1 lb. sealed	Tibbetts & Leslie, Delhi.....	A. B. Ansbacher, N. Y. & Chicago	Marked sediment after standing.	Evidently badly adulterated. ..
17	b. sealed	R. F. Case & Co., Starbuck	Fred Lavanburg, New York.....	Very little sediment.....	Fairly good .....
18	½ lb. seal'd	R. F. Case & Co., Starbuck	A. B. Ansbacher, N. Y. & Chicago	No sediment.....	Very good .....
19	¼ lb. seal'd	P. A. Henck, Paynesville....	J. Lucas & Co., Phil. & Chicago	A very little sediment	Much impurity..
20	¼ lb. seal'd	Bowker Fertilizer Co., Boston, Mass.	C. T. Raynolds Co., N. Y. & Chicago	A very little sediment	Fairly good, some impurity.....

The Sol. Arsenic in Nos. 12, 15, 16, 18 and 19 were obtained by

REMARKS.

1—Sodium sulphate present.
2—Sodium sulphate present.
3—Sodium sulphate present.
4—Sodium sulphate present.
5—Adulterated with sodium sulphate.
6—Adulterated with sodium sulphate.
7—Sodium sulphate present as an adulterant; contained only 22.04% CuO, 20 to 25% gypsum.
8—Moisture .96, Na_2So_4 .81, CuO 29.86, acetic acid, etc., 14.08.
9—Sodium sulphate present.
10—Geo. H. Countryman, druggist, Belview, on label. Sodium sulphate present.

and manufacturer, results of tests in Entomological Laboratory, chemical analysis, etc.:

Drawing.	Chemical Analysis		Purchaser.	Date of Purchase.	When Received.	Price Per Lb.
	Total Arsenic.	Soluble Arsenic.				
	Per cent.	Per cent.				
.....	56.96	.74	F. L. Washburn.....	.....	.....	.....
.....	57.55	.50	.....	.....	.....	.....
.....	56.90	.68	.....	.....	.....	.....
.....	57.25	.74	.....	.....	.....	.....
See Fig. 15.	52.05	1.85	F. L. Washburn.....	.....	.....	.....
.....	53.00	3.00	N. W. Monson.....	April 25, 1903	.....	.....
.....	58.30	18.00	F. L. Washburn.....	.....	.....	.....
.....	54.29	.95	F. A. Malmberg, Bernadotte.....	.....	May, 1903 ...	.....
.....	52.98	1.36	E. A. Holt, Delhi....	May 18, 1903.	May, 1903...	.....
See Fig. 16.	51.64	1.61	E. A. Holt, Delhi....	May 5, 1903..	May, 1903....	.....
See Fig. 17.	51.84	1.62	E. L. Peterson, Dawson.....	April 22, 1903	May, 1903....	.....
.....	52.70	3.95	E. L. Peterson, Dawson.....	April 22, 1903	May, 1903....	15c ½ lb.
.....	51.81	.....	J. S. Carlton.....	May 23, 1903.	May 29, 1903.	35 cents
.....	54.54	3.72	J. S. Carlton.....	May 23, 1903.	May 29, 1903.	35 cents
.....	55.30	4.08	E. A. Holt, Delhi....	April 27, 1903	May, 1903....	40 cents
See Fig. 18.	52.48	4.08	E. A. Holt, Delhi	May 5, 1903..	May, 1903....	35 cents
.....	55.69	2.92	Carl Lingen.....	June 1, 1903..	.....	40 cents
.....	55.75	4.61	E. P. Ferch, Odessa..	.....	.....	.....
.....	55.53	3.29	L. J. Sheldon, Paynesville	May 11, 1903.	.....	19c ¼ lb.
.....	58.70	3.19	.....	.....	.....	.....

J. A. Hummel, Assistant Instructor in the Chemical Department.

REMARKS.

11—Sodium sulphate present.
12—Moisture 1.17, Na_2So_4 .84, CuO 30.20. Purchased wholesale from Noyes Bros. & Cutler.
13—Manufacturers not known, purchased through jobbers.
14—Moisture .92, Na_2So_4 .95, CuO 30.35, acetic acid, etc., 13.24.
15—Cover found cut open when purchased. Na_2So_4 1.09, moisture 1.10, CuO 30.38, acetic acid, etc., 12.13.
16—Left over from last year's stock. Na_2So_4.
17—Na_2So_4 present.
18—Na_2So_4 present.
19—Na_2So_4 present.

It is to be noted that both wholesalers and retailers probably act in all good faith in handling Paris Green. They have no means of testing it, and there is as a rule nothing in its appearance to cause suspicion.

It will be seen from the above table that the ammonia test, the microscope test and the chemical analysis do not always tally, as might have been expected, from the fact that soluble arsenic, which would show under the microscope as small granules, and would be detected in chemical anaylsis, may be entirely dissolved in ammonia. The microscope test and the chemical analysis, however, bear each other out, as will be noted in Nos. 6 and 7.

A large amount of soluble arsenic is undesirable, since this is what burns the foliage. A high grade Paris Green should contain from 56 to 59 per cent total arsenic and a minimum amount of soluble arsenic. With these data in mind the reader can readily tell from the above table which are the good and which the poor samples. In purchasing Paris Green it is wise, in our estimation, to reject pale samples.

Note that No. 6, manufactured in New York, would be classed as "pure" under original New York law, because the total arsenic is above 50 per cent, and the excess arsenious oxide which may have been added to bring it up to the required per cent does not have to be accounted for. As stated before, the law is now so amended that any such practice in New York is impossible.

Over 3½ per cent of soluble arsenic in any sample indicates an excess which renders it undesirable for use on foliage. This ruling brands samples Nos. 7, 12, 15, 16 and 18 as bad; No. 7, showing 18 per cent of soluble arsenic, strikingly so. No. 5, made by the same party, is in marked contrast to this, showing only 1.8 per cent soluble arsenic. Nos. 12, 15, 16 and 18 are all made by Ansbacher & Co. Here again we must also note samples Nos. 1, 2, 8, made by the same firm, and making a very good showing as regards soluble arsenic. In No. 6 the microscope showed the presence of a material soluble in ammonia, since the ammonia test gave no sediment. Arsenic is soluble in this liquid, and that this was the material seen under the

microscope is proven by the chemical analysis, which gives 3 per cent of soluble arsenic. Sample No. 12 comes in the same category, while samples 15, 16 and 18 show by the various tests not only an excess of free arsenious acid, but also other adulterants insoluble in ammonia.

These striking results of our examinations have been explained by a party who is familiar with the manufacture of Paris Green on the ground of the high price of copper which prevailed some time ago, tempting manufacturers to make three tons of Paris Green with an amount of copper from which only one ton should have been made.

Learning of the results of our analysis of No. 7, the manufacturers had C. W. Drew, of Minneapolis, analyze a package of their Paris Green purchased on the open market. Mr. Drew's results are here given:

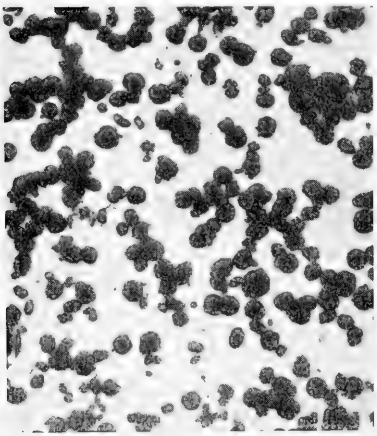


Fig. 13.—Pure Paris Green as it appears under the microscope. Photographed by J. A. Hummel.

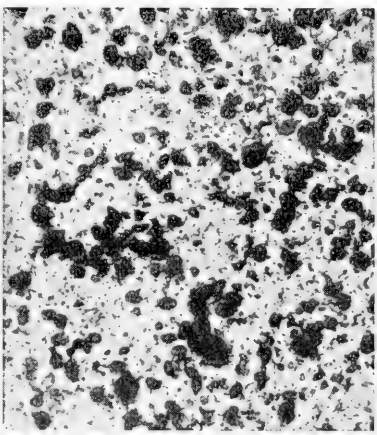


Fig. 14.—A microphotograph of sample No. 7 (see table) showing impurities. Compare with Fig. 13. Photographed by J. A. Hummel.

MINNEAPOLIS, June 19, 1903.

Fred L. Lavanburg, 18-20 River St., Chicago, Ill.

Dear Sir: I hereby certify that I purchased upon the open market an original sealed package of the "Fred L. Lavanburg Paris Green" and that I have analyzed the same, with the following results:

Moisture	.93 per cent
Sand	.00 per cent
Sodium Sulphate	.68 per cent
Total Arsenious Oxide, $As_2 O_3$	56.94 per cent
Cupric Oxide, Cu O	25.56 per cent
Acetic Acid (by difference)	15.89 per cent
Total	100.00 per cent

Yours very truly,

(Signed) CHARLES W. DREW.

As with many other analyses the above shows a deficit in copper and does not show the presence of soluble arsenic.

In the meantime our Station Chemist had carefully reviewed the work on sample 7 and made us the following statement:

AGRICULTURAL EXPERIMENT STATION,
ST. ANTHONY PARK, MINN., July 2, 1903.

Prof. F. L. Washburn,
Minn. Agr. Experiment Station,
St. Anthony Park, Minn.

Dear Sir: The conclusion reached in regard to sample No. 7 and formerly reported, namely, that it is *not pure* Paris Green, I find correct.

In pure Paris Green there is a definite relationship between the content of arsenious acid and copper oxide. High grade Paris Green should contain from 57 to 59 per cent arsenious acid, and from 29 to 31 per cent of copper oxide. In Bulletin No. 68, Chemical Division, U. S. Department of Agriculture, analyses of Paris Green samples procured on the open market are given. The smallest amount of copper oxide found in any sample reported was 27.58 per cent, and that was in a sample that contained an excess of free arsenious acid.

Sample No. 7 contained 22.04 per cent copper oxide, which is at least 7 per cent less than is found in high grade goods. This sample contained 58.3 per cent of arsenic in the form of Paris Green and in other forms. If the sample were pure there should be 29 per cent, at least, of copper oxide to combine with 58.3 per cent of arsenious acid. A deficit of 7 per cent of copper oxide means that at least 14 per cent of arsenious acid is not in combination with copper, as it should be in pure Paris Green. The microscopic examination shows the presence of foreign matter, as will be observed from the micro-photographic illustrations.

While this sample was under consideration the dealer notified the manufacturer, who, in turn, submitted a pound package from the same shipment to a commercial chemist, who reported 25.56 per cent copper oxide. Even on the basis of this, the manufacturer's analysis, the sample is short 4 to 5 per cent copper oxide and contains from 8 to 10 per cent of arsenic in excess of the copper, which indicates that the sample is only 90 per cent pure.

While this sample may correspond to the requirements of the New York State law, where it is manufactured, by containing the requisite amount of arsenic, over 14 per cent of the arsenic is not combined with copper, as it should be in pure Paris Green. Deducting all impurities, the sample on the basis of my analysis is not more than 80 per cent pure Paris Green.

Yours truly,

(Signed) HARRY SNYDER,
Chemist.

The eastern manufacturers, still insistent, had Paris Green said to be from their stock analyzed by a chemist in New York City, who sent them the following report:

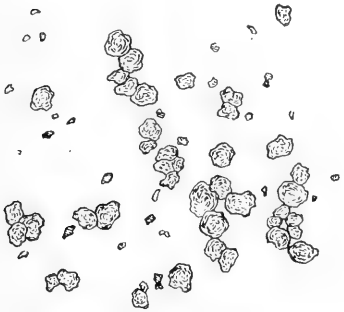


Fig. 15.—A camera lucida drawing of sample No. 5.

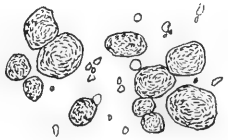


Fig. 16.—A camera lucida drawing of sample No. 10.

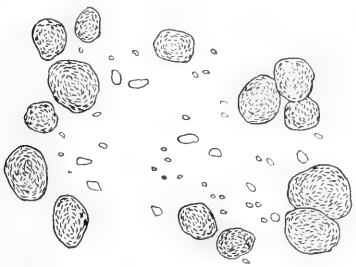


Fig. 17.—A camera lucida drawing of sample No. 11.

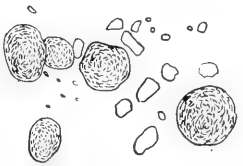


Fig. 18.—A camera lucida drawing of sample No. 16.

NEW YORK, Aug. 19, 1903.

Mr. Fred L. Lavanburg, City,

Dear Sir: In regard to the samples of pure Paris Green given me for analysis, I find your product to contain:

Combined Arsenious Oxide	54.28 per cent
Uncombined Arsenious Oxide	2.00 per cent
Copper Oxide	31.20 per cent

On the basis of this analysis, your product is about 99 per cent pure; that is, taking into consideration the acetic acid contained in the Paris Green as copper acetate, which is about 11 per cent.

There is a definite relationship between copper oxide and arsenious oxide. According to "Newth," it is 23.41 per cent copper oxide and 58.7 per cent arsenious oxide; the balance of the copper oxide is combined with acetic acid to form copper acetate. This relation of copper arsenite to copper acetate is variable not to any great extent, but still it is variable. If the copper arsenite end of the combination is high, the Paris Green will test high in arsenious oxide and low copper oxide, and vice versa.

I consider, and think, that most chemists would agree that your Paris Green is a pure article.

Respectfully,

(Signed) AUSTIN J. FARREY,
Chemist.

Our chemist, commenting upon the above report, states:

"My analyses show only 22.04 per cent of total copper oxide; this includes all of the copper combined with both the arsenic and the acetic acid. The analysis by Mr. Farrey claims 31.20 per cent. The analyses made by myself and by Dr. Drew were from separate packages from the same shipment. These different analyses, if correct, show that the different packages are very uneven in composition. Two of the packages from the same shipment were deficient in copper oxide, and show an excess of arsenic over the copper. To state that part of the copper is combined with the arsenic and part with the acetic acid does not alter the total copper oxide content, which, even on the basis of Dr. Drew's analysis, made for the manufacturer, shows a deficit. These analyses, taken as a whole, show that the Paris Green was far from uniform in composition, and that two of the packages were below grade to the extent of 10 to 20 per cent."

It is to be noted that our analyses indicate great variation from bad to good in almost every one of the standard brands examined.

CONCLUSIONS.

Do not buy Paris Green which is of a pale green color; or which leaves a white streak on a glass slip; which is not entirely soluble in ammonia; which shows under the microscope many fine particles amongst the larger roundish Paris Green granules.

A law preventing the sale of inferior Paris Green in Minnesota would be highly beneficial.

REPORTS FROM CORRESPONDENTS.

This is a new feature of work in this department. Its aim is to keep the Entomologist in touch with insect depredations in enough counties of the state to represent the conditions prevailing in all the agricultural portions of Minnesota. The leading reports for this year are given below. Another year observations will be begun in May and a report mailed by every observer each month up to and including September.

Observers are chosen from those who have shown proficiency in entomology, either at the Agricultural College or elsewhere; as more of such become available more districts will be represented.

Paynesville, Stearns Co., Minn.,
July 23, 1903.

Dear Sir: I received your letter this evening and will try to send in a report of the insect pests on the 15th of every month.

It may be of some value to you if I mention a few of the pests that have been doing damage this summer, although I cannot give date of their appearance. Potato Bugs have done a great deal of damage; they have not been so thick for years. Hessian Fly in the rye, but not much damage done.

Very truly yours,

S. Z. ROACH.

Bernadotte, Nicollet Co., Minn.,
Aug. 10, 1903.

F. L. Washburn, State Entomologist,

Dear Sir: I hereby send you some information on the Hessian Fly in this locality. There has been some damage done by the Hessian Fly this year, but not so much as last year. There is quite a difference in damage done to different fields, some fields being hardly attacked at all by the Hessian Fly. Wheat sown where corn was raised last year is very little injured. Where wheat has been grown for some years on the same field is the most injured, and also on places where the straw is weak and apt to lodge. Have found the "flax seeds" in the straw attacked by the flies. Have found two "flax seeds" in one straw in some instances. On our farm we had a piece of wheat last year so badly injured by the Hessian Fly that we didn't harvest it, but cut it down with the mower and burned it. The same piece of land was sown to wheat this spring again, without being injured hardly any. The damage done to wheat by the Hessian Fly in this locality this year is not much, as far as I know.

I have noticed Chinch Bugs in the fields this summer; they have not done any damage in this locality so far, but I have heard some complaint about the Chinch Bug doing some damage in the eastern part of this county.

Respectfully,

R. LINDQUIST.

Paynesville, Stearns Co., Minn.,
Aug. 10, 1903.

Dear Sir: The report for this month is Chinch Bugs observed in wheat July 17th; considerable damage done to wheat in this section.

Hessian Fly observed in wheat July 27th, but did not damage the wheat very much.

Crickets are quite thick, and bother considerably by cutting the bands around the bundles of grain.

Yours truly,

S. Z. ROACH.

Spring Valley, Fillmore Co., Minn.,
Aug. 11, 1903.

F. L. Washburn,

Dear Sir: As reporter of injurious insects and plant diseases, I have the honor of reporting to you as follows:

There has been no injury done to farm or field crops by any injurious insects this season, so far as I have been able to learn, in this locality. The Cabbage Moth has been busy and troublesome, but if the people will

treat their cabbage the same as their potatoes, with Paris Green for the Potato Beetle, they are easily kept down.

As to fruit, the Codling Moth is more prevalent this year than ordinary, and the Curculio has been more numerous than in recent years. I put up a fight with them for about thirty days and saved my plums in very good shape, but from present indications I fear rot at about maturity. The Currant Worm has been very destructive. I do not grow them. The above seems to cover the ground for this section at this time.

If you have blanks for this work please mail me a few.

Yours respectfully,

O. W. MOORE.

Delhi, Redwood Co., Minn.,
Aug. 12, 1903.

F. L. Washburn, State Entomologist,

Dear Sir: I have the following to report regarding insects injurious to crops in this section for the past month:

Aphis observed upon the wheat heads July 15th. They did considerable damage, causing a great many shrunken kernels.

The first effects of the Hessian Fly were noticeable about the 2nd of July. Considerable damage was done in this section. It is hard to estimate the loss, as some grain also dropped on account of weak straw, caused by rust earlier in the season.

The Cabbage Worm is doing some damage to the cabbage, although not very numerous. There are also some Aphis upon apple trees and wild plums. No serious injury has been done by these.

Potato Bugs quite numerous this year.

Yours truly,

E. A. HOLT.

Wendell, Grant Co., Minn.,
Aug. 12, 1903.

F. L. Washburn, State Entomologist,
St. Anthony Park, Minn.

Dear Sir: I have to report that the Hessian Fly has caused some damage to wheat this season in this vicinity, to the probable extent of 5 per cent. I have found a great number of "flax seeds" in the stem just above the first joint.

Chinch Bugs have never done any damage in this neighborhood, but my father says he has found a single one some years ago. He is familiar with the pest, having seen thousands of them in his old home in Wisconsin.

Potato Bugs seemed very numerous early in June, but by timely application of Paris Green solution their ravages were checked, and hence

the damage will not be great from that source. Have not been able to discover any other injurious insect causing any damage to crops in this vicinity this year so far.

Respectfully yours,

OLUF N. FOSS.

Buffalo, Wright Co., Minn.,
Aug. 14, 1903.

Prof. F. L. Washburn,

Dear Sir: The following is my report for insect pests in this locality: Chinch Bugs have been very numerous this year, damaging nearly every field to a slight extent, and in some cases the damage has been so great that nearly the whole crop has been destroyed. The acreage of wheat will be lessened in following years on this account.

Plant Lice, which have been quite a nuisance all summer, are still at work on some flowering plants, viz.: the Snowball and Poppy.

Almost no Grasshoppers have been observed.

Yours respectfully,

G. R. MILLS.

Renville, Renville County, Minn.,
Aug. 15, 1903.

Prof. F. L. Washburn,
St. Anthony Park, Minn.

Dear Sir: Your letter asking me if I could send you a report of the damage done by insects in this section has been received. I will try to do what I can for you. The "Hessian Fly," in particular, has caused a very great loss in this section this year. More than one-third of the wheat has been destroyed by this fly.

The "Grub Worm" has done some damage to the strawberry roots. The "Cut Worm" injured the garden crops to some extent, and the "Potato Bug" was very bad on the potatoes.

These are the only ones that have bothered us to any extent so far.

Very truly yours,

RUTH H. HOLMBERG.

Chokio, Stevens County, Minn.,
Aug. 17, 1903.

F. L. Washburn,

Dear Sir: Your letter at hand. The Hessian Fly has done damage here as elsewhere where I have been. I have not been over a very large territory, but they have been at Ortonville, Clinton, Chokio and on our

farm, 10 miles south of Chokio. I have seen no fields in which damage was so great as at Madison and Dawson. The damage here is from 2 to 5 per cent.

F. J. HOLTZ.

Wendell, Grant County, Minn.,
Sept. 12, 1903.

F. L. Washburn, State Entomologist,
St. Anthony Park, Minn.

Dear Sir: I have to report that very little damage to growing crops has been caused by injurious insects since my last report. Potato Bugs did some damage during the busy time of harvest, when there was no time to administer poison. My estimate of a damage of 5 per cent to wheat by the Hessian Fly I believe was correct.

Have not been able to discover any other injurious insect doing damage in this neighborhood.

Respectfully yours,

OLUF N. FOSS.

Doran, Wilkin County, Minn.,
Sept. 14, 1903.

F. L. Washburn, Esq.,
St. Anthony Park, Minn.

Dear Sir: As a final report for this season, can say that this county has been very fortunate in that the losses sustained by injurious insects were very light. The Hessian Fly affected some fields, possibly from 2 to 5 per cent of yield; on others it was not noticeable at all. A few fields of flax, planted on sod land and spring plowing, were completely destroyed by some kind of Cut Worm, but the area was very small compared with the whole acreage sown.

Respectfully,

HENRY HARRISON.

Paynesville, Stearns County, Minn.,
Sept. 14, 1903.

Dear Sir: There has been no damage done this month by insects. The damage done during the summer was as follows: Potato Bugs did a great deal of damage to the crop. Chinch Bugs ruined the wheat crop in this section. Hessian Fly in rye and wheat, but damage not great.

Yours truly,

S. Z. ROACH.

Renville, Renville County, Minn.,
Sept. 15, 1903.

Prof. F. L. Washburn,
St. Anthony Park, Minn.

Dear Sir: The grain is now all cut and it is estimated that the damage done to the crops by the Hessian Fly amounts to about one-third of the crop.

The "Strawberry Slug" is doing considerable damage to the strawberry plants. The Cut Worm has been very bad on garden products. The White Grub has also bothered. And then there is a long brown worm; I don't know what it is called. It is about 1½ inches long, very slender, and has two horns, and its body has hairs scattered over it. This worm was quite abundant on the strawberries, and now it comes into the houses. The neighbors all around are bothered with it. It is a perfect nuisance.

Last spring the Leaf Aphis did some damage to the apple trees, but not enough to kill the entire crop.

On some places the Potato Beetle killed the potato stalks entirely, but cannot tell just what the loss would be.

Very truly,

RUTH H. HOLMBERG.

Buffalo, Wright County, Minn.,
Sept. 15, 1903.

Prof. F. L. Washburn,

Dear Sir: By far the greatest damage this year has been done by Chinch Bugs. On sandy land, where wheat should have yielded 15 bu. or more per acre, the yield was cut down often one-half to two-thirds. I know of one case where less than 5 bu. per acre was harvested. Probably there were other places equally as poor. On rich ground there was no trouble.

Plant Lice come next in extent of injury. They worked mostly on apple and plum trees, not killing them, but giving some of them quite a setback. Also worked on box elder and on snowballs.

Currant Worms were general on currant and gooseberry bushes. The first brood did the damage; second did not amount to much.

Potato Bugs were very numerous during the first week in July. Where Paris Green was used, little damage was done.

Tent Caterpillars were noticed on plum and hickory trees about middle of August. These are still at work. In some cases hickory trees have been nearly stripped of their leaves.

Respectfully yours,

G. R. MILLS.

Bernadotte, Nicollet County, Minn.,
Sept. 16, 1903.

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

Dear Sir: The loss in our neighborhood from the Hessian Fly, I should think, would be about 10 per cent. There has been no damage done to the corn crop by Chinch Bugs, as far as I know, although I have noticed some Chinch Bugs in the ground.

Respectfully,
RICHARD LINDQUIST.

Delhi, Redwood County, Minn.,
Sept. 21, 1903.

F. L. Washburn, State Entomologist,

Dear Sir: According to the returns of the threshing machine, the insects have certainly done a great deal of harm. Wheat that was thought would yield from 25 to 30 bu. per acre has only averaged 10 to 15 bu.

The Grain Plant Louse was the cause of many white shrunken kernels, some heads having almost no heads at all. I would estimate the loss to wheat at 20 per cent, caused by this louse.

The Hessian Fly has also been the cause of a large amount of wheat being left upon the fields. The injury done to the wheat by this fly, I think, would be the same as that of the Plant Louse, or 20 per cent. This would leave about 60 per cent as the average wheat crop in this vicinity. I have based this report upon the appearances of the crop before it was cut, and not upon the returns of preceding years.

Oats and barley have been a fine crop, a few fields of oats averaging 70 and 75 bu. per acre, 50 to 60 bu. being the general yield. Barley averages about 40 bu. per acre.

Early seeded flax is a good crop, some fields yielding 25 bu. per acre; 20 bu. being quite general. Late seeded flax yielding from 10 to 15 bu., but not much of this has been threshed.

Corn promises an excellent crop, most fields being out of danger of frost.

Hay crop fine on high land; low lands under water. I think 80 per cent being an average crop.

Crab apples and native plums have been an excellent crop. The Plum Gouger has done considerable damage to the plums on some of the trees, about 20 per cent of some of the plums being wormy.

As there is not very much garden truck raised in this vicinity, I cannot very well make an estimate of damage done to this crop by insects. The Cabbage Worm has been at work in our cabbage. Tomatoes are plentiful, but a little late, as is also most garden truck.

Hoping this report may be of use to you, I remain

Yours truly,
E. A. HOLT.

KEY FOR ORCHARDISTS AND NURSERYMEN.

The basis of the following key is taken from one compiled by Mr. Lochhead, which appeared in the 33d Annual Report of the Entomological Society of Ontario. It seemed necessary to rearrange the key to some extent, in conformity with Minnesota conditions, eliminating some insects given in the original and adding others not given, and it also appeared desirable to the writer to append the best known remedy or remedies under most of the pests. Insects affecting the Apple, Plum, Pear and Cherry are here given (albeit there will be but little call for information regarding pests of the last two), and it is hoped, in view of the growing interest in horticulture in our state, that the key will be of use to Minnesota orchardists and nurserymen in identifying insects at work on their fruit trees. Many of the illustrations used originated in this department.

KEY TO APPLE INSECTS.

A. *Attacking the Roots:*

Causing knots or swellings on the smaller roots—bluish-white mouldy lice.

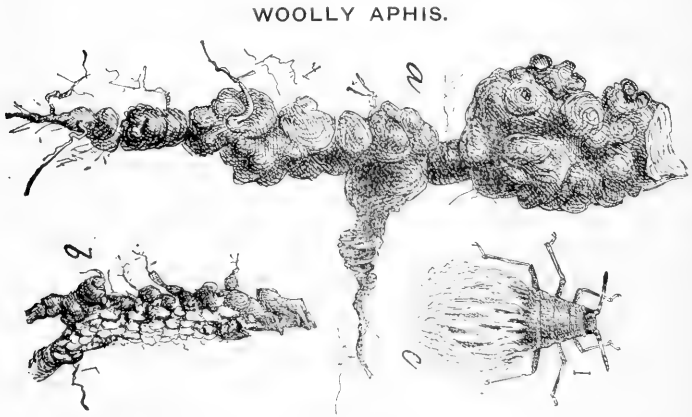


Fig. 19.—Woolly aphis. *a*, root of young tree illustrating deformation; *b*, section of root with aphides clustered over it; *c*, root louse, female; *a* and *b*, natural size; *c*, much enlarged. After Marlatt, Division of Entomology, Department of Agriculture.

REMEDIES: For the Root form, remove the earth, three to four inches of soil, about the crown for a distance of two to four feet from the tree and sprinkle in four to six pounds of finely powdered tobacco. Waste tobacco stems, which can be purchased very cheaply or obtained for nothing, can be used in place of powdered tobacco.

A large yellowish-white Grub, from 2 to 3 inches long, boring into roots of apple. Turns into a large brown beetle, from 1 to 2 inches long.

PRIONUS.

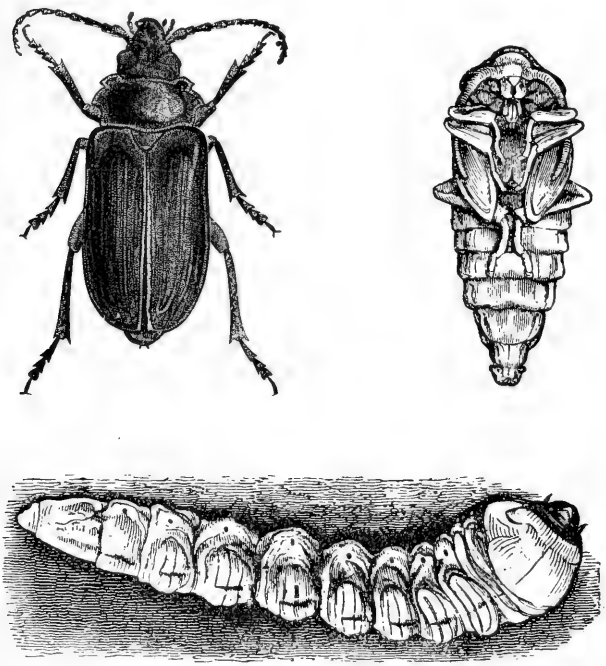


Fig. 20.--*Prionus lacticollis*, Drury. After Riley.

REMEDIES: If in large numbers it may be necessary to dig them out to save the tree.

B. *Attacking the Trunk, Branches and Twigs:*

Producing longitudinal slits in the bark; eggs under the edges of the slits.

BUFFALO TREE-HOPPER.

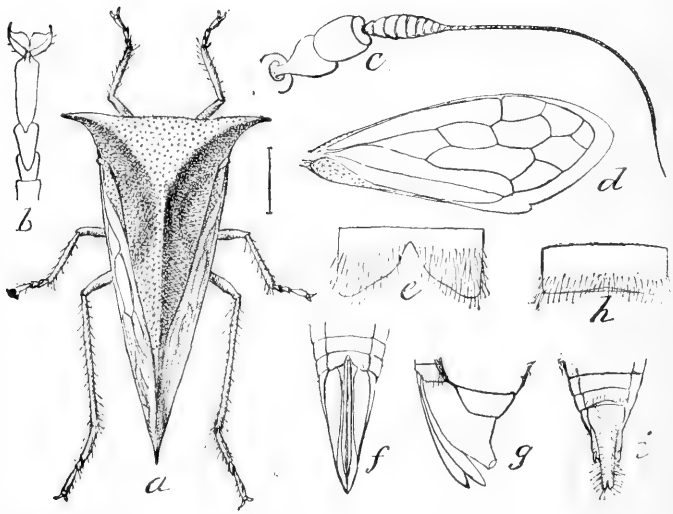


Fig. 21. *Cercsa bubalus*, Fab. *a*, female; *b*, enlargement of anterior foot of same; *c*, do. of antenna; *d*, do. of wing; *e*, last ventral segment of female; *f*, ventral view of tip of abdomen of female, showing terminal segments and ovipositor; *g*, do. lateral view; *h*, penultimate ventral segment of male; *i*, ventral view of tip of abdomen of male—all enlarged. After Marlatt, Division of Entomology, Department of Agriculture.

REMEDIES: Prune all twigs infested with eggs and burn. Clean culture is the best remedy. Keep down all weeds and unnecessary vegetation in and about the orchard. Direct application of insecticide not feasible.

a. *Fixed to Bark:*

Producing an ashy-gray incrustation on the bark; scales round, and gray and black.

SAN JOSE SCALE.

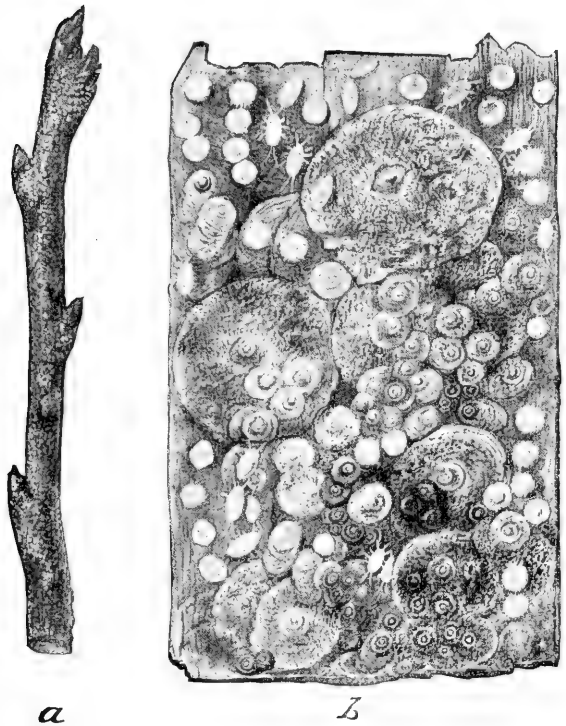


Fig. 22.—*Aspidiotus perniciosus*, Comst. *a*, infested twig, natural size; *b*, bark as it appears under a hand lens, showing scales in various stages of development, and young larvae. From Div. of Entomology, Dep. of Agriculture.

REMEDIES: In spring before buds open, spray with (1) lime sulfur salt, or (2) 40 per cent kerosene in water (Kero-water sprayer). Use hydrocyanic acid gas, which see in article on Fungicides and Insecticides.

Bark rough, with mussel-shaped scales.

OYSTER-SHELL BARK-LOUSE.

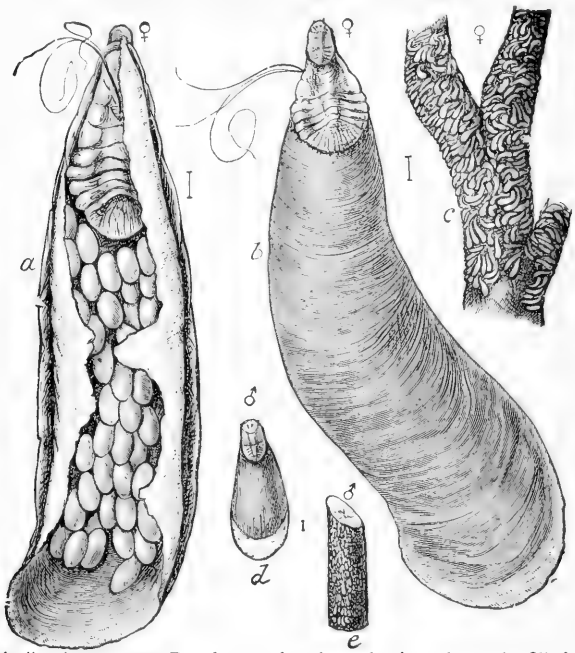


Fig. 23.—*Mytilaspis pomorum*, Bouche. *a*, female scale, from beneath, filled with eggs; *b*, same from above; *c*, twig infested by female scales; *d*, male scale, and a twig infested therewith. After Div. of Entomology, Dep. of Agriculture.

REMEDIES: Same as above.

Bark scurfy with white scales.

SCURFY BARK-LOUSE.

Fig. 24.—*Scurfy Bark Louse.*

REMEDIES: Same as preceding.

b. *Making Tunnels in the Wood:*

Large, square-headed, legless borer, at or near the ground in tunnels, with sawdust-like excrement.

ROUND-HEADED BORER.

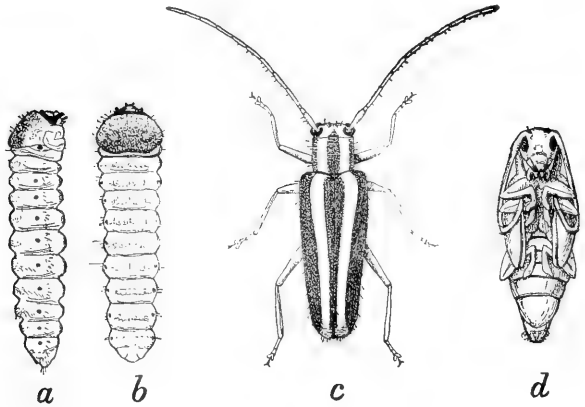


Fig. 25.—*Saperda candida*, Fab. After Division of Entomology, U. S. Department of Agriculture.

REMEDIES: Paper wrappings or deterrent washes should be combined with the digging-out process.

Large, flat-headed, legless borer, in upper trunk in tunnels, with sawdust-like excrement.

FLAT-HEADED BORER.

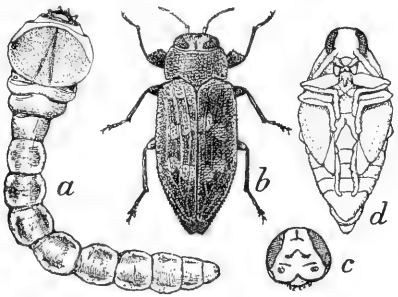


Fig. 26.—*Chrysobothris femorata*, Fab. Enlarged. After Division of Entomology, U. S. Department of Agriculture.

REMEDIES: Same as preceding.

Large larva in decaying wood.

EYED ELATER AND ROUGH OSMODERMA.

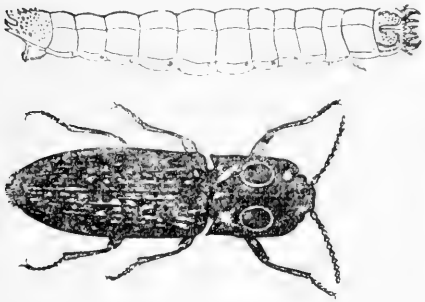


Fig. 27.—Eyed Elater. *Alaus oculatus*, Linn., and larva. After Harris.

Fig. 28.—Rough Osmoderma, *Osmoderma scabra*, Beauv. After Harris.

REMEDIES: Hardly calling for treatment.

A brown beetle, about ¼ inch long, boring into twigs in early spring, entering close to a bud; also found in pears, cherries, and sometimes grapes.

APPLE TWIG BORER.

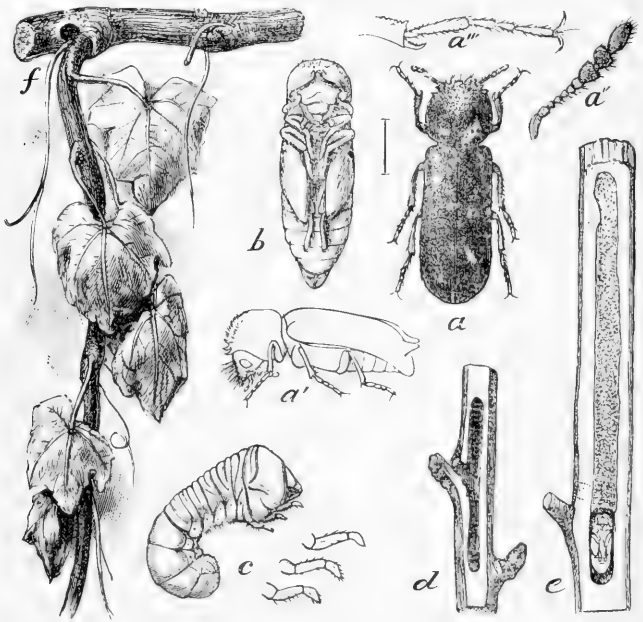


Fig. 29.—*Amphicerus bicaudatus*, Say. After Division of Entomology, U. S. Department of Agriculture.

REMEDIES: Removing and burning twigs with their burrows will check the ravages somewhat.

c. *Making Tunnels Between the Bark and Wood:*
Make little holes in bark.

FRUIT BARK BEETLE.

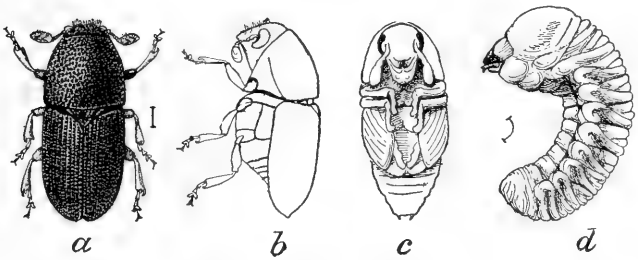


Fig. 30.—*Scolytus rugulosus*, Ratz. *a*, adult; *b*, same in profile; *c*, pupa; *d*, larva. After Division of Entomology, U. S. Department of Agriculture.

Fig. 31.—Work of *Scolytus rugulosus* in twig of apple galleries under bark. After Division of Entomology, U. S. Department of Agriculture.

REMEDIES: If the tree is seriously infested cut down and burn; if working on a tolerably healthy tree, find source of weakness, remove and then stimulate tree to greater growth by fertilizers, etc. Keep the trunk of tree covered with a lime wash to which Paris green has been added.

d. *White woolly patches on the twigs, which are usually scarred:*

WOOLLY APHIS.

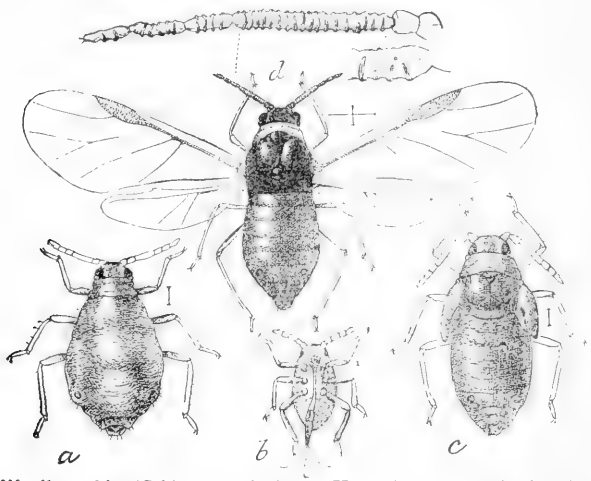


Fig. 32.—Woolly aphis (*Schizoneura lanigera*, Hausm). *a*, agamic female; *b*, larval louse; *c*, pupa; *d*, winged female with antenna enlarged above; all greatly enlarged and with waxy excretion removed. After Marlatt, Division of Entomology, Dept. of Agriculture.

REMEDIES: For the form found on trunk, branches and twigs; early in season, when white patches begin to appear on the trunk and branches, paint with pure kerosene or a very strong kerosene emulsion.

e. *Green, soft-bodied insects, in clusters on young growths, and particularly at ends of twigs and on underside of curled leaves:*

APPLE APHIS OR "GREEN APHIS."

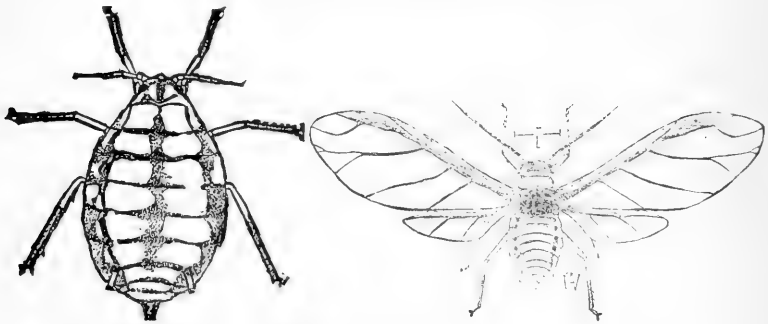


Fig. 33.—*Aphis mali*, Fab.; winged viviparous female, apterous viviparous female. After Bruher.

REMEDIES: The Lime-Sulfur-Salt wash will kill the eggs of the Aphis in winter or early spring.

If twigs are very badly covered, cut off and burn.

Spray forcibly with kerosene emulsion (1-10) if leaves are on. But when on nursery stock, see reference in article on Nursery Inspection.

f. *Small, green, active insects, which cause leaves of nursery trees to curl.* Not to be confounded with the "Green Aphis." Very destructive in Minnesota in 1903.

LEAF HOPPERS.

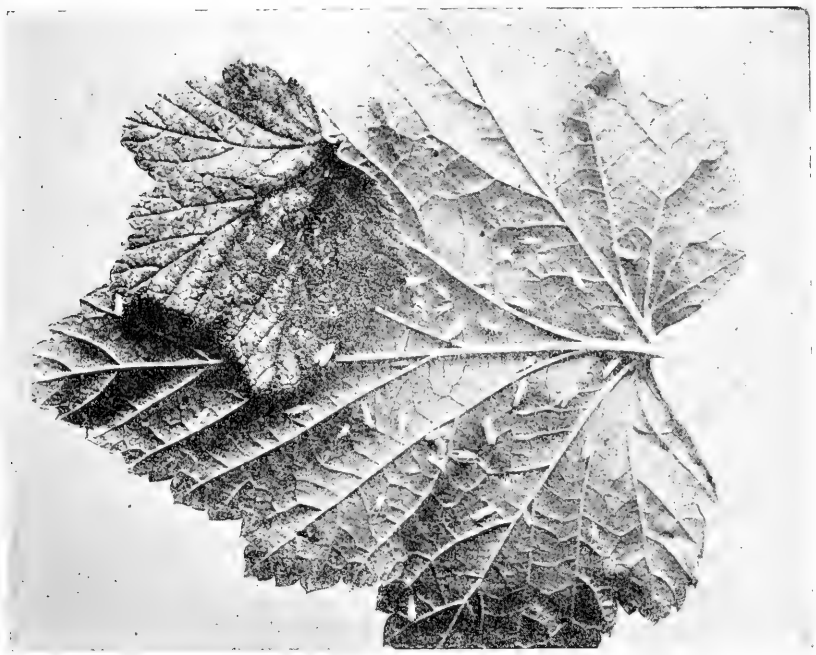


Fig. 34.—Currant leaf infested with a Leaf Hopper. *Empoasca albopicta,* Walsh. Lugger.

REMEDIES: This insect calls for a special apparatus designed to fill the air about nursery trees with a fine spray of kerosene emulsion. One nursery man claims to have obtained some relief by the use of dust spraying. See text of this report, where this pest is fully discussed.

g. *Snout Beetles gnawing off the bark in patches:*

IMBRICATED SNOUT BEETLE.

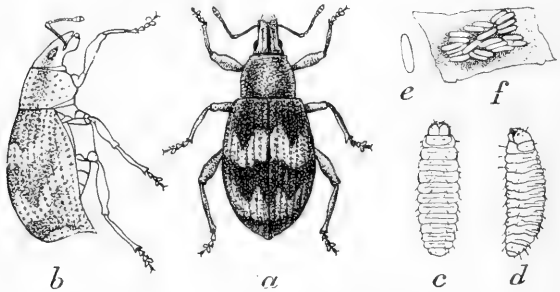


Fig. 35.—*Epicærus imbricatus*, Say. Division of Entomology, U. S. Department of Agriculture.

REMEDIES: Apply arsenicals either dry or in a spray at the rate of one pound to 100 gallons of water.

Or, beetles may be jarred, like the Curculio, into receptacle freely saturated with kerosene. Division of Entomology, Bulletin 19, 1899.

h. *Causing leaves and fruit to wither in midsummer:*

Mostly confined to pear, but also found in apple. A very small beetle, tunnelling in soft wood. Not to be confounded with Fire Blight.

PEAR BLIGHT BEETLE.

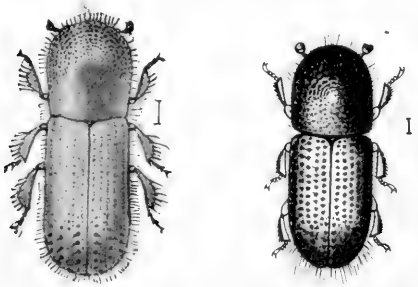


Fig. 36.—*Xyleborus xylographus*, Say; female and male Entomology, U. S. Department of Agriculture.

REMEDIES: In June or July, if twigs are blighted, examine for small, pin-like holes made by the beetle. As the larval and pupal life is lived in these burrows, cut off the infested twigs and burn.

C. *Attacking the buds:*

a. A large, gray Snout Beetle feeding on buds and twigs in spring; also found on plum and other fruit trees.

NEW YORK WEEVIL.

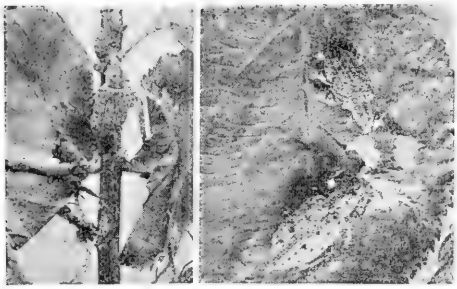


Fig. 37.—*Ithycerus noveboracensis*, Forst., eating bark and leaves of plum. Lugger.

REMEDIES: Jarring, etc., as for plum curculio. Also arsenical spray.

b. Folding together the opening leaves and feeding within.

OBLIQUE BANDED LEAF-ROLLER AND LEAF-CRUMPLER.

Fig. 38.—Leaf roller. Lugger.

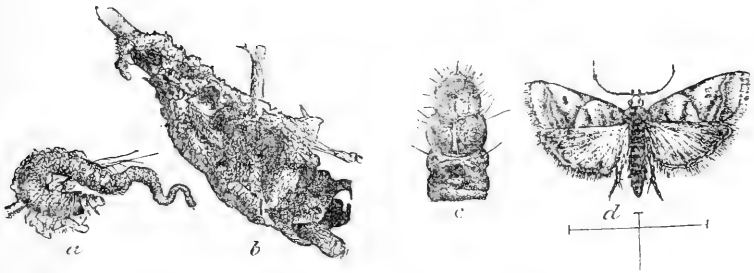


Fig. 39.—*Mincola indigenella*, Zell. *a*, a single case; *b*, case covered with leaves; *c*, front part of caterpillar; *d*, moth. After Riley.

REMEDIES: Hand picking early in season and sprays will keep in check.

c. Eating the center of the bud, or tunnelling it.

EYE SPOTTED BUD-MOTH.

Fig. 40.—*Tmetocera ocellana,* Schiff.

REMEDIES: Spray with Paris green, one pound to 150 gallons of water, just before buds break. Spray again just after buds open.

d. Measuring worms—"Loopers"—eating leaves of buds.

CANKER-WORMS.

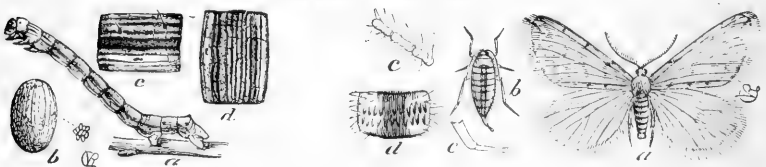


Fig. 41.—Spring Canker Worm, *Paleacrita vernata,* Pack. After Riley.

REMEDIES: Bands of sticky substance, like tar, on trees in March for spring cankerworm, and again the first of September for fall canker-worm.

Also, if trees are badly infested, spray with Paris green once before blossoms open, and again after petals fall.

e. Caterpillars feeding within pistol-shaped cases, and eating irregular holes in the bud leaves.

PISTOL-CASE BEARER.

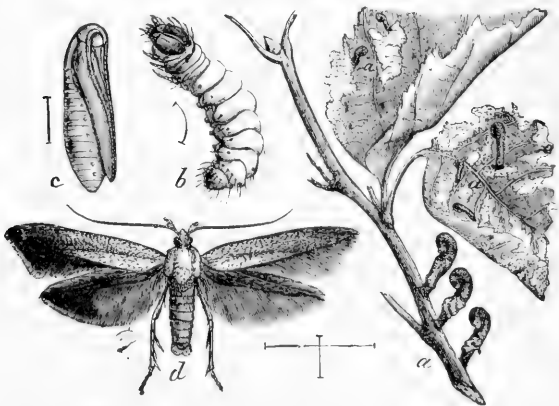


Fig. 42.—*Coleophora malivorella,* Ril. From Division of Entomology, Department of Agriculture.

REMEDIES: Two or three thorough sprayings with Paris green, one just before buds begin to swell, one soon after the young leaves appear and the third after the petals fall.

D. *Attacking the leaves:*

a. Gregarious caterpillars.

1. *Caterpillars protected by webs.*

a. Webs in forks of branches in spring.

TENT CATERPILLAR.

Fig. 43.—Tent Caterpillar, *Clisiocampa americana*, Harris. Lugger.

REMEDIES: Cut out and burn the egg masses during the winter or early spring.

When the caterpillars are collected within their tent, in early morning, or on cloudy, chilly days, wipe out with a rag or burn out these tents with their mass of worms, or use a wire brush on end of pole for collecting tents and contents when in high trees.

Three or four thorough sprayings with Paris green will destroy the pests. Spray first before the blossoms open, again when the petals fall, and again after an interval of eight to 10 days.

b. Webs covering the leaves in summer and early autumn.

FALL WEB-WORM.

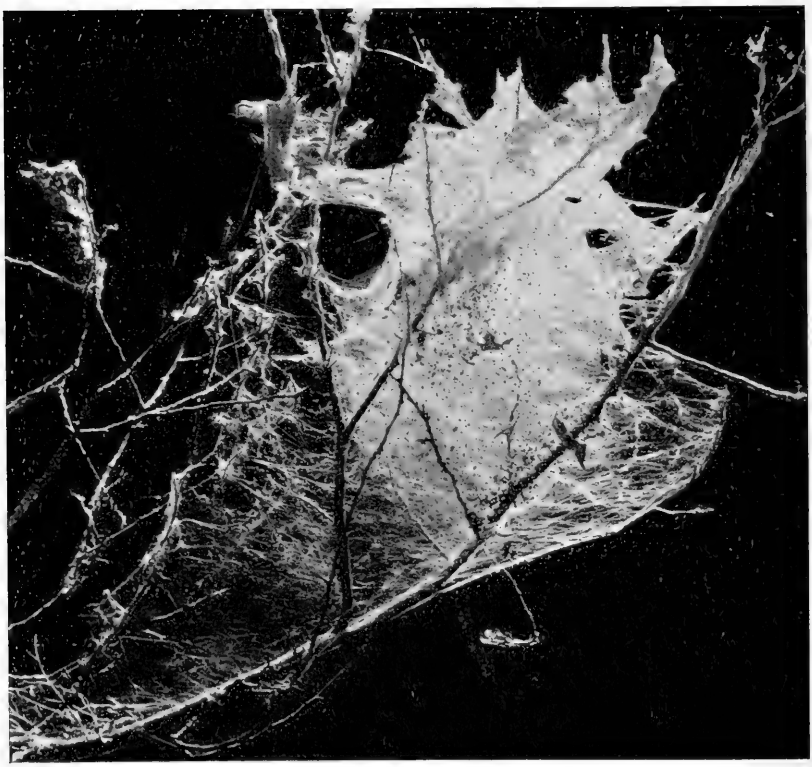


Fig. 44.—Fall web worm. Lugger.

REMEDIES: The methods of combating given for Tent Caterpillars will destroy also the Fall-web-worm.

c. Leaves partly eaten and drawn together by a web.

PALMER WORM.

Fig. 45.—*Ypsolophus pomotellus*, Harr. After Fitch.

REMEDIES: Spraying with Paris green just after blossoms fall, and again eight or ten days after, will keep the pest in check.

2. *Caterpillars not protected by a web:*

a. Clustered on limbs.

YELLOW-NECKED CATERPILLAR.

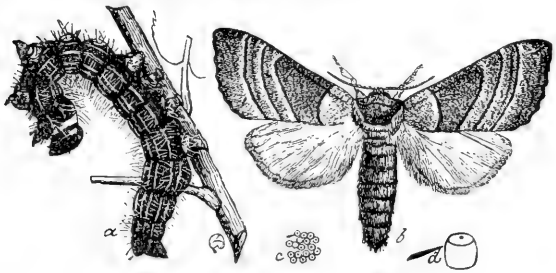


Fig. 46.—*Datana ministra*, Drury. *a*, caterpillar; *b*, adult; *c*, eggs; *d*, egg enlarged. After Riley.

REMEDIES: Hand picking, unless the worms are in very large numbers, in which case spray with arsenical poisons.

RED-HUMPED APPLE-TREE CATERPILLAR.

Fig. 47.—*Oedemasia concinna*, Sm. and Abb. Lugger.

REMEDIES: Same as preceding.

3. *Green, soft-bodied insects, with sucking mouths.*

PLANT LICE.

See Fig. 33.

REMEDIES: Same as Apple Aphis.

b. Solitary Caterpillars:

1. *Protected Caterpillars:*

a. A green worm mining within the leaf. Mine becomes an irregular brownish patch; pupa inside of folded leaf.

APPLE LEAF MINER.

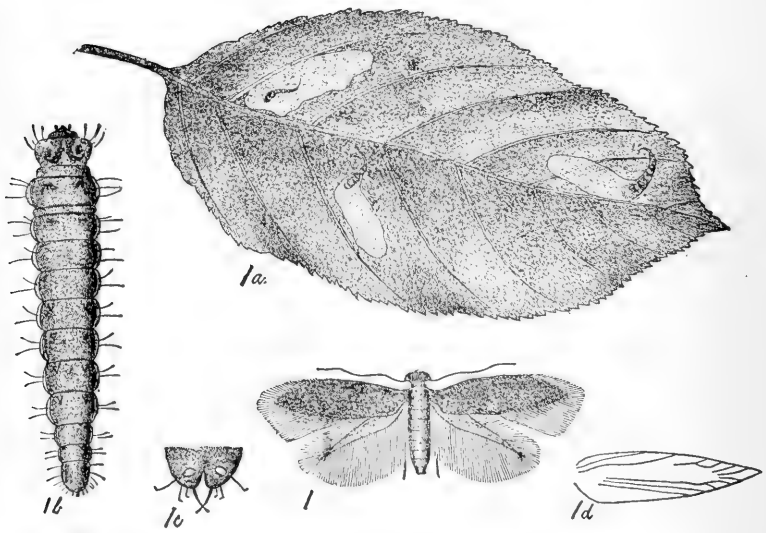


Fig. 48.—*Tischeria malifoliella*, Clem. After Comstock.

REMEDIES: Usually not in sufficient numbers to cause any appreciable injury.

b. Mining within the leaf, mature larva and pupa within small, oval seed-like bodies.

RESPLENDENT SHIELD BEARER.

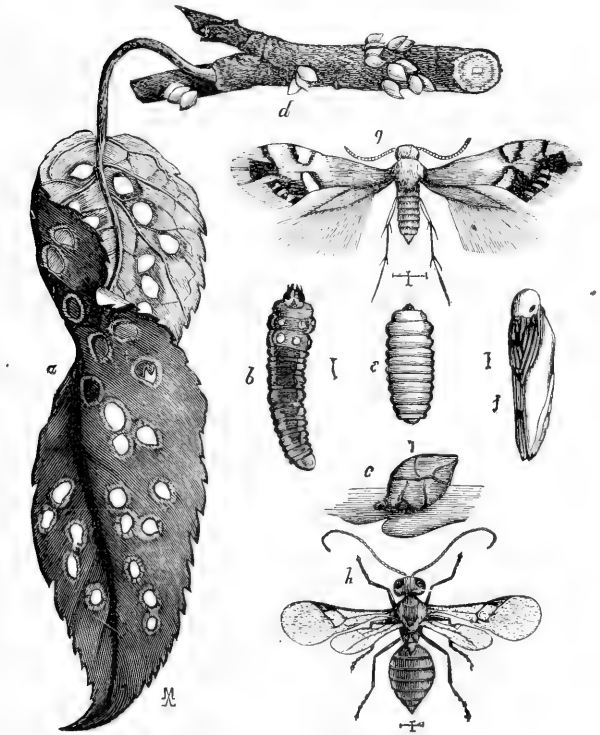


Fig. 49.—*Aspidisca splendoriferella*, Clem. From Div. of Entomology, Department of Agriculture.

REMEDIES: Probably will not be in sufficient numbers to warrant using remedies.

c. Feeding within pistol-shaped cases which stand out from the leaf.

PISTOL-CASE BEARER.

REMEDIES: See page 62.

d. Feeding within folded leaves.

LEAF-ROLLER.

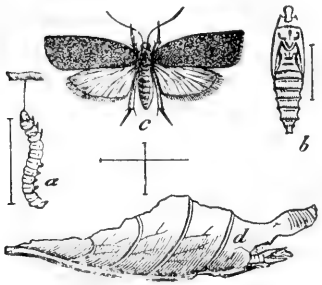


Fig. 50.—*Teras minuta*, Rob. *a*, caterpillar; *b*, pupa; *c*, moth; *d*, empty pupal skin projecting from folded leaf. After Riley.

See also *Cacœcia rosaceana*, Fig. 38.

REMEDIES: If very numerous an arsenical spray used repeatedly will lessen their numbers.

e. Feeding within tubes of silk, open at both ends, on epidermis and inner tissues, leaving the veinlets.

BUD-MOTH.

See Fig. 40.

REMEDIES: See Eye-spotted bud moth above.

f. Feeding on tissues of leaves beneath a silk web. Leaves in nursery sometimes look corroded and rusty.

APPLE-LEAF SKELETONIZER.

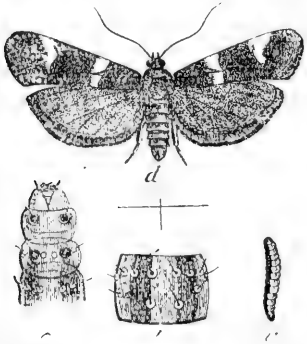


Fig. 51.—*Canarsia hammondi*, Ril. *a*, larva; *c*, front part of same, enlarged; *b*, on joint still more enlarged; *d*, moth. After Riley.

REMEDIES: Arsenical sprays will keep in check.

2. *Unprotected Caterpillars:*

a. Measuring worms, feeding in the daytime.

CANKER-WORMS.

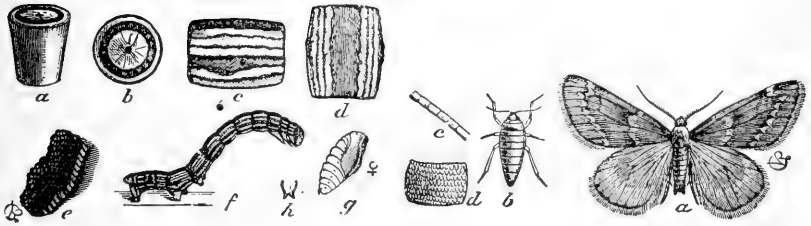


Fig. 52.—Fall Canker Worm, *Anisopteryx pometaria*, Harr. *a*, *b*, single eggs; *e*, egg mass; *c*, *d*, joints of caterpillar; *f*, caterpillar; *g*, pupa. On right, *a*, male moth; *b*, female moth; *d*, one joint of same. From Div. of Entomology, Department of Agriculture.

REMEDIES: See page 62.

b. Sleek 16-legged caterpillars, feeding at night.

CUTWORMS.

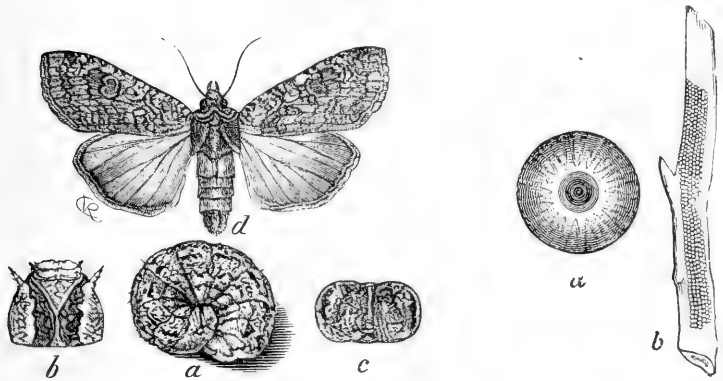


Fig. 53.—*Peridroma saucia*, Hub. After Riley.

REMEDIES: Preventive measures:

1. Cleaning up and burning all rubbish, etc.
2. Cotton bands placed around the tree to prevent worms climbing up.

Destructive measures:

1. Poisonous baits, such as bran, dropped in little bunches near base of trees. See page . .

These caterpillars work at night and remain concealed during the day near the scene of their night's work. When buds or leaves appear to be eaten, look for the worm, which may be buried a few inches in the soil, within a foot of the injured tree.

c. Large, green caterpillar, covered with spiny tubercles.

CECROPIA MOTH.

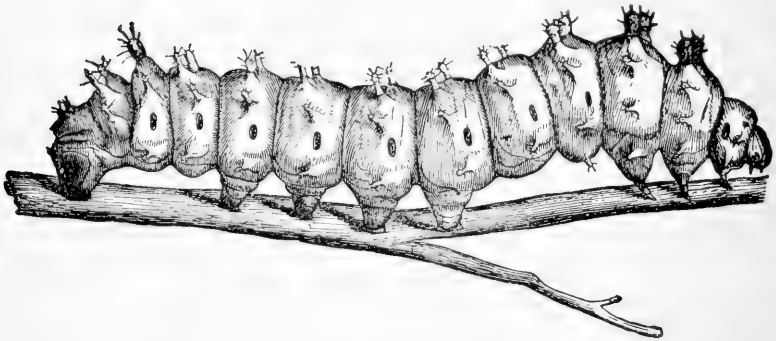


Fig. 54.—*Attacus cecropia*, Linn.; caterpillar. After Riley. See also colored plate.

REMEDIES: Hand picking is probably all that is ever necessary.

d. Large, apple-green caterpillar, with white oblique stripes on sides.

POLYPHEMUS MOTH.

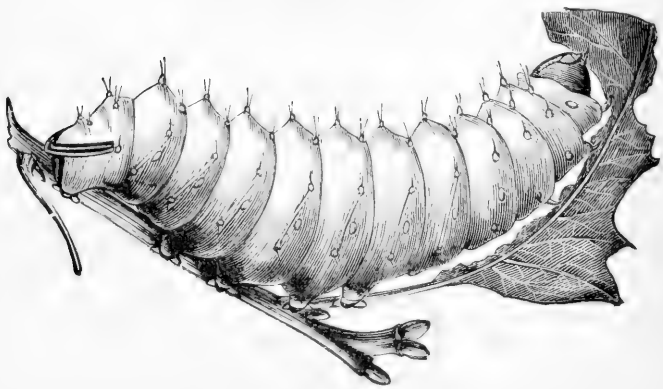


Fig. 55.—*Telea polyphemus*, Linn.; caterpillar and pupa. After Riley.

Fig. 56.—*Telea polyphemus*, Linn. Lugger. Reduced in size.

REMEDIES: Same as preceding.

e. Greenish caterpillar, 2½ inches long, marked with white, brown, lilac and yellow, and bearing clusters of greenish spines.

IO EMPEROR MOTH.

Fig. 57.—*Hyperchiria Io*, Linn.; caterpillar. After Riley.

IO EMPEROR MOTH—Continued.

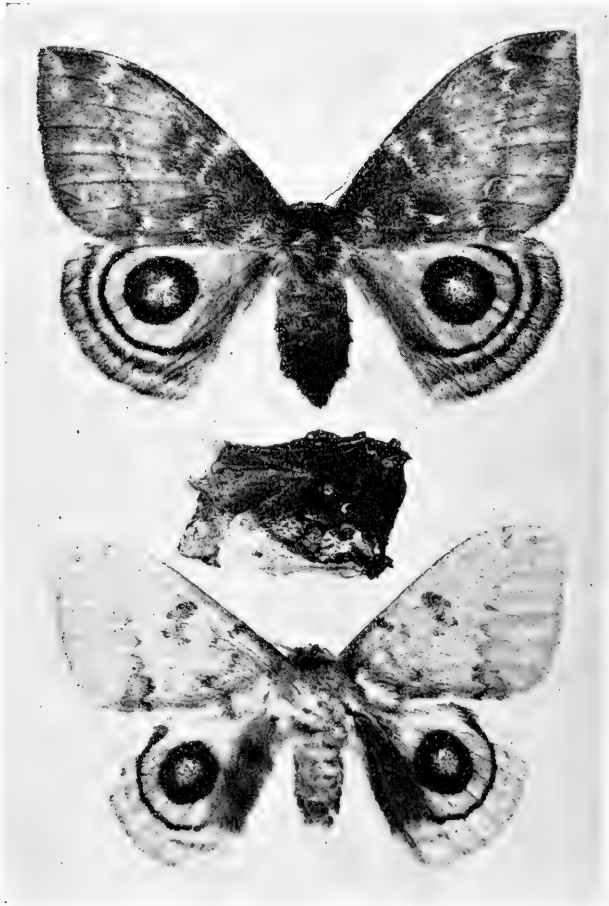


Fig. 58.—*Hyperchiria Io*, Linn.; male, female and cocoon. Lugger.

REMEDIES: Same as two above.

f. Hairy caterpillars, resembling Tent Caterpillars, but without web.

TENTLESS OR FOREST TENT CATERPILLARS.

Fig. 59.—*Clisiocampa distria*, Hub. Lugger.

REMEDIES: Practically same remedies as for Tent Caterpillar.

g. Large, green caterpillar, with a reddish-brown horn at tail and seven oblique stripes on each side.

APPLE SPHINX.

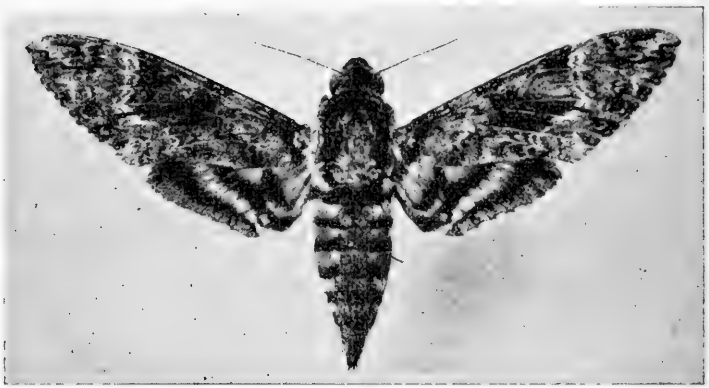


Fig. 60.—*Sphinx gordius*, Cram., Lugger.

REMEDIES: Hand picking will probably be sufficient; if not, use any arsenical poison.

h. Small caterpillar, with brown head and yellowish green body, feeding on leaves.

APPLE-TREE BUCCULATRIX.

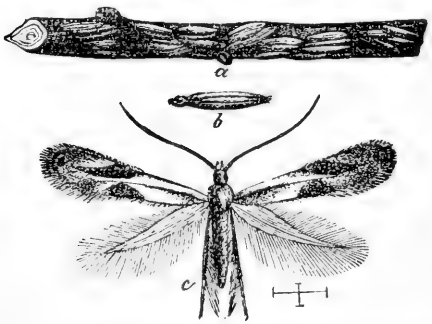


Fig. 61.—*Bucculatrix pomifoliella*, Clem. After Riley.

REMEDIES: Never very troublesome. Caustic washes applied during the winter and Paris green during summer will prevent any serious ravages.

3. *Beetles:*

a. Large brown beetle feeding at night on leaves.

MAY-BEETLE.

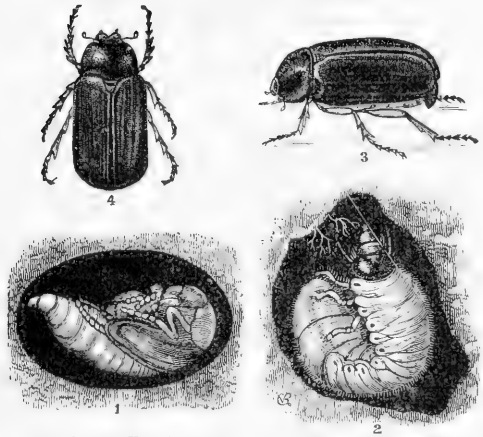


Fig. 62.—*Lachnosterna fusca*, Froehl.—After Division of Entomology, U. S. Department of Agriculture.

REMEDIES: Spraying trees with Paris green.

E. *Attacking the Fruit:*

a. *Boring tunnels through the fruit:*

1. Tunnels mostly about the core; brown excrement often visible at opening at blossom end of apple and elsewhere on fruit.

CODLING MOTH.

Fig. 62¼.

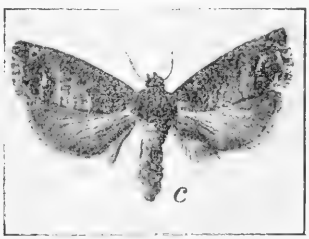


Fig. 62¾.

Fig. 62¼.—Apple injured by Codling Moth larva. Slingerland, Bulletin 41, Division of Entomology, U. S. Department of Agriculture.

Fig. 62¾.—Codling Moth, enlarged.—Slingerland, Division of Entomology, U. S. Department of Agriculture.

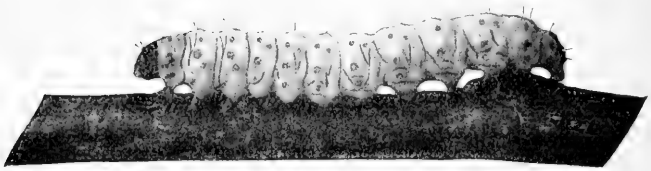


Fig. 62½.—Codling Moth larva (apple worm), enlarged. Slingerland, Division of Entomology, U. S. Department of Agriculture.

REMEDIES. Bands of burlap on trunks of trees, and carefully examine every five days, destroying larvæ.

Spraying with arsenical poisons just after blossoms fall and before calyx closes. A second spraying should follow, 10 or 12 days later, and a third spraying 10 or 12 days after the second. A fourth spraying might be desirable and necessary in badly infested localities.

Destroying all fallen fruit by letting hogs run in orchard, or by burying.

Arsenate of lead is fast taking the place of Paris green as a spraying compound, being safer as regards foliage and requiring fewer applications. See page 99.

2. Tunnels through fruit irregular and numerous.

APPLE MAGGOT.

Fig. 63.—*Trypeta pomonella*, enlarged 5 times. Original.

REMEDIES: Provide for destruction of windfalls and spraying with arsenical sprays.

b. *Puncturing the Fruit:*

1. Puncturing the fruit and distorting it, a 4-humped beetle.

APPLE CURCULIO.

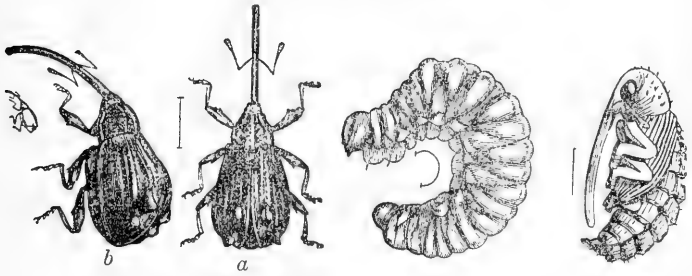


Fig. 64.—*Anthonomus quadrigibbus*, Say. After Riley.

REMEDIES: Same remedies as for Plum Curculio.

2. Purplish spots about the circular scales.

SAN JOSE SCALE.

See Fig. 22.

REMEDIES: See Scales, page 124.

c. *Eating Holes in the Fruit:*

1. Large, light-yellow or apple-green caterpillars, with a broad, cream-colored stripe along the side.

GREEN FRUIT WORMS.

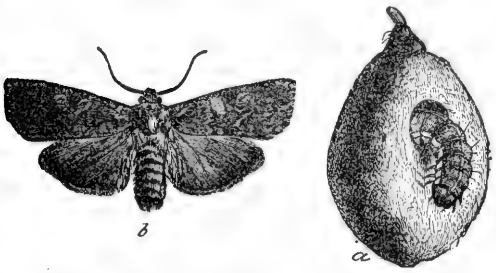


Fig. 65.—*Xylina antennata*, Walk. From Div. of Entomology, Department of Agriculture.

REMEDIES: Hand picking is probably all that will be necessary. If very numerous an arsenical spray will hold them in check.

2. Beetle, yellowish, hairy, ½ inch long.

BUMBLE-FLOWER BEETLE.

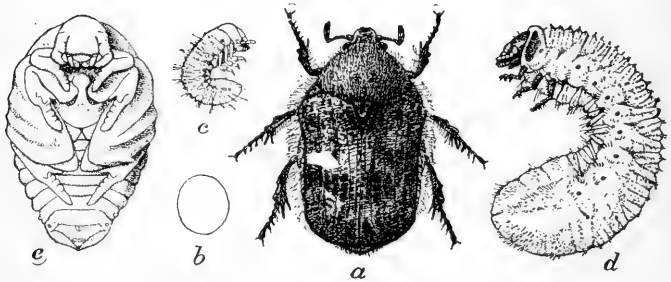


Fig. 66.—*Euphoria inda.* After Division of Entomology, U. S. Department of Agriculture.

Fig. 67.—*Euphoria inda* in apple. Lugger.

REMEDIES: Hand picking only remedy.

WINTER CONDITIONS OF SOME OF THE APPLE INSECTS.

A. *Attached to trunk, branches and twigs:*

White cocoons, ½ to ¾ inch long, under loose bark, or burlap, during fall and winter.

CODLING MOTH.

REMEDIES: See above.

Bracelets of varnished eggs around twigs in fall and winter.

TENT CATERPILLAR.

REMEDIES: See above.

Clusters of cylindrical eggs on branches and twigs in winter.

FALL CANKERWORM.

REMEDIES: Remove eggs. See also page 62.

Small, oval, shining, black eggs, usually clustered in axils of buds, in crevices, or under bark of upper branches and twigs, in winter.

APPLE APHIS.

Fig. 67½.

REMEDIES: Lime Sulfur and Salt Wash. See also page 58.

Minute pistol-shaped cases on bark in winter.

PISTOL-CASE-BEARER.

See Fig. 42.

Black, crumpled leaves folded together and fastened to the branches during winter—half-grown caterpillars in tortuous tubes within.

LEAF CRUMPLER.

Large silken cocoons, 3 inches long, firmly attached to twigs during winter.

CECROPIA MOTH.

See Fig. 109, page 172.

Elongated, white-ribbed cocoons, ⅓ inch long, on twigs during winter.

APPLE LEAF BUCCULATRIX.

Mussel-shaped scales, with whitish eggs underneath in winter.

OYSTER-SHELL BARK-LOUSE.

See Fig. 23.

REMEDIES: See pages 53 and 54.

Whitish scales, with purple eggs underneath in winter.

SCURFY BARK-LOUSE.

See Fig. 24.

REMEDIES: See page 54.

Minute black circular scales, with a depressed ring about a central nipple.

SAN JOSE SCALE.

See Fig. 22.

REMEDIES: See pages 53 and 124.

A mass of eggs on a cocoon fastened to a dead leaf or a twig in winter.

TUSSOCK MOTH.

REMEDIES: Hand picking

Eggs in oval slits.

BUFFALO TREE HOPPER.

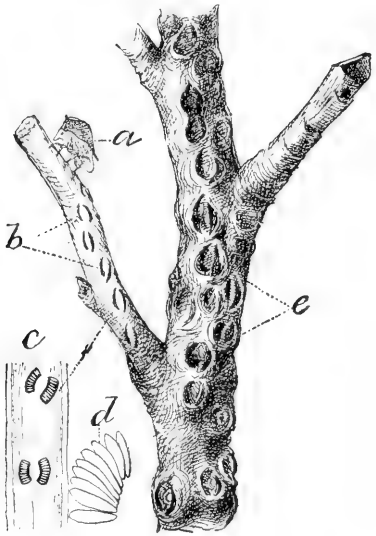


Fig. 68.—*Ceresa bubalus*, Fab. Twig of apple showing: *a*, female at work; *b*, recent egg punctures; *c*, bark reversed with egg in position, slightly enlarged; *d*, single row of eggs, still more enlarged; *e*, wounds of two or three years' standing on older limbs.

REMEDIES: Prune infested twigs as far as possible.

A KEY TO PLUM INSECTS.

A. *Attacking the Trunk, Branches and Twigs:*

Making tunnels in the wood; sawdust-like excrement at the mouth of tunnels.

FLAT-HEADED BORER.

REMEDIES: See page 55 under Apple Insects.

Making tunnels in the bark:

FRUIT BARK BEETLE.

REMEDIES: See page 57 under Apple Insects

Bases of buds perforated, the bark becomes discolored, and the leaves and fruit wither. Do not confound with the fungus "Fire Blight."

PEAR BLIGHT BEETLE.

REMEDIES: See page 60 under Apple Insects.

Boring in the sap wood, a whitish worm, with a flat head. Turns into a beetle, about 1 inch long, copper-colored.

DIVARICATED BUPRESTIS.

Fig. 69.—*Dicerca divaricata*, Say. After Division of Entomology, U. S. Department of Agriculture.

REMEDIES: Caustic washes applied to bark in order to kill the eggs is the only remedy suggested.

Pale-colored worm, with darker head and legs, boring in trunk. Turns into a dark-colored, clear-winged, wasp-like moth.

PLUM TREE BORER.

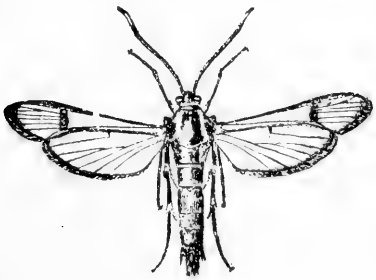


Fig. 70.—*Sesia pictipes*, G. & R. Male.

REMEDIES: Cut out and burn all infested parts if possible.

Fixed to Bark:

a. Flat, or saddle-shaped, or hemispherical dark brown scales. Large scales after mid-summer are brittle and contain only a whitish dust or empty egg-shells. Wintering forms are small and flattish.

PLUM LECANIUM.

REMEDIES: See Scales, page 124.

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b. Ashy-gray appearance of bark of badly infested trees; small gray, or black circular scales.

SAN JOSE SCALE.

REMEDIES: See pages 53 and 124.

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c. Mussel-shaped scales, with whitish eggs underneath in winter.

OYSTER-SHELL BARK LOUSE.

REMEDIES: See page 54 and Scales, page 124.

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d. Bark scurfy, with white scales; purplish eggs underneath in winter.

SCURFY BARK LOUSE.

REMEDIES: See page 54 under Apple Insects.

Producing longitudinal slits and eventually oval-shaped scars.

BUFFALO TREE HOPPER.

REMEDIES: See page 52 under Apple Insects.

B. *Attacking the Leaves:*

1. *Feeding in Colonies:*

a. Protected by webs in the forks of branches.

AMERICAN TENT CATERPILLAR.

REMEDIES: See page 63 under Apple Insects.

b. Protected by webs covering the leaves.

FALL WEB-WORM.

REMEDIES: See page 64 under Apple Insects.

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c. Not protected by webs, greenish lice, with sucking mouths.

PLUM LEAF APHIS.

REMEDIES: See page 58 under Apple Insects.

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d. Hairy Caterpillars, closely resembling American Tent Caterpillar, but without web.

TENTLESS OR FOREST TENT CATERPILLAR.

REMEDIES: See page 73.

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2. *Solitary:*

a. Measuring worms feeding in the day-time and in spring.

CANKER WORMS.

REMEDIES: See pages 62 and 69.

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b. Smooth, reddish caterpillars, about 1 inch long, in July. Head dark, with white markings.

PLUM GEOMETER.

Fig. 71.—*Eumacaria brunneraria*, Pack.

REMEDIES: Spray with Paris green or any arsenical insecticide.

c. Sucking the sap from the buds and leaves in May, causing them to wither; a brownish bug about ⅓ inch long.

TARNISHED PLANT BUG.

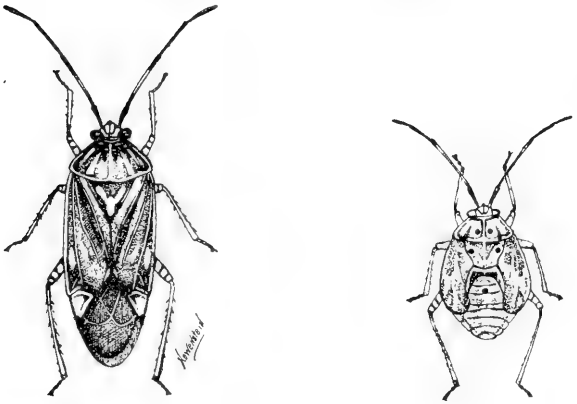

Fig. 72.—*Lygus pratensis*, Linn., and young. Lugger.

REMEDIES: Allow no rubbish to collect under which the bugs may hibernate. Possibly a kerosene spray applied early in the morning, when the bugs are sluggish, will kill many.

d. Fat, greasy caterpillars feeding at night in spring. Frequently found concealed nearby in morning.

CUTWORMS.

REMEDIES: See pages 69 and 161.

e. Hairy caterpillars, with long black plumes over head and tail.

TUSSOCK MOTH.

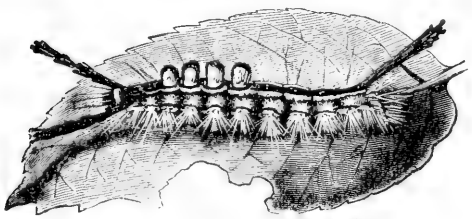

Fig. 73.—See also colored plate.

f. Large buzzing beetle.

JUNE BUG.

REMEDIES: See page 75 under May Beetle.

g. Large grayish Snout Beetle feeding on bud and leaves in spring.

NEW YORK WEEVIL.

See Fig. 37.

REMEDIES: Arsenical poisons applied in time and thoroughly will lessen their numbers. By jarring the tree and catching the falling insects, as for the curculio, many can be destroyed.

h. Large apple-green caterpillar, with a tail horn, and with seven broad, oblique white stripes along each side.

PLUM TREE SPHINX.

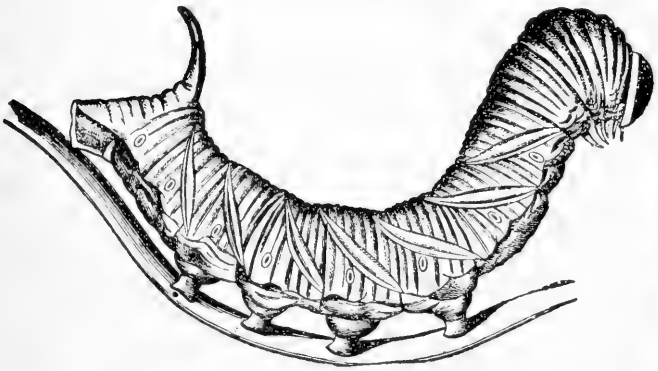

Fig. 74.

Fig. 75.

Fig. 74.—*Sphinx drupiferarum*, S. & A.; caterpiller. After Saunders.
Fig. 75.—*Sphinx drupiferarum*, S. & A.; pupa.

Fig. 76.—*Sphinx drupiferarum*, S. & A. Moth. Lugger.

REMEDIES: Hand picking is all that will be necessary.

i. A grayish-brown worm, resembling the bark in color, about 1½ inches long when full grown. Short, fleshy horn on ninth segment.

PLUM TREE CATOCALA.

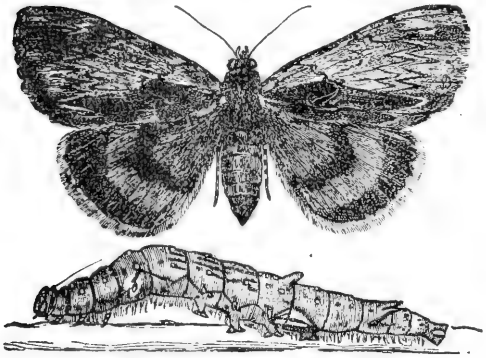

Fig. 77.—*Catocola ultronia*, Hub.

REMEDIES. Same as preceding.

Other larvæ are occasionally found feeding on the leaves of plum.

THE VICEROY, POLYPHEMUS AND CECROPIA.

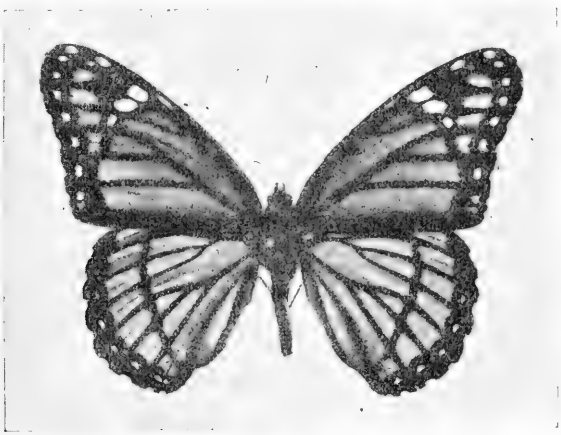

Fig. 78.—The Viceroy. *Basilarchia archippus.*—Lugger.

REMEDIES: Same as preceding.

C. *Attacking the Fruit:*

Puncturing and making a crescent-shaped slit in the skin of the young fruit, which soon drops.

PLUM CURCULIO.

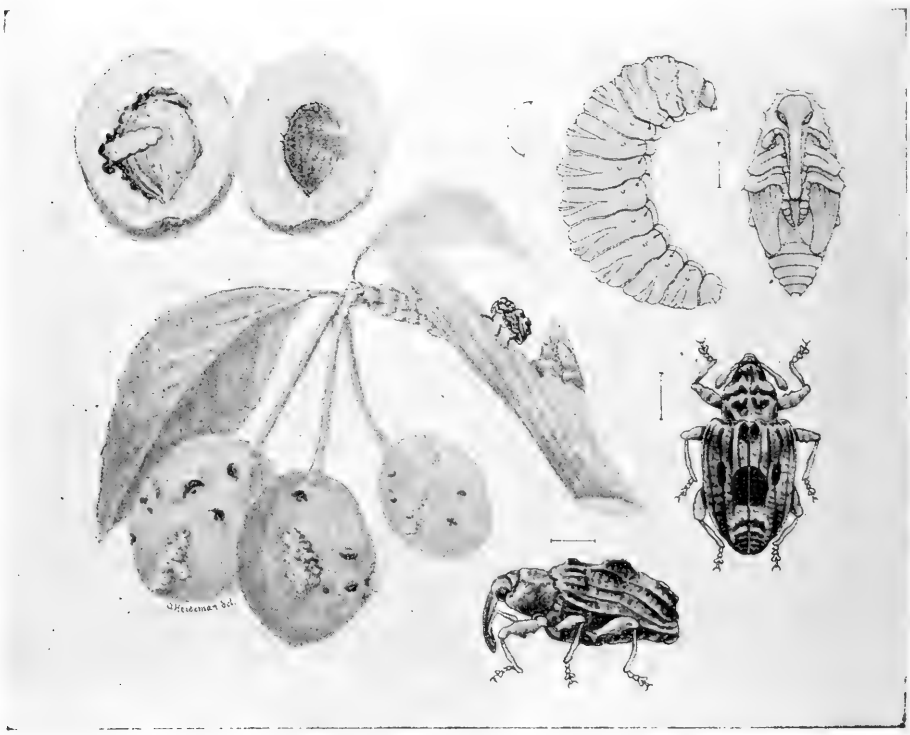

Fig. 79.—*Conotrachelus nenuphar*, Herbst. Lugger.

REMEDIES: Spray thoroughly with arsenical insecticides before the leaves expand.

Jar the trees every few days in early morning, catching the dropping beetles in an inverted umbrella-shaped machine, or on a sheet, and destroy the beetles by burning or crushing.

Destroy all fallen fruit.

Making a round hole in the young fruit.

PLUM GOUGER.

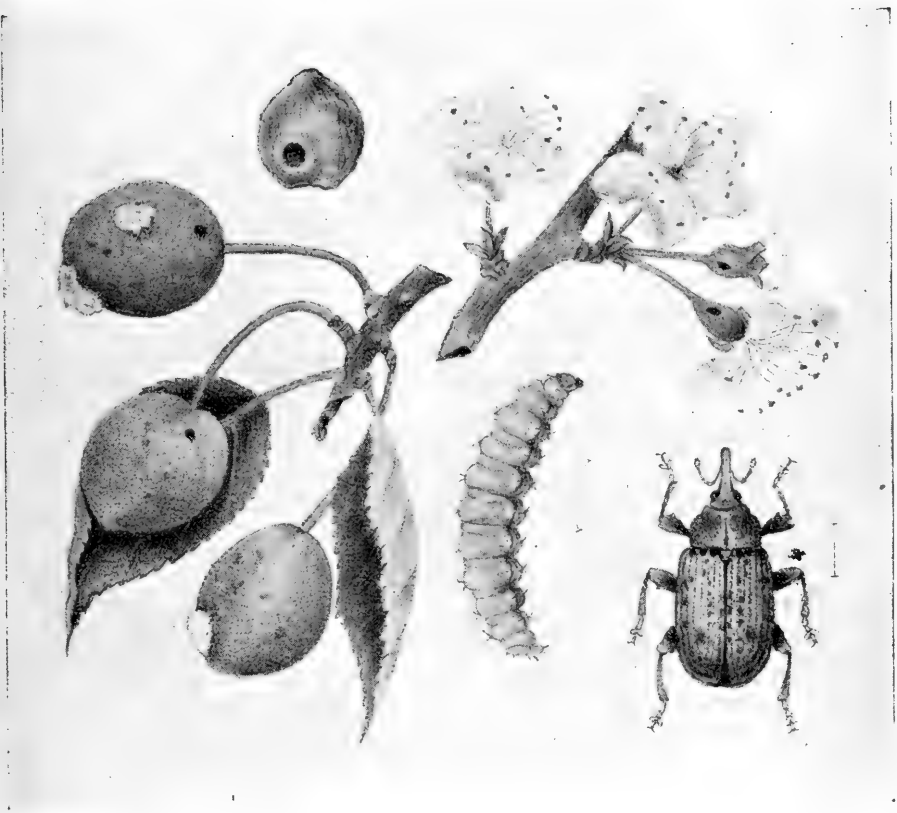

Fig. 80.—*Coccotorus scutellaris*, Lee. Lugger.

REMEDIES: Practically same as preceding.

Eating holes in the ripe fruit.

BUMBLE FLOWER BEETLE.

REMEDIES: See page 78.

Eating holes in the half-ripe fruit.

ROSE CHAFER.

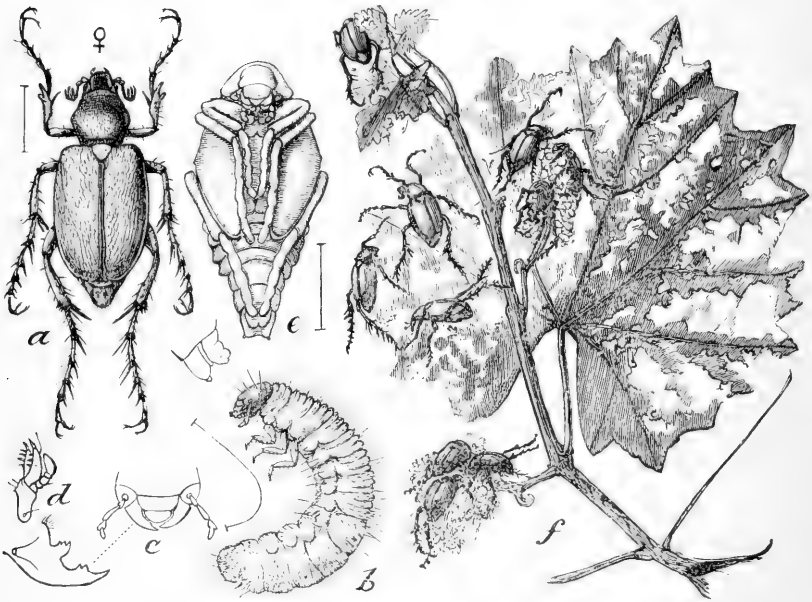

Fig. 81.—*Macrodactylus subspinosus*, Fab.—After Division of Entomology, U. S. Department of Agriculture.

REMEDIES: Jarring, as for curculio. Frequent cultivation, commencing early in spring, and fall plowing, will measurably decrease the pests.

KEY TO PEAR INSECTS.

A. *Attacking the Root:*

Large yellowish-white borer, with a brown head, boring holes in the roots.

BROAD-NECKED PRIONUS.

REMEDIES: See page 51.

B. *Attacking the Trunk, Branches and Twigs:*

The following insects, which attack apple, also attack pear:
Round-Headed Apple-Tree Borer.
Flat-Headed Apple-Tree Borer.
Oyster Shell Bark-Louse.
Scurfy Bark-Louse.
Apple Twig Borer.
San Jose Scale.
Fruit Bark Beetle.

REMEDIES: See remedies for the various species under Apple Insects.

Large, soft whitish larvæ boring deeply into the wood.

PIGEON TREMEX.

Fig. 82.—*Tremex columba*, Linn., Imago original.

REMEDIES: Not common enough to call for attention.

Perforations at the base of some buds; twigs blighted and leaves withered about mid-summer.

PEAR BLIGHT BEETLE.

REMEDIES: See page 60.

C. *Attacking the Bud:*

The following insects, which attack the buds of apple, also attack those of pear:

Oblique Banded Leaf-Roller.

Eye Spotted Bud-Moth.

Canker Worms.

REMEDIES: For remedies see these various forms under Apple Insects.

D. *Attacking the Leaves:*

A slug-like, slimy larva feeding in July and September on the tissues of the upper side of the leaves.

PEAR TREE SLUG.

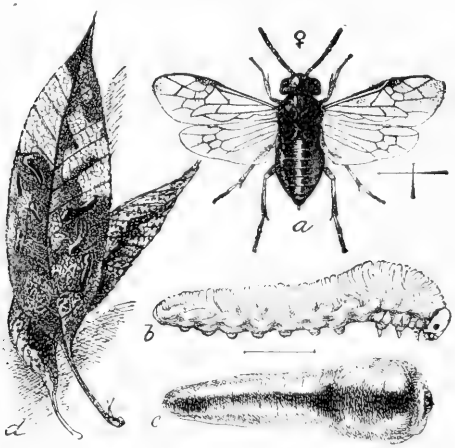

Fig. 83.—Pear Tree Slug: *a*, adult Saw Fly, female; *b*, larva with slime removed; *c*, same in normal state; *d*, leaves with larvae natural size; *a*, *b*, *c* much enlarged. Marlatt, Div. of Entomology. U. S. Department of Agriculture.

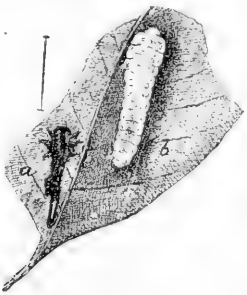

Fig. 83½.—Pear Tree Slug: *a*, last moulted skin; *b*, larva after casting skin, somewhat enlarged. Marlatt, Div. of Entomology, U. S. Department of Agriculture.

REMEDIES: Air-slaked lime dusted over leaves; arsenical sprays.

"Reddish blister spots, 1/8 inch or more in diameter, appearing on leaves in spring, and changing to black, corky spots in July, each with a minute opening in it."

PEAR LEAF BLISTER.

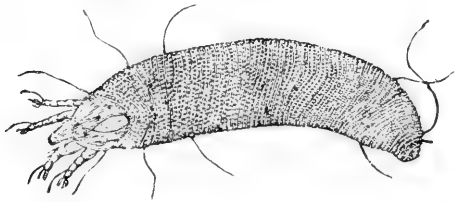

Fig. 84.—*Phytoptus pyri.* After Comstock.

REMEDIES: The Lime-Sulfur and Salt wash has been found excellent for this pest.

The following insects, which feed on the leaves of apple, also feed upon the leaves of pear:

Red-Humped Apple-Tree Caterpillar.
Fall Web Worm.
Tent Caterpillar.
Yellow-Necked Caterpillar.
Canker Worms.
Bud Moth.
Tussock Moth.
Cecropia Moth.
June Beetle.
Goldsmith Beetle.
New York Weevil.

REMEDIES: See under Apple Insects.

E. *Attacking the Fruit:*

The following insects, which attack the apple and plum, also attack the pear:

Codling Moth.
Plum Curculio.
Bumble-Flower Beetle.
Apple Curculio.

REMEDIES: See under Apple and Plum.

KEY TO CHERRY INSECTS.

A. *Attacking the Root:*

Thick, whitish grub, with brown head and legs, feeding in decaying roots. Beetle large, with powerful mandibles.

STAG-BEETLE.

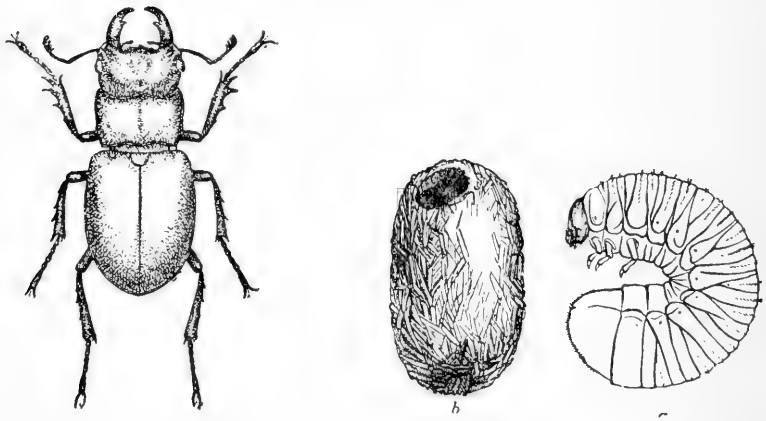

Fig. 85.—*Lucanus dama*, Thunb, Adult; *a*, larva; *b*, cocoon. After Fuchs and Harris.

REMEDIES: No remedy called for.

Large, white fleshy grub, with reddish head, feeding in old roots.

ROUGH OSMODERMA.

See Fig. 28.

REMEDIES: Same as above.

An enormous grub, from 2½ to 3 inches long, yellowish-white. Turns into a large brown beetle, 1 to 2 inches long. See under Apple.

PRIONUS.

REMEDIES: See page 51.

B. *Attacking the Trunk, Branches and Twigs:*

A Snout Beetle gnawing the twigs and fruit.

IMBRICATED SNOUT-BEETLE.

See Fig. 35.

A small beetle boring into the branches just above a bud, and burrowing downwards.

APPLE-TWIG BORER.

REMEDIES: See page 56.

A flattened grub tunnelling in the bark and sap-wood; beetle bronzy metallic.

DIVARICATED BUPRESTIS.

REMEDIES: See page 82.

Large sucking insect, with transparent wings, inflicting wounds on the smaller limbs and depositing eggs therein, in August and September.

DOG-DAY CICADA.

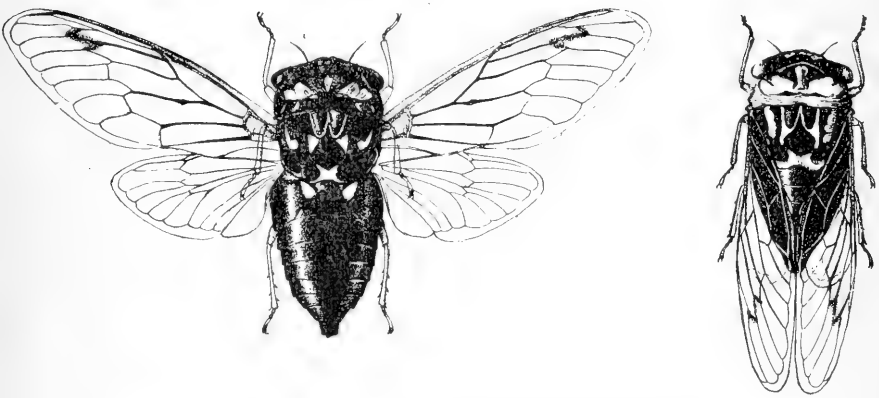

Fig. 86.—*Cicada tibicen*, Linn. Male and female. Lugger.

REMEDIES: Cutting off twigs showing slits containing eggs the only feasible remedy.

Small circular scales, black in winter, with a circular depression about a central nipple.

SAN JOSE SCALE.

REMEDIES: See page 53 and Scales, page 124.

Hemispherical or flatted dark brown scales. See Plum Lecanium.

CHERRY TREE SCALE.

REMEDIES: See page 124

C. *Attacking the Leaves:*

A small beetle feeding on the leaves of red cherry.

CHERRY-LEAF BEETLE.

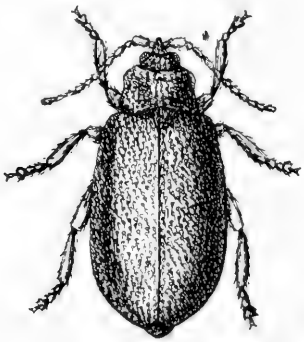

Fig. 88.—*Galerucella cavicollis*, Lec. After Pettit.

REMEDIES: Arsenical sprays if any remedy should be called for.

A slug, shiny, dark-green, ½ inch long, feeding on soft tissues, leaving the veins.

PEAR OR CHERRY SLUG.

REMEDIES: See page 92.

A black Plant Louse, appearing in the spring as soon as leaves of cultivated cherries expand. They gather on under side of leaves. Found on Sand Cherry also.

CHERRY TREE PLANT LOUSE.

REMEDIES: See page 58 for general remedies for Plant Lice; also page 134.

Large bluish-green caterpillar, 2 inches long, with blue warts on each segment and coral-red ones on third and fourth segments. Evidently very rare in this state, if it occurs at all. Transforms into Promethea Moth.

PROMETHEA MOTH.

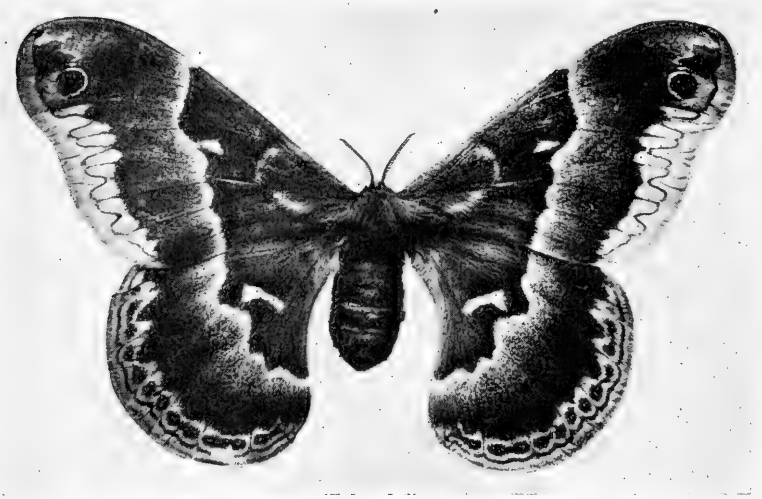

Fig. 88½.—Promethea Moth. Original.

REMEDIES: Hand picking of caterpillar.

Large pale-green, spiny caterpillar, striped on each side with white and lilac.

IO MOTH.

REMEDIES: See pages 71 and 72.

Caterpillars in colonies, protected by webs in forks of branches in spring.

AMERICAN TENT CATERPILLAR.

REMEDIES: See page 63.

Caterpillars in colonies, not protected by webs, covering the leaves in summer and early autumn.

FALL WEB-WORM.

REMEDIES: See page 64.

D. *Attacking the Fruit:*

Making a crescent cut on the cherry; grub, white and footless, with a brownish, horny head, feeding within.

PLUM CURCULIO.

REMEDIES: See page 88.

INSECTICIDES AND FUNGICIDES.

As spraying, both for injurious insects and fungous diseases, has become the popular as well as the scientific method of combating these scourges, the following results were compiled in order that the farmers and the fruit growers of Minnesota might have the direct benefit of the researches and experiments conducted along these lines in Experiment Stations and in other reliable places. During the last few years some of the best brains of the country have been at work experimenting with the various insecticides and fungicides, trying to find the right proportions, etc., to kill the insect or disease and yet not affect the vitality of the plant in any way. Some of the sprays used are as near perfect as can be desired, while others have yet to be invented which will do the work satisfactorily. Following this list of insecticides and fungicides is an alphabetical list of some of the leading insect pests and plant diseases, with references, by number, to remedies in this list or to pages in this report where the insect is fully discussed.

1. **Ammoniacal Copper Carbonate—**

This fungicide is used in place of the Bordeaux Mixture when there is danger of the latter staining the fruit. Bordeaux Mixture is the common and the best practical fungicide. However, when the fruit becomes half-grown, the Bordeaux Mixture is apt to discolor and produce disfigurements, such as "russeting" of the apple, etc. It is at this period, therefore, that the above fungicide is used. The Ammoniacal Copper Carbonate can be used without any danger of discoloring the fruit.

FORMULA:

Copper Carbonate, 5 ounces;
Ammonia (26° Beaume), 3 pints;
Water, 45 gallons.

Dissolve the Copper Carbonate in the ammonia. This may be kept any length of time in a stoppered bottle, and

can be diluted to the required strength when ready for use. The prepared mixture loses strength on standing.—(Mass. Bul. 80, 1902.)

2. **Arsenate of Lead—**

This is the least soluble of all the arsenical insecticides, and is, therefore, not liable to burn the foliage, even if used in large proportions. It is also quite adhesive.

FORMULA—

Dissolve 11 ounces acetate of lead (sugar of lead) in 4 quarts of water in a wooden pail, and 4 ounces arsenate of soda (50 per cent purity) in 2 quarts of water in another wooden pail. (The sugar of lead can be dissolved more quickly by using warm water.)

If only a small quantity of the arsenate of lead is required it can be purchased in the prepared paste form.

The above solutions poured into 150 gallons of water is required for Codling Moth, Tent Caterpillars, etc.; while these solutions poured into only 25 gallons of water is required for the Elm Leaf Beetle.—(Mass. Bul. 80, 1902.)

Arsenate of lead may be used whenever Paris Green is recommended.

3. **Arsenic Bran Mash—**

FORMULA:

White arsenic, 1 pound;
Brown sugar, 1 to 2 pounds;
Bran, 6 to 10 pounds.

Mix thoroughly and then add water to make a wet, but not sloppy, mash.

It is used against Cutworms working in garden crops, at the rate of one teaspoonful at the base of each plant. (Cal. Bul. 142, 1902.) With tender plants like melons care should be taken lest heavy rains wash the poison against the stems and thus burn the plants.

For grasshoppers scatter the mash over the land where the 'hoppers are thickest. (Col. Bul. 71, 1902.) See also Criddle Mixture.

4. **Arsenite of Lime—**

FORMULA:

White arsenic, 1 pound;
Freshly burned lime, 2 pounds;
Water, 1 gallon.

Boil together for 45 minutes. Keep the resulting product in a tight vessel.

One quart of this added to a barrel of water is used against biting insects. However, in Oregon (Oregon Bul. 75, 1903), as well as in other states, it very often burns the foliage.

5. **Arsenite of Soda—**

FORMULA:

(Known as the "Kedzie" formula.)

Boil 2 pounds white arsenic and 8 pounds sal soda for fifteen minutes in 2 gallons of rain water. Put in a jug and label "Poison." When ready to spray slake 2 pounds of lime and stir it into 40 gallons of water, adding a pint of the mixture from the jug.

The arsenic in this mixture is equivalent to 4 ounces of Paris Green, and may be used whenever Paris Green is recommended. This insecticide is used in preference to the Arsenite of Lime, because in the Arsenite of Soda one is sure of all the arsenic being combined to become insoluble in water, and thus there is no danger of burning the foliage. Arsenite of Lime is cheaper, but Arsenite of Soda is more reliable.

6. **Benzine—**

May be sprayed into cracks and crevices for bedbugs.

7. **Bisulfid of Carbon—**(See Carbon Bisulfid.)

8. **Borax—**

For cockroaches spread powdered borax on bread, sweet potatoes or banana peelings, or mix with sweetened chocolate and place the bait where the roaches can get it.—(Col. Bul. 71, 1902.)

See also Olive Oil, Kerosene. Or use borax freely about sink, wainscoting, etc. See p.... F. L. W.

9. **Bordeaux Mixture—**

For use as a liquid spray there are several formulæ for this very important fungicide, but the principle of making is the same in each.

Have a stock solution of copper sulphate made by suspending copper sulphate (blue vitriol) in a bag just below the surface of a tub of water, at the rate of 1 pound to a gallon of water. Make also a stock solution of lime; use a known quantity of good lime, slake slowly and add water to make a thick milk of lime; allow to cool before using, and always keep the lime covered with water. When ready to spray dilute the required amount of each of the stock solutions to 25 gallons, and then pour the two diluted solutions together.

For dormant trees use:
Cu So^4, 6 pounds;
Lime, 6 pounds;
Water, 50 gallons.

For plants in foliage use:
Cu So^4, 4 pounds;
Lime, 6 pounds;
Water, 50 gallons.

For tender foliage, such as plum, cherry and peach, use:
Cu So^4, 3 pounds;
Lime, 6 pounds;
Water, 50 gallons.

—(Oregon Bul. 75, 1903.)

If the lime is of good quality and the mixture is made as directed, there will be no burning of the foliage. However, it is always best to determine whether enough lime has been used by testing the mixture.

"There are three simple tests which may be used. First, hold a clean, bright knife blade in the Bordeaux Mixture for at least one minute. If it becomes copper-plated more lime should be used. Second, pour some of the Bordeaux Mixture into a shallow dish and, holding it up to the light, blow gently across its surface. If properly made a thin pellicle will form on the surface of the liquid. If this does not form more lime should be added. Third, dissolve one ounce of ferro-cyanide of potassium in 5 or 6 ounces of water. Pour some of the Bordeaux Mixture into a white dish and add to it a few drops of the ferro-cyanide solution. If sufficient lime has been used no change will be noticed. If a brownish-red discoloration takes place more lime should be added."

Up to the present year the only practical method in which to use this fungicide was in the liquid form. Thanks, however, to the work of Dr. Bird, of the Missouri Experiment Station, a successful dust spray having the same chemical composition as the liquid spray has been discovered. Previous to this time the dry product, supposed to be Bordeaux, had a very different chemical composition from the true Bordeaux Mixture, and was of very little fungicidal value.

The following is an account of the dust spray of Bordeaux, written by J. M. Steadman in the "Country Gentleman" of Aug. 13, 1903:

"The new Bordeaux powder can be made by any fruit grower or gardener with very little trouble, and at a very nominal expense. It can be made during the winter and stored in a dry place, where it will keep indefinitely.

"In order to make this new Bordeaux powder one should first make a large quantity of air-slacked lime. This can be readily done by taking about 75 pounds of good quick lime, pounding up the lumps and spreading it over a large area, thus allowing it to air-slack readily.

When completely air-slacked, this should then be sifted through a fine sieve; a 100-mesh sieve is the proper one to use. One can break up the lumps in this sieve so as to utilize the bulk of the air-slacked lime by rubbing it through the sieve by means of a block of wood. As this is a stock dust, to be used as a carrier in the place of water, it would be just as well to make up a much larger quantity, so as to have it on hand at a minute's notice. After it is thoroughly air-slacked and sifted, the powder should be kept in a dry place, such as the hay loft or the garret of the house.

"Dissolve 4 pounds of copper sulphate in 2½ gallons of water by placing the copper sulphate in a coarse bag and suspending it just below the surface of the water until dissolved. This is to be kept in a vessel by itself.

"Slack 4 pounds of good quicklime by sprinkling over it slowly 2½ gallons of water in such a manner as to slack the lime to a fine powder and give as a result a milk of lime solution. This must now stand until cooled before using it.

"In a large shallow box one should then place 60 pounds of the sifted air-slacked lime which has already been made as a stock carrier. In another vessel pour the milk of lime and the copper sulphate solution, both at the same time, and stir thoroughly until the whole is well mixed. Then turn this into a double flour sack and squeeze out most of the water.

"Empty this blue material just made into the 60-pounds of air-slacked lime, and at once work it up thoroughly with a hoe. If after this has been thoroughly mixed the material is too wet, more of the lime dust should be added. This material must then immediately be rubbed through a comparatively coarse sieve, while it is still somewhat damp. It should then be thoroughly mixed again by means of a stick and spread out in a dry place and allowed to dry. When this is perfectly dry it must then be sifted through a fine sieve of 100 meshes, in which case all lumps can be ground by means of a stick rubbed over the sieve. The resultant powder should have a uni-

formly blue color. In case it looks streaked or mottled, it should be stirred until all of the mixture is of a uniformly blue color. This powder, now completed, will keep indefinitely in a dry place, and contains copper sulphate in the same chemical combination as is found in the liquid Bordeaux Mixture. There is a large excess of powdered lime in this which is not in chemical combination with copper, but which is there simply as a carrying agent."

The liquid form of Bordeaux is used successfully on—

Apple, for
Bitter Rot.—W. Va. Bul. 66, 1900.
Canker.—Delaware Bul. 57, 1902.
Scab.—U. S. Dept. Agr. Farmers' Bul. 38, 1896.

Cantaloupe, for
Blight.—Col. Bul. 68, 1902.

Celery, for
Blight.—Cornell Bul. 188, 1901.

Chyrsanthemum, for
Rust.—Ind. Bul. 85, 1902.

Currant, for
Anthracnose.—N. Y. Bul. 199.

Gooseberry, for
Mildew.—Cornell Bul. 188, 1901.

Grape, for
Anthracnose.—Col. Bul. 69, 1902.

Pear, for
Leaf-Blight.—Cornell Bul. 188, 1901.

Plum, for
Black Rot.—W. Va. Bul. 66, 1902.
Shot-Hole Fungus or Leaf-Blight.—Col. Bul. 69, 1902.
Plum Pockets.—N. C. Bul. 92, 1894.

Potato, for
Blight.—Cornell Bul. 188, 1901.

Strawberry, for
Leaf-Blight.—Cornell Bul. 188, 1901.

Tomato, for
Leaf-Blight.—Cornell Bul. 188, 1901.

10. **Bordeaux Mixture plus Paris Green, etc.**—(A Fungicide plus an Insecticide.)

When there are both insects and plant diseases to combat, instead of applying the Bordeaux Mixture alone, or the Paris Green alone, a combination of the two "kills two birds with one stone." In fact, when spraying with the Bordeaux Mixture, even if not sure that injurious insects are present, it is quite safe and desirable to add the insecticide. According to the N. Y. State Bul. 220, 1902, although the combination spray stopped the scab to a considerable extent, it caused spotting, yellowing and dropping of the apple leaves in July. The injury, however, was not serious.

Use 4 ounces Paris Green or 1 gallon Arsenate of Lead (as per formula) in 50 gallons of the Bordeaux Mixture.

11. **Bordeaux Resin Mixture**—(See Resin Lime Mixture.)

12. **Bran Mash**—(See Arsenic Bran Mash.)

13. **Camphor**—(See Naphthaline.)

14. **Carbon Bisulfid**—

This substance is used against a number of insects, and also other animals, which cannot be combatted with internal or even contact poisons. This liquid volatilizes very rapidly, and the gas being heavier than air must be generated from above. It is used with good success against ants, buffalo beetle, clothes moths, museum pests, prairie dogs, stored grain insects, etc.

For Ants—First find the ant hill; then with a cane make several holes ten to twelve inches deep, into each of

which pour 3 to 5 tablespoonfuls of Carbon Bisulfid. Cover the ant hill with an old blanket or burlap, preferably moist, to keep in the fumes, and leave twenty-four hours. Sometimes more than one treatment is necessary.

For the Buffalo Beetle—A very strong percentage of the Carbon Bisulfid must be used to enable the fumes to penetrate into the body of the rugs, carpets, etc., where the insects are.

For Insects in Stored Grain—Use one pound of Carbon Bisulfid to each one thousand cubic feet. Place the liquid in a shallow dish on the top of the grain; close the bin tightly and leave for twenty-four hours.

CAUTION: Keep lights of all kinds away when using.

15. **Copper Acetate—**

This fungicide, and the following one, may be used instead of the Bordeaux Mixture, when the fruit or plants are nearly ready for market. They are also recommended to be used against fruit rot.

Use 6 ounces Copper Acetate (Diabasic Acetate), powdered form, in 50 gallons of water. First make a paste with water and then dilute to the required strength. (Mass. Bul. 80, 1902.)

16. **Copper Carbonate—**

Use one pound of Copper Carbonate in 40 gallons of water. Mix the Copper Carbonate with water to make a paste, then dilute to the required strength. (Del. Bul. 29, 1895.)

17. **Copper Sulphate—**(Blue Vitriol or Blue Stone.)

A solution of Copper Sulphate is used as a remedy for grain smuts. (See also Formalin, Corrosive Sublimate.) It may also be used as a spray in place of the Bordeaux Mixture.

For dormant trees use:

Copper Sulphate, 1 pound;
Water, 25 gallons.

For trees in foliage use:

Copper Sulphate, 1 pound;
Water, 250 gallons.

For oat or wheat smut:

Soak the seed 10 to 12 hours in a solution of 1 pound of Copper Sulphate to 25 gallons of water. Then put the seed for 5 or 10 minutes into lime water, made by slacking 1 pound lime and diluting to 10 gallons with water. The lime tends to prevent the Copper Sulphate from injuring the seed. (Oregon Bul. 75, 1903.)

19. **Corrosive Sublimate—**

Corrosive Sublimate is deadly poison to all animal life, and therefore care must be taken to prevent animals from eating the materials treated. It is used against potato scab and grain smuts. (See also Formalin.)

For use dissolve 2 ounces of corrosive sublimate in 2 gallons of hot water; then dilute to 15 gallons; allow to stand 5 to 6 hours, agitating several times meanwhile. (Always employ wooden or earthen vessels; never metallic.)

For Potato Scab—Place the scabby potatoes in a sack and immerse in this solution for 1 to 2 hours. Plant the seed before it becomes contaminated with stray spores of the scab that may be found on dirty floors of the barn, etc.

For Smuts—The seed may either be soaked, as for potato seed, or may be sprayed thoroughly with the solution. In either case the seed must not be kept wet long enough to heat.

For Bedbugs—

A mixture of Corrosive Sublimate, 1 ounce,
Alcohol, ½-pint,
Turpentine, ¼-pint,

sprayed in all cracks and crevices where bugs might lodge, will effectually rid a house of the pests. More than one or even two doses will probably be necessary.

19. **Creolin—**

Commercial Creolin is a blackish brown liquid, costing about 25 cents a pint. This is highly recommended for dog fleas, which sometimes become very annoying pests in dwelling houses. As the cat and dog is the source of the pest, these animals must be rid of the insects. The animals should be washed thoroughly with a mixture of creolin and water. For dogs a 3 per cent solution should be used, or four tablespoonfuls to a gallon of water; for cats a 2 per cent solution, or two tablespoonfuls of creolin to a gallon of water. Get the creolin well mixed with the water before using. (New Hampshire Bul. 94, 1902.)

20. **Criddle Mixture—**

This mixture has met with great success in Manitoba as a remedy against grasshoppers.

FORMULA:

Paris Green, 1 part;
Salt, 2 parts;
Horse manure, 100 parts (by measure).

Mix the Paris Green with the water; mix this through the horse manure and then add enough water to make a soft but not sloppy mash. If the horse manure is fresh the addition of the salt is not necessary. Use as the Arsenic Bran Mash, i. e., simply scatter the mixture over the land where the "'hoppers" are thickest. It is most effective when spread in hot, sunny weather. See also p..

21. **Crude Petroleum—**

"Crude Petroleum is an oily, inflammable liquid, varying in color from very dark brown to greenish tints. By refining it yields a number of valuable products, including paraffin, lubricating and illuminating oils and a series of highly volatile oils. It is the heavier oils that make it especially valuable as an insecticide. Crude petroleum varies in appearance and composition according to the locality from which it is taken. The eastern oils are said to vary greatly from the western and most for-

eign oils, the former having a paraffin and the latter an asphalt base. The true indication of the safety of petroleum as an insecticide evidently depends upon its specific gravity; as it has been found that petroleum having a specific gravity of 43 degrees or above (Baume oil scale at a temperature of 60 degrees F.) is less likely to injure the trees than petroleum of a lower specific gravity, although oils of a lower specific gravity have been successfully used in some instances, notably in Canada." (N. Y. State Bul. 202. 1901.)

This is one of the best scale insect remedies. It should be applied on a bright, sunny day in early spring, and must be applied thoroughly, evenly and avoid overdrenching.

On perfectly dormant apple trees a 40 per cent emulsion is used; on perfectly dormant plum trees a 25 per cent emulsion is used.

22. **Cupram**—(Ammoniacal Copper Carbonate.)

23. **Formalin**—

This has been found to be the best remedy for potato scab and smuts.

For Potato Scab—Soak the seeded potatoes for two hours in a solution of a ½-pint of formalin to 15 gallons of water.

For Grain Smuts—Soak the seed one to two hours in a solution of 1 pound of formalin to 50 gallons of water.

24. **Gasoline**—

This is used like benzine for bedbugs by spraying into crevices, etc.

25. **Green Arsenoid**—(See Scheele Green.)

This insecticide is applied in the same manner as Paris Green. It contains no acetic acid, and is thus not so liable to burn the foliage. It costs less than Paris Green (12c. to 15c per pound), and being finer remains in suspension longer. Dr. Marlatt, of the Division of Entomology, U. S. Department of Agriculture, says it should replace Paris Green as an insecticide. (Colorado Bul. 71, 1901.)

26. **Gum Camphor**—(See Naphthaline.)

27. **Hellebore**—

This is an internal poison. It is used in place of Paris Green in the case of cauliflower or cabbage when there is danger of poison remaining on the part to be eaten. Hellebore is not poisonous to man, and so can be handled with impunity.

For Currant Worms—Sprinkle the hellebore on the leaves, on the under side when possible, when the dew is on, or after the leaves have been sprinkled with water, to insure its sticking.

28. **Hydrocyanic Acid Gas**—

It is fully recognized that fumigation with hydrocyanic acid gas is one of the best methods of combating scale and other insects. For this reason many large nurseries in the region infested with San Jose Scale fumigate all their nursery stock before shipment. The laws of some countries require this, while no nursery stock, except evergreens, can be shipped into Canada without first being fumigated with this gas at the port of entry. The gas is now used in greenhouses, granaries, mills and other buildings subject to infestation by insects or objectionable animals of any kind. The gas is a deadly poison to all animal life and great care must be taken in generating it. Unless thoroughly acquainted with its use, the entomologist or some competent authority better be consulted before handling.

The chemicals used in the production of the gas must be very accurately determined. The formula per cubic foot of space usually used is:

Potassium cyanide, 0.25 grammes;
Sulphuric acid (98 per cent), one-half more acid, liquid measure, than cyanide;
Water, one-half more water, liquid measure, than acid.

"The amount of cyanide necessary for any enclosure is determined in terms of grammes per cubic feet of space

enclosed. To determine the exact amount of cyanide necessary to fumigate a room, car, ship or building of any kind, the cubic contents must be accurately computed. As an example, a room 20x30x10 feet contains 6,000 cubic feet of air space. To estimate the amount of cyanide required for this enclosure, multiply 6,000 by 0.25; thus: $6,000 \times 0.25 = 1,500$ grammes. To reduce this to ounces, divide by 28.35, as there are 28.35 grammes in an ounce; thus: $1,500 \div 28.35 = 53$ ounces, the exact amount of cyanide needed for the enclosure. It is now easy to determine the amount of acid and water, as a half more acid, liquid measure, than cyanide, and a half more water than acid are used; thus: $53 \div 2 = 26.5$, which, added to 53, equals 79.5 ounces of acid, or practically 5 pounds, liquid measure. Again, 79.5, or practically 80, as we usually discard fractions, divided by 2 equals 40, which, added to 80, makes 120 ounces of water."—Fumigation Methods, Johnson.

In combining the chemicals, measure the acid and pour it into an earthenware dish, wooden bucket, tub, etc.; measure the water and pour it in with the acid; if a room is to be fumigated have the bag containing the potassium cyanide suspended from a pulley directly above the jar of acid, and from a distance drop in the cyanide, bag and all; if the space is under a tent, the cyanide can be dropped in directly from the hand; close the door tightly or drop the tent quickly, and leave for the desired length of time.

For nursery stock an air-tight building, made by double boarding and padding with felt, etc., is employed, into which the nursery stock is taken and there fumigated. Exposure, 30 to 40 minutes.

For dormant trees a canvas tent is used to enclose the entire tree, or if the tree is small enough a fumigator, a box frame covered with canvas, is placed over the tree, and the gas generated in the enclosed space. An exposure of 30 minutes is usually sufficient.

For greenhouse pests, although the treatment is yet in the experimental stage, some horticulturists fumigate

their greenhouses four or five times a year, and are able to keep down all injurious pests except the red spider.

When fumigating mills and other buildings for pests, be sure that there is some method for ventilating the room or rooms from the outside. After fumigation the room must be thoroughly ventilated at least half an hour before venturing therein. Give 20 to 24 hours' exposure.

29. Iron Sulphate and Sulphuric Acid—

FORMULA:

Hot water, 100 parts;

Iron sulphate, as much as will dissolve (about 100 pounds);

Commercial sulphuric acid, 1 part.

Add the acid to the crystals and then pour on the water. This is a good fungicide for dormant grape vines attacked with anthracnose. (Mass. Bul. 80, 1902.) Apply with sponge or brush.

30. Kerosene—

This insecticide is used pure, and also diluted with water, for scale insects, plant lice, etc. When diluted a mechanical emulsion, made by a kerowater spray pump, or a regular emulsion is employed. (See Ker. Emul.) Experiments seem to indicate that, like crude petroleum, the safest time to apply is on a bright, windy day in early spring, just before the buds begin to swell, in the form of a very fine spray.

One part of kerosene to six parts of water can be used on trees in foliage without injury, while plant lice are killed in a mixture as weak as 1 part of kerosene to 15 or 20 parts of water. (Col. Bul. 71, 1902.) For plant lice, therefore, 1 part of kerosene to 10 of water is probably the best proportion to use. This proportion will also kill young scales.

Pure kerosene if properly applied may be used on apple trees in winter without great danger to the trees, but 40 per cent and 60 per cent is almost as destructive to insects, and may be used on apple and pear trees in winter

without danger. (W. Va. Bul. 78, 1902.) Under no circumstances, however, is pure kerosene recommended to be used on plant life of any kind. It has been used undiluted on plants dormant and in foliage (apple trees and others) without apparent injury, but there are too many uncertainties attending its use to warrant its application.

For sprays always purchase the 150 degree fire test kerosene.

For Cockroaches—With an atomizer spray into the cracks, etc., where the roaches are located.

We have kept roaches within bounds by having an atomizer handy containing kerosene, and spraying a roach whenever seen. See p. 162. F. L. W.

31. **Kerosene Emulsion—**

This, probably, is the best form into which kerosene can be put in order to obtain the best results. When the kerosene is in an emulsion the proportion of kerosene is known to a certainty, while with the Kero-water sprays the proportion is not always just what one expects.

A stock emulsion is made as follows:

HUBBARD FORMULA:

Hard soap, shaved fine, ½ pound;
Kerosene, 2 gallons;
Water, 1 gallon.

Dissolve the soap in boiling water; remove from the stove and add the kerosene while the water is still boiling hot; churn with a spray-pump until it gets to a soft, butter-like mass.

For Plant Lice use 1 part of the stock to 10 parts of water. Some insects will require a much stronger mixture.

32. **Kerosene Milk Emulsion—**

When small quantities of emulsion are wanted it is often less trouble to make it with milk than with the soap and water.

FORMULA:

Sour milk, 1 gallon;
Kerosene, 2 gallons.

Dilute as in the preceding. If the milk is sweet add a little vinegar.

33. **Lead Arsenate**—(See Arsenate of Lead.)

34. **Lime**—

Lime is of little if any value as an insecticide, being simply a deterrent and irritant. It can be used wet or dry on foliage without harm. When dusted on pear or other tree-slugs it prevents them from doing much damage.

It is used to prevent Sun Scald by making a coating on the body of the tree in early spring. To increase the adhesive power make according to the following formula:

Skim milk, 6 gallons;
Water, 30 gallons;
Lime, 60 pounds;
Salt, 10 pounds. (Can. Exp. Farm Rpt., 1900.)

35. **Lime-Sulphur-Salt**—

Recent experiments show that this is probably the best scale insecticide yet discovered. It must be used only on dormant trees. When applied at this time it has also been found to exterminate Woolly Aphis, Pear Leaf Blister Mite, "Red Spider" eggs, etc.

FORMULA:

Quick lime, 50 pounds;
Sulphur, 50 pounds;
Salt, 50 pounds;
Water, 150 gallons.

Slake the lime thoroughly, then add the sulphur; cover with water and boil briskly for at least one hour. Then add the salt and boil 15 to 20 minutes longer. Add water to make 150 gallons.

During the past summer Dr. E. P. Felt, N. Y. State Entomologist, experimented on the method of making

this mixture. He obtained excellent results "in using a lime-sulphur wash, consisting of 25 pounds of lime and 20 pounds of sulphur to 60 gallons of water. The lime added, a sufficient quantity of water is brought nearly to a boil in a kettle, and while the slaking is in operation the sulphur is put in and the whole well stirred, in order to take advantage of the heat generated by the slaking lime. This assists materially in bringing the sulphur into solution, and we find it necessary to boil the combination but 30 minutes."—Country Gentlemen, Nov. 12, 1903.

36. **Liver of Sulphur**—(See Potassium Sulfid.)

37. **London Purple**—

This is a common arsenical insecticide, although not used as much as formerly. It is a waste product in aniline dye manufacture. It is cheaper than Paris Green and is held in suspension in water longer, but the composition is very variable and more of the arsenic is in a soluble form than in Paris Green, therefore it is more dangerous to foliage, and is not recommended.

38. **Lye, Washing Soda, Etc.**—

These are in popular favor, but experiments show them to be of not much use. When trees are dormant one pound of lye to three gallons of water may be used on the limbs of the trees. For trees in foliage 1 pound to 40 gallons of water, but this will kill only the very tender insects, and stronger than this will burn the foliage.

39. **Naphthaline, Gum Camphor, Moth Balls**—

All these are simply repellants; that is, the odor from these is disagreeable to the insects and they keep away. Moth balls are a combination of the first two. They are used against museum pests, clothes moths, etc. (See Carbon Bisulphid.)

40. **Paragrene**—

This arsenical insecticide contains too much free arsenious acid to be good. It is sure to burn the foliage. (Cal. Bul. 126, 1899.)

41. **Paris Green—**

Although there are several better arsenical insecticides, Paris Green is the most popular. In samples studied at this Station we find that even the Paris Green from the best manufacturers contains at times a great deal of uncombined arsenic. Therefore, it is to be expected that some persons get better results than others in its use. Some will have the foliage burned very badly and others not at all. In another part of this bulletin the analyses of samples of Paris Green are reported. It would be well to study the figures there given before purchasing one's next supply of Paris Green.

Arsenical insecticides are used to combat the various insects that *eat* the foliage and the fruit.

Paris Green may be applied either by dusting or spraying. In dusting, to prevent the Paris Green from being applied too thickly at one place, 1 pound of Paris Green is mixed thoroughly with 25 to 50 pounds finely slaked quicklime or cheap flour. This is dusted over the leaves of the vines, trees, etc., in the early morning when the dew is on. For methods of application see page 154.

In spraying use 1 pound of Paris Green;
2 to 4 pounds of fresh lime;
160 to 200 gallons of water.

Slake the lime gradually, sprinkling in the Paris Green, then add the rest of the water. (Mass. Bul. 80, 1902.)

Or, make a paste of the Paris Green and water and then add to the mixture of lime and water.

42. **Petroleum—**(See Crude Petroleum.)

43. **Potassium Sulfid—**

A stock solution is made as follows:

FORMULA:

Potash, 32 pounds;
Sulphur, finely ground, 37 pounds;
Salt, 2 pounds;
Water, 50 gallons.

The potash, sulphur and salt may be mixed together in a large metal tub with a little water; the chemical action will make it boil. For spraying dilute with 100 times as much water. It is used against the active stages of the red spider. Three applications at intervals of one week kills the eggs and moulting forms. (Cal. Bul. 145, 1902.)

A solution, which loses strength upon standing, is made by mixing ½ to 1 ounce potassium sulfid (Liver of Sulphur) in one gallon of water. It is used against surface mildews of gooseberry (Cornell Bul. 188, 1901), rose, etc.

44. **Pyrethrum—**

This is the ground-up flowers of the Pyrethrum plant. It loses strength unless kept in a tight can or jar. When burned in a room it will destroy mosquitoes, flies, fleas, cockroaches, etc. It may be used as a spray, 100 grains of powder to 2 gallons of water.

45. **Resin Bordeaux**—(See under Resin Lime Mixture.)

46. **Resin Lime Mixture—**

As a fungicide or an insecticide this mixture is not of itself very useful. Some plants, however, have a smooth, glossy epidermis; the Resin Lime Mixture, added to a regular fungicide or insecticide, acts as a carrier, and insures the sticking of the necessary poisonous ingredients.

FORMULA:

Pulverized resin, 5 pounds;
Concentrated lye, 1 pound;
Fish or other animal oil, 1 pint;
Water, 5 gallons.

Place the oil, resin and one gallon of hot water in an iron kettle and heat until the resin softens. Then add the lye and stir thoroughly. Now add 4 gallons of hot water and boil until a little will mix with cold water and give a clear, amber-colored liquid. Add water to make up to 5 gallons. Keep this as stock.

Paris Green Resin Mixture—
Resin stock solution, 1 gallon;
Water, 16 gallons;
Milk of lime, 3 gallons;
Paris Green, ½-pound.

This is an excellent remedy for cabbage worms and other caterpillars on cabbage, cauliflower or turnips. Cauliflowers *must not* be sprayed after the "flower" is exposed; cabbages may be sprayed when the plants are one-third grown and again just before the heads are formed. There is then no danger to the consumer from such treatment.

Bordeaux Resin—The Bordeaux Mixture is made in the usual method (liquid form), then 2 gallons of the stock solution is added to every 48 gallons of Bordeaux, the whole being stirred. It is best to dilute the stock resin with 8 parts of water before adding to the Bordeaux. That is, in preparing a 50-gallon barrel of mixture, the copper sulphate and lime are diluted enough to make 40 gallons, after which 2 gallons of stock resin is diluted to 10 gallons and then added to the Bordeaux Mixture.

This is an excellent remedy for Asparagus Rust. (N. Y. Exp. Sta. 188, 1900.)

47. **Resin Soap—**

This substance may be used against plant lice and other soft-bodied sucking insects. It may also be used, like the preceding substance, with Paris or Bordeaux, to make these stick to glossy surfaces.

Formula No. 1:
Resin, 2 pounds;
Caustic soda, 1 pound;
Tallow, 1 pound.

Dissolve the soda in 1½ gallons of water; then add resin and tallow and dissolve them by applying a moderate degree of heat; add water enough to make 3 gallons.

Before using dilute 1 pint of soap with 16 pints of water. This is a summer wash. (Col. Bul. 71, 1903.)

FORMULA No. 2:

Resin, 20 pounds;
Concentrated lye, 4 pounds;
Fish oil, 2½ pints;
Water, 100 gallons.

Place the resin, lye and oil in a kettle with sufficient water to cover them to a depth of 3 or 4 inches. Boil about 2 hours, making additions of water, until the compound looks like very black coffee. Dilute to one-third the final bulk with hot water or with cold added slowly over the fire, making a stock solution that must be diluted to 100 gallons when ready for use. This is a winter wash.

48. Saccharate of Copper—

This fungicide is used extensively in France in place of Bordeaux Mixture.

FORMULA:

Copper Sulfate, 4 pounds;
Lime, 4 pounds;
Molasses, 4 pints;
Water, 25 gallons.

Slake 4 pounds lime and dilute it with water. Dissolve 4 pints of molasses in a gallon of water and mix with the lime. Stir thoroughly and let it stand a few hours. Dissolve 4 pounds copper sulfate in 10 gallons of water and pour in the lime-molasses solution while stirring briskly. Allow the mixture to settle. Draw off the clear greenish solution for use. (Mass. Exp. Sta. Bul. 80, 1902.)

49. Scheele Green—

This is not the same as Green Arsenoid. Scheele Green is entirely worthless as an insecticide, because it contains so much soluble arsenious oxide.

50. Soap—

This is quite valuable as a contact insecticide.

Use Ivory soap (10c. size), 1 bar;
Water, 15 gallons.

Apply warm, as it thickens on cooling. It is recommended for Rose Mildew, "Red Spider," Plant Lice, etc. (Am. Gard., Feb. 8, 1902.)

51. Sulfur—

Sulfur, applied as flowers of sulfur, dry, through a blow-gun of some sort, or mixed in water or soap solution in the proportion of an ounce to a gallon of the liquid and applied as a spray, is especially destructive to "red spiders." (Col. Agr. Exp. Sta. Bul. 71, 1902.)

52. Tobacco—

This is a very important contact insecticide. In the form of fine dust it is excellent for bearing trees affected with root-lice; two-thirds inch of surface earth is taken away from around the tree and 1½ to 2 pounds of dust is evenly scattered over the surface and afterwards covered with earth. The first application should be made in June, and if necessary repeated in August. (Md. Agr. Exp. Sta. Bul. 65, 1900.) It may also be used in the form of dry stems against root-lice by applying it in the same way as the dust.

As a decoction of the stems it may be used as a spray against plant lice; or first spray with water and then sprinkle with the dust. (Col. Bul. 71, 1903.)

The decoction is also good for lice on cattle.

Tobacco smoke, when generated in an enclosed space, is fairly successful in combating plant lice.

53. Turpentine—

Similarly used as Benzine and Gasoline.

54. Whale Oil Soap—

This is good in combating scales in family orchards or in old commercial orchards. It is too expensive, however, for general use. (Ga. Exp. Sta. Board of Ent. Bul. 5, 1902.)

For the winter spraying of scales use:

2 pounds of the soap to each gallon of boiling water.

For pear slug use:

½-pound to 1 gallon of water. (Iowa Bul. 50, 1902.)

For plant lice use:

1 pound to 8-10 gallons of water. (Col. Bul. 71, 1902.)

55. **White Arsenoid—**

This is Barium Arsenite. As an insecticide it is very unsatisfactory in California, because it is so soluble, and thus is injurious to the foliage. (Cal. Bul. 126, 1899.)

SOME OF THE MORE IMPORTANT FUNGOUS DISEASES AND INJURIOUS INSECTS, WITH THEIR REMEDIES.

Anthracnose of Grape—

Before buds open in the spring use No. 29. Repeat in 3 to 4 days to cover the untreated portions.

Anthracnose of Raspberry—

Before buds open use No. 17.

Cut out infested canes.

When growth has commenced use No. 9. Repeat at intervals, one to three weeks.

Ants—

See No. 14. Also page 164.

Aphids—

See Nos. 31, 35, 52.

See figures on page 58.

Apple Tree Borers—

See figures 25 and 26 on page 55.

Paper wrapping or deterrent washes should be combined with the digging-out process. In California carbon bisulfid has given very satisfactory results.

Army-Worm (Fall)—

Frequent rotation in crops which will admit of fall plowing.

Asparagus Rust—

See No. 46.

Bedbugs—

See No. 19.

Black Knot of Plum—

Cut out and burn. Before buds open treat with No. 17. When buds open treat with No. 9.

Box Elder Bug—

If in great numbers they lessen vitality of tree. Use No. 31 to kill young bugs.

Buffalo Tree-Hopper—

See figure 21 on page 52; also figure 68.

Cleanliness must extend to fence rows and adjacent fields. As a rule thoroughly cultivated orchards are never bothered. Caustic washes.

Cabbage Worms—

See Nos. 41 and 27.

Flour sprinkled over leaves is said to be beneficial.

Cabbage Maggots—

If injury is started little can be done. Carbolic soap wash will kill a few of the maggots. Best preventive is tarred paper collars on recently set plants.

Chinch Bug—

See text of Report.

Codling Moth—

See figures 62¼ and 62½, pages 75 and 76.

No. 41 immediately after blossoms have fallen.

Same in 7 to 10 days thereafter.

Bands on trunk and examination of same every 5 to 6 days.

Cucumber Beetle (Striped)—

Keep plants thoroughly covered with No. 9 or 41, dry.

Curculio—

See text of Report.

Currant Worms—

In early part of season No. 41. After this No. 27. Spray often.

Fire Blight or Pear Blight—

Cut out and burn before blossoms open.

In June cut out infected parts again and burn. Cut 6 inches below blight. After blossoming, cut out again. Prune and burn cuttings before leaves drop. Spraying with No. 9 checks a little.

Flax Wilt—

It is claimed that treating the seeds by sprinkling No. 23 is beneficial. Clean and grade the seed. After treatment with formaline the seed must be handled immediately until it is found to be dry. The practicability of this method has yet to be demonstrated.

Fleas—

See No. 19.

Grasshoppers—

See text of Report.

Hessian Fly—

See text of Report.

Mildew of Cucumber, Squash and Melon—

Spray with No. 9 every ten days until frost.

Onion Smut—

Sulphur and air-slaked lime in equal parts, applied in the drill with the onion seed, is very effective. (N. Y. Sta. Bul. 182, 1902.)

Onion Maggots—

May be destroyed by an application of carbolic soap wash, and attack may be warded off by sprinkling sand moistened with kerosene along the rows when the young plants are coming up. (E. P. Felt, Country Gentleman, June 25, 1903, page 551.)

Plum Gouger—

See text of Report, page 89.

Plum Pockets—

No effective remedy. Evil lessened by cutting off and burning all affected parts.

Potato Blight—

When vines are young spray with No. 9. Repeat at intervals of two to three weeks during season.

Potato Scab—

See Nos. 19 and 23.

Rot (Brown)—(*Monilia fructigena.*)

Gather and burn all mummified fruits in fall or early spring. Gather all fresh fruit showing signs of decay and burn. Spray with No. 9 up to 3 or 4 weeks of ripening, then spray with No. 15.

Rust—

See No. 23.

Scales—

See figures 22, 23, 24, pages 53 and 54.
See Nos. 28, 31, 35.

Smut—

See No. 23.

Sow-Bugs in Hothouses—

Slice juicy potatoes, sprinkle with Paris Green and leave them in places frequented by the bugs. (Bul. 18 (N. S.), p. 98, Div. Ent., U. S. Dept. of Agr.)

Squash Bug—

1. Protect by netting.
2. Excessive seeding.
3. Good culture.
4. Clean culture.
5. Hand picking in early morning.

See also page 159.

Tent Caterpillars—

See text of Report, pages 63 and 64.

Woolly Aphis—

See Tobacco, Kerosene Emulsion, etc.
See Nos. 30, 52.
See pages 50 and 58 of Report.

IDENTIFICATION OF INSECTS.

We have below listed some of the more important inquiries which have reached us regarding insects during the year. These inquiries were not always accompanied by specimens, although leaving no doubt in the mind of the Entomologist as to what the pest under discussion was; at other times the specimens sent were so badly crushed (notably plant lice) that, although in a general way it was evident from text of letters what the insect was, "Grain Plant Louse," "Plum Aphis," "Apple Aphis," etc., one could not with safety give the scientific name for the genus and species. The Grain Plant Louse, for instance, about which many inquiries were sent in, may have been *Nectarophora cerealis* or *N. granaria*, or something else. The desired end in all cases, however, was attained by the correspondent receiving the common name, when not known to himself, and remedies, when remedies were asked for. The subjoined list presents an interesting calendar as to the first appearance of certain pests, their comparative abundance and their continuance through the season. For instance, our first complaint of Apple Aphis ("Green Aphis") came in April. It may be said in passing that severe cold weather, with some snow and ice, at this time killed these early hatched lice far better than any treatment man might have given.

In June various Aphids or Plant Lice, not including the Grain Plant Louse, began their serious work and kept at it during the summer. The Currant Worm appeared on the scene in May and was heard from occasionally during May and June. Cutworms began to call for attention in May, as did insects affecting strawberry plants, notably the Strawberry Weevil and the Flea-Like Negro Bug, both of which were heard from in June. In May, too, White Grubs, the larvae of different species of *Lachnosterna*, began their ravages, attacking this year, barley and wheat as well as lawns, and being heard from as late as August. They were unusually severe this season. The Striped Cucumber Beetle made his first bow just as the curtain was going down on the May record.

Our old enemy, the Chinch Bug, which I found issuing from winter quarters in April, began to be heard from in July (Stearns county), and from that time on was in evidence through the mails until the end of the first week in August. The Grain Plant Louse or Grain Aphis began to call for postage stamps about the middle of July, frightening many farmers, who thought in some cases that their entire wheat crop was threatened. Parasites kept this pest within bounds, and it did but little damage, although during the latter half of July and into the first week in August it was frequently heard from. Our most serious pest, the Hessian Fly, added to the Entomologist's mail from July 11th to September 9th.

DATE.	NAME.	POSTOFFICE.	COUNTY.	INSECT IDENTIFIED.	REMARKS.
April 15	Prof. McDermott			Oyster shell scale—*Mytilaspis pomorum*	
April 24	Fred Mohl	Adrian	Nobles	Apple aphis	
April 27	Mrs. Belle Angus	Garfield	Douglas	Galls	
April 28	G. A. Anderson	Renville	Renville	Apple aphis	
May 2	N. N. Monsen	Cannon Falls	Goodhue	"Red Spider"—*Tetranychid*	On house roses.
May 11	C. E. Older	Luverne	Rock	Woolly aphis—*S. lanigera*	
May 12	Thos. E. Cashman	Owatonna	Steele	Buffalo Tree hopper—*Cervsa*	
May 22	Dr. H. Jones	Preston	Fillmore	Currant Saw Fly—*Nematus ribesii*	
May 23	Mrs. J. W. Nabon	White Bear Lake	Ramsey	Cut Worms	
May 23	Uri D. Miller	Brook Park	Pine	Strawberry Weevil—*Anthonomus signatus*	
May 25	E. W. Olsen	Winthrop	Sibley	Ants and Plant Lice	
May 26	Henry Grinde	Hinckley	Pine	Strawberry Weevil—*Anthonomus signatus*	
May 29	B. S. Bennett	Fosston	Polk	Wire Worms	
May 29	F. J. Keashing	Elk River	Sherburne	Scale—*Lecanium*	In wheat.
May 29	O. F. Trace	Sauk Rapids	Benton	Currant Worms—*Nematus ribesii*	On oleander.
May 29	H. Crippen	Langdon	Washington	White Grubs—*Lachnosterna*	
May 29	Dr. M. H. Reynolds	St. Anthony Park	Ramsey	Eggs of Mallophaga	In barley.
	J. A. Lindig	St. Anthony Park	Ramsey	Striped Cucumber Beetle—*Diabrotica vittatta*	On fowl.
June 2	Prof. S. B. Green	St. Anthony Park	Ramsey	Flea-like Negro Bug—*Corimelæna*	On Hubbard squash.
June 3	Mrs. Laura S. Cowling	St. Paul	Ramsey	Black Ants	On strawberries.
June 3	J. D. Conan	Ely	St. Louis	Divaricated Buprestis—*Dicerca divaricata*	
June 4	N. P. Clark	St. Cloud	Stearns	Plant Lice	Said to be "biting off leaves o: Poplar."
June 4	Mrs. Agnus Hudson	Lake City	Wabasha	Cecropia Moth—*Attacus cecropia*	On turnips.
June 4	H. G. Westman	Sandstone	Pine	Strawberry Weevil—*Anthonomus signatus*	
June 5	George Crippen	Cottage Grove	Washington	White Grub—*Lachnosterna*	
June 9	Mrs. Wallace	Minneapolis	Hennepin	Cabbage Maggot	In wheat.
June 9	Herman Boettcher	West St. Paul	Dakota	Cabbage Maggot	
June 10	McConnon & Co	Winona	Winona	Grasshoppers	
June 15	Robert Waldron	Minneapolis	Hennepin	Plum aphis	Poison for.
June 15	W. S. Foster	Milaca	Mille Lacs	Currant Worms—*N. ribesii*	
June 16	John Stevens	Glenwood	(Wis.)	Mite	
June 18	F. E. McGregor	Crookston	Polk	Elm-aphis—*Schizoncura americana*	Working on potato bug.
June 23	Mr. Moore	Spring Valley	Fillmore	Plant Lice	
June 24	C. N. Green	Brook Park	Pine	Strawberry Weevil—*Anthonomus signatus*	On fir balsam.
June 24	J. A. Schmitz	St. Paul	Ramsey	Maple scale—*Pulvinaria innumerabilis*	
June 24	J. N. Babcock	Benton Harbor	(Mich.)	Cottony Maple Scale—*Pulvinaria innumerabilis*	On box elder.
				Scurfy Bark Louse—*Chionaspis furfurus*	

DATE.	NAME.	POSTOFFICE.	COUNTY.	INSECT IDENTIFIED.	REMARKS.
June 26	F. E. Smith	Pine City	Pine	Lice	On plums.
June 27	Mr. Wellington	St. Anthony Park	Ramsey	Potato "Bugs"—*Doryphora decem-lineata*	
June 27	H. M. Jewett	St. Paul	Ramsey	Elm Tree Louse—*S. americana*	
June 27	Mr. Herbst	Sparta	(Wis.)	Flea-like Negro Bug—*Corimelæna*	
July 10	Mr. Frye	St. Paul	Ramsey	Fleas	Remedies for.
July 10	Mrs. L. von Lars	St. Cloud	Stearns	Chinch Bug—*Blissus leucopterus*	
July 11	A. A. Wilson	Brownton	McLeod	Hessian Fly—*Cecidomyia destructor*	Bad in wheat.
July 15	Victor Stearns	Duluth	St. Louis	Apple aphis	
July 16	R. S. Mackintosh	Auburn	(Ala.)	Horned Corydalis—*Corydalis cornuta* Corythuca	
July 16	A. B. James	Langdon	Washington	Grain aphis	
July 20	Eben E. Lawson	New London	St. Louis	Chinch Bug—*B. leucopterus*	
July 20	Jewell Nursery Co	Lake City	Wabasha	Yellow Spotted Willow Slug—*Nematus ventralis*	On willow.
July 20	Peter Behman	Robbinsdale	Hennepin	Black-c Owlet Cut Worm—*Noctua-c-nigrum*	
July 20	John Bryant	Motley	Morrison	Tortoise Beetle—*Cassida bi-color*	On wild morning glory.
July 20	Gus Sheffield	Moorhead	Clay	Stalk Borer—*Hydroecia (Gortyna) nitela*	
July 21	D. D. Storms	Clearwater	Wright	Chinch Bugs—*B. leucopterus*	
July 21	Adolph Klinger	Crookston	Polk	Grain Plant Louse	
July 21	W. O. Falk	Alexandria	Douglas	Grain Plant Louse	At Hawley, Lake Echo, Belleview, etc.
July 23	E. A. Holt	Delhi	Redwood	Grain Plant Louse	
July 23	C. A. Rasmussen	Red Wing	Goodhue	Gad Flies—*Chrysops æstuans* Gad Flies—*Chrysops univittatus*	
July 25	J. S. Gimelson	Belleview	Blue Earth	Grain Plant Louse	
July 25	Albert Hanson	Litchfield	Meeker	Chinch Bugs—*B. leucopterus*	
July 27	H. Wadsworth	Glencoe	McLeod	White Grubs—*Lachnosterna rugosa*	In lawn.
July 27	E. L. Hacking	Grand Rapids	Itasca	Grain Plant Louse	
July 27	P. Dougherty, Jr	Maple Lake	Wright	Chinch Bugs—*B. leucopterus*	
July 28	P. S. Krantz	Georgeville	Stearns	Chinch Bugs—*B. leucopterus*	
July 28	George Schneider	Brownsville	Houston	Chinch Bugs—*B. leucopterus*	
July 28	Knute Bonde	Battle Lake	Otter Tail	Grain Plant Louse	
July 28	James Hanna	Forest City	Meeker	Chinch Bugs—*Blissus leucopterus*	
July 28	J. H. Reid	Hawley	Clay	Grain Plant Louse	
July 29	J. A. Hendricks	Fosston	Polk	Grain Plant Louse	
July 29	Chas. J. Estlund	Kennedy	Kittson	Lice	On box elder.
July 29	F. J. Holtz	Dawson	Lac qui Parle	Hessian Fly—*Cecidomyia destructor*	
July 29	Jos. Tagley	Mentor	Polk	Grain Plant Louse	On wheat.
				Vagabund Gall Louse—*Pemphigimus vagabundi*	On cotton wood.

DATE.	NAME.	POSTOFFICE.	COUNTY.	INSECT IDENTIFIED.	REMARKS.
July 29	Harland W. Page	Northfield	Rice	Grubs—*Lachnosterna*	On lawn.
July 30	C. Clough	Fosston	Polk	Grain Plant Louse	
July 30	Norbert Motzsko	Browerville	Todd	Chinch Bugs—*B. leucopterus*	
July 31	John Ness	Underwood	Otter Tail	Grain Plant Louse	
July 31	L. J. Sheldon	Paynesville	Stearns	Chinch Bug—*B. leucopterus*	
July 31	Wm. F. Jewson	Mankato	Blue Earth	White Grub—*Lachnosterna*	
Aug. 3	Dr. A. P. Stewart	Owatonna	Steele	Sphinx Caterpillar	Parasitized by Braconid.
Aug. 3	F. W. Ghering	Milaca	Mille Lacs	Chinch Bug—*B. leucopterus*	
Aug. 3	Gordon N. Morse	Sauk Center	Stearns	Chinch Bug—*B. leucopterus*	
Aug. 3	Bowing Bros	St. Cloud	Stearns	Chinch Bug—*B. leucopterus*	
Aug. 3	John Kohr	Montevideo	Chippewa	Hessian Fly and Grain Plant Louse	
Aug. 4	Northfield News	Northfield	Rice	White Grubs—*Lachnosterna rugosa*	In lawn.
Aug. 4	H. P. Stanchfield	Foreston	Mille Lacs	Chinch Bug—*B. leucopterus*	
Aug. 5	B. P. Swanson	Pillager	Cass	Chinch Bug—*B. leucopterus*	
Aug. 6	G. F. Freeman	Angus	Polk	Tortoise Beetle—*Chelymorpha*	
Aug. 9	S. C. Brace	Mabel	Fillmore	Saw Fly larva	On evergreens.
Aug. 11	N. J. Hagen	Hendrum	Norman	Cecropia Silk Worm—*Attacus cecropia*	
Aug. 12	Dr. R. Schiffmann	St. Paul	Ramsey	Imported Locustid—*Diestrammena*	Injuring orchids in greenhouse.
Aug. 12	Mrs. Burdick	Minneapolis	Hennepin	Gall Fly—*Cecidomyia*	On box elder.
Aug. 17	Dr. G. R. Christie	Long Prairie	Todd	"Worms"	On black and white oak, no specimens.
Aug. 17	W. S. Jones	Dassel	Meeker	Black Ants	
Aug. 21	Dr. Burnside Foster	St. Paul	Ramsey	Muscid or Oestrid larva—(Referred by Coquillet to *Gastrophilus cplipsalis*, French,)	In pustules on child's face, neck hands, etc.
Aug. 26	G. L. Christie	Long Prairie	Todd	Orange Striped Oak Worm—*Anisota senatoria*	On red oak.
Sept. 9	F. B. Rathbun	Corvuso	Meeker	Hessian Fly—*C. destructor*	¼ wheat crop lost.
Sept. 22	Mrs. Flora Thayer	Canova	(S. D.)	Plum Gouger—*Coccotorus scutellaris*	
Sept. 22	A. Norling	Svea	Kandiyohi	Hessian Fly—*C. destructor*	
Sept. 27	John Brown	Minneapolis	Hennepin	Larva—*Jasoinades*	
Oct. 9	J. F. Kingmen			Rat-tailed Larva—*Eristalis*	Found in water in deserted woodpecker's nest.
Oct. 16	Dr. Lee	Minneapolis	Hennepin	Caterpillar of Achemon Sphinx—*Philampelus achemon*	
Oct. 21	A. B. Underwood	Lake City	Wabasha	*Centhophilus*	
Nov. 9	A. Guillemin	Grand Meadow		Earth Worm	On cabbage; supposed by correspondent to be poisonous.
Nov. 10	J. H. Stair	Crookston	Polk	White Fly—*Aleurodes*	On fuchsia.
Nov. 11	C. A. King	Spring Valley		Snowy Tree Cricket—*Oecanthus niveus*	
Dec. 3	C. M. Loring	Minneapolis	Hennepin	Tree Hopper—*Enchenopa binotata*	Egg masses on Bitter Sweet.

NURSERY INSPECTION.

The fact that in the past other states could ship nursery stock into Minnesota with no restrictions whatever has been a stimulus to those of our citizens interested in horticulture to secure the passage of some law which would at least regulate this, particularly as some of the neighboring states and very many states throughout the Union will not allow stock to cross their borders without a certificate of inspection. Efforts in this direction in Minnesota have been a failure until this year, when the following bill was passed:

STATE OF MINNESOTA.

THIRTY-THIRD SESSION.

H. F. No. 245.

A BILL

FOR AN ACT TO PREVENT THE INTRODUCTION AND SPREAD OF INJURIOUS INSECTS AND DANGEROUS PLANT DISEASES IN THE STATE OF MINNESOTA.

Be It Enacted by the Legislature of the State of Minnesota:

Section 1. The Entomologist of the State Experiment Station is hereby constituted the State Entomologist and charged with the execution of this act. He may appoint such qualified assistants as may be necessary, fix a reasonable compensation for their labor, and pay the same; and their acts shall have the same validity as his own. He shall, by himself or his assistants, between the first day of May and the fifteenth day of September, in each year, when requested by the owner or agent, or when he has reasonable ground to believe that any injurious insect pests or dangerous and contagious plant disease exist, carefully examine any nursery, fruit farm or other place where trees or plants are grown for sale, and if found apparently free from any injurious insect pests or dangerous or contagious plant diseases, he shall issue his certificate stating the facts (good for one year unless revoked), and shall collect therefor a fee of five dollars ($5.00) per day and expenses.

Sec. 2. The State Entomologist shall have authority, when requested by the owner or agent, or when he has reasonable grounds to believe any injurious insect pests, or dangerous and contagious plant diseases exist, to enter upon any of the grounds mentioned in section 1, hereof, public or private, for the purpose of inspection; and, if he finds any nursery, orchard, garden or other place, infested by any injurious insect pests, or dangerous and contagious plant diseases, he may, by himself or his assistants, enter upon such premises and establish quarantine regulations.

If, in his judgment, any insect pests, or dangerous and contagious plant diseases may be eradicated by treatment, he may, in writing, order such treatment, and prescribe its kind and character. In case any trees, shrubs or plants are found so infested that it would be impracticable to treat them, he may order them burned. A failure for 10 days after the delivery of such order to the owner or persons in charge to treat or destroy such infected trees or plants as ordered, shall authorize the Entomologist to perform this work by himself or his assistants, and to ascertain the cost thereof. He shall certify the amount of such cost to the owner or person in charge of the premises, and if the same is not paid to him within 60 days thereafter he shall certify the amount thereof to the county attorney, whose duty it shall be to proceed forthwith to collect the same of him in a civil suit, and return the amount so recovered over to the state auditor to reimburse the state for the money expended.

Sec. 3. When nursery stock is shipped into the state accompanied by a certificate of inspection by a State Entomologist from the state from which the shipment has been made, stating that the stock has been inspected and found to be free from any injurious insect pests, or dangerous and contagious plant diseases, it shall be held prima facie evidence of the facts therein stated, but the State Entomologist, by himself, or his assistants, when he or they have reason to believe that any such stock is nevertheless infested by any injurious insect pests, or dangerous or contagious plant diseases, shall be authorized to inspect the same and submit it to like treatment as that provided for in section 2 hereof; and if, by reason of the failure for 48 hours of the owners of such stock to comply with the treatment prescribed, or to destroy the stock, if so ordered, the State Entomologist, or his assistants, are required to perform the work themselves, and it shall be the duty of the Entomologist to certify the amount of the cost thereof to the owner or the person in charge of such stock so treated or destroyed; and, if the same is not paid to him within 10 days thereafter, he shall certify the amount thereof to the county attorney of the county in which the stock may be found in an affidavit, and it shall be the duty of the county attorney to file said affidavit with the village, city or town clerk of the village, city or town in which such stock may be, and the same shall thereupon constitute a lien thereon, which it shall be the duty of the county attorney to proceed to collect forthwith in a civil suit, and to turn over the amount recovered

by him in such suit to the state auditor to reimburse the state for the money expended.

Sec. 4. It shall be unlawful for any person, firm or corporation to bring into the state any trees, plants, vines, cuttings and buds, commonly known as nursery stock, unless accompanied by a certificate of inspection by a State Entomologist of the state from which the shipment is made, showing that the stock has been inspected and found apparently free from any injurious insect pests, or dangerous and contagious plant diseases.

Sec. 5. Any person violating or neglecting to carry out the provisions of this act, or offering any hindrance to the carrying out of this act, shall be adjudged guilty of a misdemeanor; and, upon conviction before a justice of the peace, shall be fined not less than $10, nor more than $100 for each and every offense, together with all the costs of the prosecution, and shall stand committed until the same are paid.

Sec. 6. All fees or other amounts collected or received by any person under the provisions hereof shall be by him forthwith turned into the state treasury to be paid over to the state auditor to be added to the fund provided for combating injurious insects in Minnesota, and all expenses incurred in enforcing the provisions hereof shall be paid out of said fund.

Sec. 7. This act shall take effect and be in force from and after June 1, 1903.

It will be noted that this is not a strong bill; the Entomologist can only inspect premises where stock is grown for sale, and then only upon request of owner, or when he has reason to suspect the existence of dangerous insect pests or dangerous and contagious plant diseases. Still, it is a step in the right direction, and the law can be made more stringent when public sentiment and the horticultural interests demand it.

At a meeting of official inspectors, held at Washington, D. C., in November, the writer was impressed with the fact that in the majority of states where fruit is raised the conditions are so much more serious as regards insect pests than in this state, that one is not surprised at the much more stringent inspection laws by which those states are characterized. Nevertheless, lest we feel too great a security, it must be noted that we have some pests here which are dangerous and should be kept most decidedly in check, notably the Woolly Aphis of the Apple. In the meanwhile our law gives us a feeling of security, in that it is aimed to prevent the introduction of diseased or infested stock into Minnesota from other states.

In conformance with the law, twenty-five nurseries were inspected this year, and the money received turned over to the State Treasurer, as evidenced by the following account:

F. L. WASHBURN, IN ACCOUNT WITH STATE AND NURSERIES.

DEBIT BY CASH RECEIVED.

1903.	Name and Town.	No. of Cert.	Cash.
June 15.	W. L. Taylor, Howard Lake	1	
	D. M. Bowers, Howard Lake	2	
	W. H. Eddy, Howard Lake	3	$7.85
	J. W. Beckman, Cokato	4	
	John Eklof, Cokato	5	
July	J. P. Andrews, Faribault	6	
	O. F. Brand & Son, Faribault	7	
	Mitchell Nursery Co., Owatonna	8	
	Clinton Falls Nursery Co., Owatonna	9	
	Wedge Nursery Co., Albert Lea	10	52.65
	J. D. Richardson & Son, Winnebago City	11	
	Fairmont Nursery Co., Fairmont	12	
	Fred Mohl, Adrian	13	
	C. E. Older, Luverne	14	
July 21.	Deephaven Nursery, Excelsior	15	1.55
	Chas. Hawkins Nursery, Excelsior	16	1.55
Aug. 12.	Fred Cowles, West Concord	17	2.50
	W. E. Fryer, Dodge County	18	2.50
Aug. 14.	F. E. Weld, Lake Sarah Nursery, Rockford	19	3.44
	A. K. Richards, Maple Plain	20	3.44
Sept. 17.	Frank Yahnke, Winona	21	7.74
Sept. 18.	Nels Anderson, Lake City	22	9.06
Sept. 19.	John Hawkins, Rose Hill Nursery, Minneapolis	23	2.00
	B. F. Hoyt, St. Paul	24	1.50
	L. L. May & Co., St. Paul	25, 26	6.20
	Total		$101.98

CREDIT BY CASH PAID STATE TREASURER.

1903.	
June 29	$7.85
Sept. 30	94.13
Total	$101.98

It will be remembered that we had very bad weather just before and just after September 15th, and it was impossible to get into the nurseries for work at that time, hence the last few nurseries were inspected immediately after that date. Furthermore, as an accommodation, the following nurseries were inspected late in the season, the owners claiming that they were either away or unaware of the time limit set by the law:

Hennepin Nursery, Mr. Higbie, Eden Prairie.
Albert Lea Nursery, Albert Lea.
Minnesota State Nursery, Albert Lea.
Mr. Sampson, Excelsior.

The Jewell Nursery Company, Lake City, was inspected in the spring before the law went into effect. These names do not appear on the above list, and the parties have been notified that here after inspection must be made within the date prescribed by the law.

The nurseries have been found to be, for the most part, in excellent condition, remarkably free from serious pests, and showing by the very clean cultivation and the manifest activity therein a growing interest taken in this line of work. The nurserymen, without exception, afforded the Entomologist every opportunity to make examinations, and were in every way extremely courteous. This may be a good opportunity for the writer to express his appreciation of the kind treatment received at their hands.

As intimated above, a little Woolly Aphis was found, the usual quota of Green Aphis; some Buffalo Tree Hoppers and the small Green Tree Hopper, *Empoasca mali*, Osborn, which has been extremely prevalent in many of the nurseries, causing the leaves to curl and checking the growth of the trees. This is a difficult pest to combat and calls for some experimental work on the part of the Entomologist next summer. As usual, Fire Blight was found in many of the orchards, but all nurserymen and orchardists appear to know the way to check that by proper pruning.

In connection with Plant Lice the following suggestions may be of use to nurserymen. As is well known, the lice are so closely ensconced under the curled leaves that spraying does not ordinarily reach them. A much more effective way, where the

trees are from two to four years old, let us say, is to have a man or boy pass along the row with a pan containing the proper strength of kerosene emulsion, or a mixture of whale oil soap and water and tobacco extract. The latter is excellent for aphids. Bend over the affected branches, swashing them to and fro, if

Fig. 89.—Treating young nursery trees for plant lice. Original.

that expression can be used, in the liquid. This insures the lice being thoroughly wet if done thoroughly. See Fig. 89.

The present inspection laws of the other states and of Canada, as far as can be ascertained at date of writing (December, 1903), are appended for the information of our fruit growers and nurserymen.

ALABAMA: The work is under the charge of a State Board of Horticulture, consisting of Commissioner of Agriculture, President of Alabama State Horticultural Society and the Director of the Alabama Polytechnic Institute. The Professor of Horticulture in Polytechnic Institute is made State Horticulturist, and,

under direction from the board, visits any part of state where pests are supposed to exist. Owners of infested trees are notified by him and treatment prescribed, the expense being borne by the owner. A refusal to comply with instructions of State Horticulturist or of the Board is a misdemeanor. Unlawful to sell, or to offer for sale, or to give away within the state, stock known to be infested. The State Board, or its agents or employes, may enter any premises in discharge of its duties. Provision is made for preventing the introduction of dangerously injurious crop pests of all kinds from without the state. All sales, or gifts, or shipments of stock within the state must be accompanied by a certificate of inspection on the part of the State Horticulturist. All nursery stock shipped into Alabama must be accompanied with a permit in the shape of a certificate issued by the board. Transportation companies or common carriers are not allowed to deliver nursery stock to any consignee residing within the State of Alabama, unless the package bears the official tag or certificate, without notifying the State Horticulturist, and also warning the shipper of his risk. Any person, firm or corporation receiving stock not accompanied by a certificate is guilty of a misdemeanor and liable to fine.

ARIZONA: No law.

ARKANSAS: The Entomologist of the Experiment Station is made, by law, the State Inspector. He examines nurseries upon request of owners, and grants certificates to such as are free from dangerous insects and plant diseases. He receives as fee $5.00 for each fifty acres or fraction thereof examined and all traveling expenses, paid by the nurserymen. No stock can be shipped into the state without a certificate of inspection attached thereto.

CALIFORNIA: Work is in charge of a State Commissioner of Horticulture, appointed by the Governor. His salary is fixed at $250.00 per month, $1,500.00 per year for traveling expenses, and can appoint a clerk at $1,500.00 per annum and a Deputy Commissioner at a salary of $200.00 per month. He is authorized to establish, maintain and enforce such quarantine regulations as he deems necessary. He investigates complaints

and is empowered to take any means required to insure safety to horticultural interests. He is ex officio a member of all County Boards of Horticulture in the state.

CANADA: (With special reference to Manitoba.) Importation of nursery stock, generally, from the U. S. not allowed. This ruling, however, does not apply to greenhouse plants, herbaceous perennials, including strawberries; herbaceous bedding plants, conifers, bulbs and tubers and *Cottonwoods grown in Minnesota and Dakota.*

Importations of the above stock must be fumigated at port of entry or in transit (Winnipeg, Man., for Dakota and Minnesota stock), even if accompanied with certificate of inspection. Importations by mail are subject to the same provisions.

Packages must be addressed so as to enter Canada at a port of entry, and the route by which they will be shipped must be clearly stated upon each package. All stock which is immature or too far advanced for safe fumigation when received is not allowed to enter, and is held at risk of shipper. Fumigation houses in Manitoba are kept open from March 15th to April 15th in the spring, and from October 7th to December 7th in the fall. To insure safe delivery, therefore, shipment must be made accordingly.

Parties importing stock in violation of the law are liable to a fine of $200 for each offense, and the stock is destroyed.

COLORADO: The State Board of Horticulture appoints county inspectors and they inspect all shipments of nursery stock; if these are infested, the inspector has authority to disinfect or burn or ship back into the county from which they came. Said inspector has the power to order disinfected all packing houses and nurseries and orchards found infested, and the owner is liable if he refuses to comply with the orders of the inspector in this particular.

CONNECTICUT: State Entomologist is empowered to cause the destruction or proper treatment of infested trees and shrubs, and if owner neglects or refuses to act after receiving instructions from the State Entomologist he will be subject to a fine of not more than $50.00. Nursery stock shipped into the

state must bear a statement that it has been thoroughly fumigated, in addition to the certificate of inspection issued by a state or government officer. Inspection of nurseries at least once a year is compulsory, and if no serious pests are present a certificate to that effect may be given. The Entomologist or his deputies may enter any orchard, field, garden, nursery or storehouse, when, in his judgment, such places are dangerously infested, and may order the owner or occupant or person in charge to give the property suitable treatment or to destroy the same. The owner receives no compensation from the state, and if he refuses to comply with the order of the State Entomologist he may be fined not more than $50.00.

DELAWARE: An inspector is authorized by the State Board of Agriculture to inspect nurseries and orchards at least once each year. No stock can be shipped into the state without a certificate. All stock offered for sale or shipment must be fumigated.

FLORIDA: No inspection law. The law provides a penalty for selling diseased nursery stock. This law, however, cannot be enforced. Certified nurserymen have appliances for fumigating, and those in dangerous neighborhoods fumigate all stock susceptible to San Jose Scale and such other insects as can be reached by hydrocyanic acid gas. Nurserymen obtain certificates from the State Entomologist upon request. Many nurserymen never have their stock inspected.

GEORGIA: Nurseries located within the State of Georgia are inspected between August 1st and November 1st of each year. All nursery stock must be fumigated by the grower before being sold or shipped. Infested nurseries are not allowed to sell stock under any circumstances. All shipments must be accompanied by a copy of the inspection certificate.

Nurseries located in other states, and who desire to ship stock into Georgia, are required to file with the State Entomologist (Atlanta, Ga.) a copy of the inspection certificate issued by their own State Entomologist. For southern states such certificate filed must be based upon an inspection made not earlier than July 1st, and for northern states upon an inspection made not earlier than

June 1st. The nurseryman is required to also file with the State Entomologist of Georgia, together with his certificate, a written statement that he will fumigate with hydrocyanic acid gas all stock shipped by him into Georgia, such fumigation to be in a manner approved by the State Entomologist of Georgia. When requested to do so, the nurseryman must also furnish the State Entomologist (of Georgia) information relative to the nature of stock to be shipped, the consignees, dates of shipment, and such information as may be required. When requested to do so by the State Entomologist, he must also furnish an affidavit that all stock shipped by him into Georgia will be fumigated, in lieu of the written statement above mentioned.

Upon receipt of the certificate and statement covering fumigation (or affidavit) as above mentioned, the State Entomologist of Georgia will issue Georgia official tags, which must be attached to all shipments into that state. These official tags are furnished at actual cost of printing, which is 60 cents for the first 100 or part thereof, and 25 cents for each additional 100.

IDAHO: Has created a State Board of Horticultural Inspection, consisting of five members, viz.: the Director of the Experiment Station and the Professor of Zoölogy in University of Idaho (both ex officio). The other three members are appointed by the Governor and hold office for three years. This board appoints a State Horticultural Inspector, at a salary of not less than $900.00 per annum. The state is divided into not more than ten districts, and a deputy horticultural inspector provided for each district if necessary. Each inspector appointed receives as compensation $5.00 per day for each day employed. These inspectors or the State Inspector are empowered, of their own motion, or upon complaint of interested parties, to enter upon any property, private or public, for the purpose of inspection, and, if premises are infested, are authorized to take any measures they deem fit to eradicate the evil. The expense of removing nuisances of this kind is paid by the owners of the property. A bond is required of parties doing business in the state, and upon receipt of same the board issues a certificate to the applicant. Stock shipped into state must have been fumigated or bear certificate of inspection by the proper officer.

ILLINOIS: Full authority is given the State Entomologist in the case of nursery or orchard inspection. He inspects nurseries once a year and gives a certificate to those that are clean. Stock cannot be shipped without a certificate. Transportation companies are liable if they deliver stock within the state not accompanied by a certificate.

INDIANA: State Entomologist inspects all nurseries in the state at least once a year, granting certificates to those which are found free from pests. No shipments can be made within the state without a certificate and no stock can be shipped into the state without a certificate signed by a state or government official whose duties are to inspect such stock.

IOWA: State Entomologist is authorized to establish quarantine against insect and plant pests. He inspects nurseries at least once a year and issues certificates to those which are found to be clean. Stock cannot be shipped into the state without a certificate from the proper officer.

KANSAS: No law.

KENTUCKY: State Entomologist inspects nursery stock at least once a year, issuing certificates to those that are free from insect or fungous pests. A copy of this certificate must accompany all shipments. Stock cannot enter the state without being accompanied by a certificate.

LOUISIANA: Neither fruit nor nursery stock can be shipped into the state if infested with injurious insects or plant diseases; neither can any such stock be propagated or sold. The State Entomologist is authorized to inspect any trees or nursery stock brought into the state, which stock must be accompanied with the name of the shipper and the locality where grown. Nurserymen and orchardists must destroy or disinfect fruit trees dangerously diseased.

MAINE: All nursery stock shipped into state must bear certificate of inspection. Any stock entering without certificate must be returned to shipper at expense of latter. A certificate of proper fumigation, however, in the form of an affidavit made before a justice of the peace, shall be accepted in lieu of a certifi-

cate of inspection. Transportation companies bringing stock into state not properly certified to as above described shall be deemed guilty of a misdemeanor, and upon conviction shall be subject to a fine of not more than $100 for each offense. Any person suspecting the presence of San Jose Scale upon property in his possession must notify Commissioner of Agriculture, who shall cause stock to be inspected, and, if found dangerously infested, shall see that the best known treatment is applied. The commissioner or his employes may enter any grounds, private or public, and treat any trees, shrubs or vines infested. Any parties selling stock without an unexpired certificate thereon within the state, or who shall cause same to be transported within the state, is subject to a fine of not more than $100 for each offense.

MARYLAND: All nurseries are inspected by State Entomologist and State Pathologist every six months, and certificate is issued if stock is found clean. No nursery stock can be shipped without a copy of this certificate. No stock can be shipped into state without copy of certificate issued by the proper officer in state from which said stock is shipped. Fumigation of all nursery stock sold within the state is compulsory.

MASSACHUSETTS: State Nursery Inspector appointed annually by State Board of Agriculture, and he, in turn, may appoint not more than three deputies. All places where nursery stock is grown, sold or offered for sale must be inspected by this officer at least once each year, and if stock is found clean a certificate to that effect is issued. If stock is infested with dangerous insects or fungous pests, certificate is withheld until owner of stock has taken the proper measures to suppress the evil. A penalty of from $25 to $100 is imposed upon any party selling stock who does not hold an unexpired certificate. A certificate of fumigation, in form of an affidavit before a justice of the peace, is acceptable in place of a certificate of inspection. Shipment into state without a certificate of inspection or of fumigation is forbidden. The inspector, or any of his deputies, may at any time enter any public or private grounds in discharge of any of their duties as prescribed by law.

MONTANA: State divided into six districts, appointed by the State Board of Horticulture. Stock sold in the state must be inspected by its inspector, and if found infested or diseased must be destroyed. Nursery stock may be ordered fumigated by the inspector when necessary. All stock shipped into the state must be inspected and fumigated before being delivered to purchaser. Importers of nursery stock pay the expense of inspection. Boxes, packages, etc., holding nursery stock in shipment must be burned as soon as emptied. Green and citrous fruits offered for sale in the state have to be inspected; they are burned if found infested. Nursery stock sold within state has to be accompanied by a statement as to whether or not the stock was grown in Montana.

MICHIGAN: State Inspector is appointed by the State Board of Agriculture. He inspects orchards and nurseries of the state and issues certificates. A small license is required each year. Non-residents cannot sell nursery stock within the state without having this license. A bond is also required from nurserymen. Nurserymen and agents are liable if they do not comply with these regulations.

All nursery stock or plants, shrubs, etc., infested with San Jose Scale must be burned by the owner within 5 days after a written notice to that effect has been received from State Inspector of Nurseries. All stock grown in any nursery or orchard in which San Jose Scale has been found, or grown within ½ mile of where San Jose Scale has been found, and also all nursery stock grown outside of the state destined to be shipped into state must be fumigated.

MINNESOTA: The Entomologist at the Experiment Station is made State Entomologist and is authorized to inspect premises where nursery stock is raised for sale when requested to do so by the owner. He cannot enter private grounds against the wish of the owner; he can, however, investigate when complaints are made against any nurseryman on the ground that he is carrying infested or diseased stock. Certificates are granted to nurserymen whose stock is found to be clean. No shipment can be made into the state without a certificate signed by the proper official in the state from which shipment is made.

MISSISSIPPI: No law.

MISSOURI: An inspector examines nurseries and orchards, prescribing measures of relief where the same are infested. Nursery stock cannot be shipped into the state without a certificate. There is no internal inspection law.

NEBRASKA: No law.

NEVADA: No law.

NEW HAMPSHIRE: State Board of Agriculture appoints annually a State Nursery Inspector, and he, in turn, may appoint not more than two deputies.

Inspection at least once a year of all nurseries or places in the state where nursery stock is grown, sold or offered for sale is compulsory. If stock is found to be free from pests a certificate is granted. If pests are found, the owner of the stock must take such measures to repress the same as the inspector prescribes, and certificate is withheld until this is done. A penalty of from $25 to $100 for each offense is imposed upon any party selling nursery stock who does not hold an unexpired certificate. An affidavit of proper fumigation upon stock offered for sale (i. e., fumigation approved of by the inspector), made before a justice of the peace, will be accepted in lieu of a certificate of inspection. Stock entering the state must be accompanied by a certificate of inspection or of fumigation. The inspector or his deputies have at all times the right to enter any public or private grounds in the discharge of their duty as prescribed by law. All parties violating the act providing for the protection of trees and shrubs shall be prosecuted by the Secretary of the State Board of Agriculture.

NEW JERSEY: Nurserymen call upon the State Entomologist to inspect their stock and receive from him a certificate if no dangerously injurious insects are present. No nursery stock can be shipped into the state without a certificate, and the State Entomologist or his deputy can detain, examine and, if necessary, destroy or send back to the shipper any stock so received. He is further authorized, if he has reason to doubt the genuineness of any certificate attached to car, box, bale or parcel of

stock, to detain same until said stock has been inspected, and if found infested may be treated as though without a certificate. Any nurseryman selling or shipping to points within the state without a certificate of inspection or of fumigation shall be deemed guilty of a misdemeanor and subject to a fine of $50.00 for each offense. Any nurseryman to whom a certificate has been issued who shall use the same on stock not actually inspected shall be deemed guilty of a misdemeanor and subject to a fine of $100 for each offense and his certificate may be withdrawn and cancelled, in the discretion of the State Entomologist.

The State Entomologist or his deputies may enter upon any lands on which he may deem an inspection necessary, and any interference with or obstruction to the Entomologist or his deputy when engaged in this work subjects the offender to punishment.

NEW YORK: Every person becoming aware that his stock is in any way infested must report same to Commissioner of Agriculture at Albany, and said Commissioner shall take such action as the law prescribes, even to the point of destroying the stock if necessary.

Examination of stock is made once each year and certificate granted when stock is found clean. All stock sold must be accompanied by a certificate of inspection, and any nurseryman, agent, dealer or broker sending out or shipping nursery stock without a certificate, or in any way changing a certificate, shall be guilty of a misdemeanor. Fumigation is provided for when San Jose Scale is present.

NORTH CAROLINA: The Crop Pest Commissioner is appointed to make rules, which have the force of laws. A license must be obtained from this commissioner before any party can sell or give away trees, shrubs, etc. Shipments of nursery stock within the state must be accompanied by certificate, and transportation companies are liable if they deliver stock not so accompanied. No fees are charged for licenses; nurserymen, however, have to pay the actual traveling expenses of the Entomologist who inspects their grounds twice each year.

NORTH DAKOTA: No law.

OHIO: Work under the supervision of the State Board of Agriculture, which appoints inspector and assistants. Inspection of premises where stock is grown for sale is made once each year. It is unlawful for any person to keep infested stock upon his premises or upon premises under his charge or control. A certificate, good for one year, is given each grower if his stock has been found clean. Inspector or assistants may make examination of any premises, if deemed necessary, and may revoke licenses. The board, through its inspector or assistants, may order and enforce any treatment of infested stock which may be deemed necessary before renewing certificate. All stock shipped for sale within the state must be accompanied by certificate, and stock shipped into the state must have certificate signed by proper officer in state from which stock is shipped. Agents or common carriers are liable if they handle stock without certificate and do not notify the board. Certified stock entering the state may be inspected if deemed necessary.

OKLAHOMA: No law.

OREGON: Quarantine work in charge of State Board of Horticulture, for which purpose the state is divided into five districts, with a horticultural commissioner policing each district. Certificates are granted to owners of stock free from pests or diseases. Infested trees are disinfected. No trees allowed to enter the state from any district where "yellows" or "rosette" are known to exist. Inspection required each year before shipments, in September, October or November. All pear and apple trees and all stock grown on apple roots must be fumigated before delivery, or certificate will not be issued.

PENNSYLVANIA: The work is in charge of the Secretary of Agriculture, and an examination is made every year and a certificate granted the owner if nursery stock is free from dangerous insects and plant diseases. Shipments within the state must be accompanied by a certificate. Shipments into the state must be accompanied by certificates of inspection. All infested stock in the state or entering the state must be fumigated.

RHODE ISLAND: No law.

SOUTH CAROLINA: The State Board of Entomology is represented by three members of Board of Trustees of Clemson College. This board appoints an entimologist and assistants if necessary, said entomologist to act as inspector. This officer or his assistants are empowered to enter any premises in the state in discharge of his duties as inspector; any hindrance on the part of the owner entails a fine or imprisonment. The inspector shall prescribe treatment for infested stock. Failure or refusal on the part of the owner of infested stock to execute the treatment prescribed by the Entomologist shall subject the owner to a fine or imprisonment. Sale of nursery stock within the state is unlawful unless said stock is accompanied by inspection tag of the Entomologist, he being the official inspector. Annual inspection is compulsory, and no stock can be sold within the state which has not been inspected within six months previous to date of sale. Shipments into state must be accompanied by certificate of inspector in state from which stock is shipped.

Transportation companies and common carriers are liable for non-conformance to laws; said companies or carriers not allowed to receive stock not accompanied by a certificate. Certificates of inspection are withheld until nurserymen comply with the instructions of the Entomologist in regard to treatment of stock when treatment is necessary.

SOUTH DAKOTA: No law.

TENNESSEE: A certificate from the State Entomologist must accompany all nursery stock offered for sale within the state. These certificates are good for one year. This officer is empowered to inspect nurseries, greenhouses, etc., whenever in his estimation it seems best. Nursery stock found infested must be destroyed. No shipment into the state allowed without certificate of inspection, and transportation companies and common carriers must advise the State Entomologist if packages are received without such certificate. An effort will be made at the coming session of the legislature to make the inspection apply to orchards in the inspection of nursery stock.

TEXAS: No law.

UTAH: A State Board of Horticulture, consisting of four members, is appointed by the Governor, subject to the approval of the Senate, and this board is authorized to make regulations for the quarantining and disinfecting of stock which in their opinion is dangerous.

County Commissioners appoint County Boards of Horticulture when horticultural interests appear to demand the same. Each County Board appoints a County Inspector. Stock has to be disinfected, when necessary, upon the order of County Board. Diseased or infested stock, or rubbish harboring insects, etc., must be burned. No stock can be imported into state without a certificate of fumigation. Certificates of fumigation are granted to residents when it is proved to the inspector or his deputy or to the County Board that the stock under discussion has been so treated.

VERMONT: No law.

VIRGINIA: Rules regulating inspection, importation, quarantine, etc., of nursery stock are made by the Board of Crop Commissioners, which board consists of the Board of Control of the Virginia Agricultural Experiment Station. Supervision and inspection of stock are placed in hands of State Entomologist, appointed by the above board. Violation of regulations made by the board on the part of nurserymen or orchardists means a fine of from $50 to $100 for each and every offense. Conditions of transportation and sale of plants or parts of plants, commonly known as nursery stock, within the state are regulated by board. The State Entomologist is empowered to determine nature and method of treatment of infested plants, and his orders to this effect can be enforced by a process of law if necessary. The Crop Pest Commission, or its agent, may enter any premises for the purpose of examining plants and trees, and any person hindering them shall be subject to fine. Annual inspection by State Entomologist is provided for and the issuance of certificates to parties whose stock is clean.

WASHINGTON: A properly qualified Horticultural Inspector is appointed by the Governor. County inspectors are nominated by county horticultural societies and such nomination

confirmed by the Board of Commissioners. These county inspectors receive $4.00 per day and actual expenses, paid by the county in which inspector is appointed. A license is required. Shipment of infested stock into the state is punishable by law. The Commissioner of Horticulture is allowed to employ a clerk, who is to be continually in the office of the commissioner during office hours.

WISCONSIN: No stock can be shipped into the state without a certificate of inspection.

WYOMING: No law.

A DESTRUCTIVE LEAF HOPPER.

Empoasca mali, Osborn.

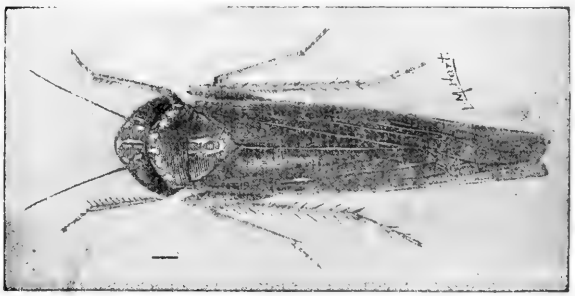

Fig. 90.—Leaf Hopper, much enlarged. Lugger.

This green leaf hopper has been exceedingly destructive this year in nurseries in the southern part of the state, affecting apples particularly, though also found on other stock. It causes the leaves to curl very much in the same way that the green apple lice do, but need not be confounded with the latter, which is found in large numbers generally on the under side of the curled leaf, while the hopper, if present, is in fewer numbers, and is much more active, either flying at once if disturbed, or, with wonderful agility, quickly shifting his position so as to keep the leaf between himself and

his fancied enemy. The growth of young apple trees from two to four years old suffered serious check from this minute insect. As seen in the accompanying illustrations, one could readily tell at a glance when during the summer the insect was doing its worst work from the fact that the branches took a fresh start after the period of injury, as evinced by the uninjured leaves.

This insect, which is the same as the *Empoa albopicta* of Forbes, and *Tettigonia mali* of Le Baron, probably lays its eggs in slits in stems of plants near the ground. It has but few natural enemies and is very difficult to combat successfully. Mr. Mohl of Adrian thinks he met with some success by using the dust sprayer, but the writer met with the most conclusive evidence in

Fig. 91.—Nursery row injured by this leaf hopper. Original.

a conversation with Professor Stedman, Entomologist of Missouri, who has devised a spraying machine, evidently destined to be of great use in nurseries large enough to warrant the expense entailed in its manufacture. It consists of a spray pump and tank mounted on a high cart, the wheels being sufficiently high and at the right distance apart to "straddle" two rows of trees. "The wheels are as high as my head," said Professor Stedman. The pipes and nozzles from the pump are so arranged that the spray comes from below, striking the leaves underneath, as well as from above, and enveloping four rows, the two between the wheels and the one on each side, with such a fog that the tree hoppers, whether on the leaves or in flight, perished in large numbers. Kerosene emulsion was used, and gave, according

to Mr. Stedman, excellent results. The men working the machine, however, preferred the following, as calling for less labor: The pump and tank were removed from the cart and a light frame in the form of a half circle, with the open part in front, put in its place. The sides of this semi-circular frame came outside the wheels, the rear part projecting behind the wheels. Upon the inside of the frame was tacked cheap cloth, which cloth was

Fig. 92.—One apple shoot showing injury more in detail. Original.

smeared with home-made "tanglefoot." In driving over the rows, four rows being included as with the spray, the disturbed hoppers, rising in the air, came in contact, to a great extent, with the smeared surface and perished. When loaded with insects the old tanglefoot is scraped off and a new supply added. Professor Stedman will no doubt report in full upon this appa-

ratus later on. In the meanwhile the above suggestions, made from memory and with the consent of the originator, may contain hints for our nurserymen who are seriously suffering from the depredations of this minute yet destructive insect. A nurseryman in southern Minnesota, writing under date of September 7th, says: "Leaf hoppers just as numerous as ever."

TWO STRAWBERRY INSECTS.

Complaint has reached the Entomologist this season of the "Strawberry Weevil," *Anthonomus signatus*, and of the "Flea-like Negro Bug," a species of *Corimelæna*, attacking strawberries.

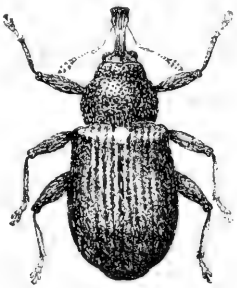

Fig. 93.—Strawberry Weevil. Original.

The Strawberry Weevil, shown in Fig. 93, is a hard pest to combat; there is no real remedy. Entomologist Sanderson of Texas advises the burning over of old beds as helpful. Inasmuch as it is claimed that the insect only attacks the staminate varieties of strawberries, we have suggested "planting chiefly the pistillate varieties, using only occasional rows of staminate plants, which latter rows may, if it seems desirable, be protected by cheap coverings until the buds are ready to open." Spraying with Paris Green in Bordeaux Mixture, 1 pound of the former to every 100 gallons of the latter, is said to be helpful to some extent. This must be done before the beetles appear, once before blooming and again two or three days after appearance of first blossoms. There should be three applications in order to keep buds and blossoms fairly well covered with a coating of poison.

The fact that bees visit these blossoms forms a decided objection to the method, and it may be said that any insecticide has but little value.

The insect lays one egg in a bud, piercing the stalk of the bud to prevent it developing further. The pollen in the bud affords food to the larva which hatches from the egg.

Of strawberries the Sharpless is said to be the worst affected, although strawberries are not the only plant affected, many wild flowers suffering also.

Their habit, stated as a fact, of feeding upon the raspberry suggests to Dr. Fletcher of Canada the possibility of making use of the latter as a trap crop.

The second of these pests, the "Flea-like Negro Bug," see Fig. 94, feeds not only upon strawberry, but also upon blackberry

Fig. 94.—The Flea-like Negro Bug. Original.

and raspberry. One variety affects the potato. As a rule this insect does not cause serious injury, its greatest fault consisting of laying its eggs on raspberries and blackberries, which, when crushed in the mouth of a person eating berries, gives rise to a most unpleasant buggy taste.

THE GRAIN PLANT LOUSE.

It is fortunate that, in the case of this pest, which multiplies with amazing rapidity, which manifestly cannot be treated when on the wheat, we have a large number of parasitic and predaceous insects ready to wage war upon it if climatic conditions favor them. This fact will in a measure account for the temporary alarm among many of our farmers in July of this year when they first saw upon the wheat heads countless thousands of these green lice, busily engaged in sucking the juices from the plants; which lice, as the warmer, drier weather of harvest time approached, weather unfavorable to the lice but favoring its parasites, disappeared, fading away before the onslaught of its enemies. Sometimes, however, this insect, which was evidently introduced from

Europe years ago, may cause serious damage, and it is evident that we are quite at the mercy of the weather and the comparative abundance of its parasites, both plant and animal, in the matter of immunity from loss. It may not be present one year, may be exceedingly abundant another season; may be taken care of by parasites one time and at another cause very serious injury. As far as our knowledge extends at the present time, man can do absolutely nothing against it.

The Entomologist received many letters during last July, asking for help in connection with this insect. To these letters we had to reply substantially as above. This season the insect's parasites apparently helped us out, and no serious loss was occa-

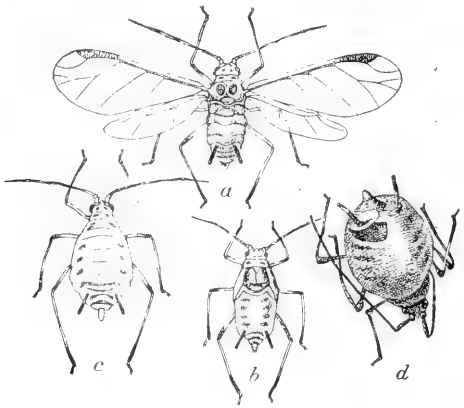

Fig. 95.—A Grain Plant Louse. *N. cerealis*: *a*, winged migrant; *b*, nymph of winged migrant; *c*, wingless parthenogenetic female; *d*, wingless female, showing exit hole of parasite, all enlarged. Marlatt, Division of Entomology, U. S. Department of Agriculture.

sioned by them, as far as we can ascertain. The actual scientific name was not ascertained, many of the specimens reaching the office in a crushed condition, and others, received in better shape, were, in the press of work at the time, laid one side "for a few hours" until the Entomologist had leisure to identify them, and, as frequently happens in such cases, the "leisure hour" never came until the specimen had died and shriveled or had crawled away, and the end of the season found us without the scientific name. Correspondence with Theo. Pergande, a specialist in this group, leads us to believe that without doubt this particular

louse was either *Nectarophora cerealis* or *N. granaria*. Either name or any other would answer for our constituents, who did not care "what the beast was called," but desired some remedy

Entomologist Sanderson of Texas says that this genus caused serious loss in Texas during the season just passed. The above figure shows *N. cerealis* in wingless and winged forms and also one killed by a parasite.

The actual method of hibernation of this louse, assuming it to be *N. cerealis*, is not known, though it is believed that it passes the winter in the egg stage on the wheat. It may and probably does affect other plants beside wheat, but it is to be noted that it has no connection whatever with the Green Aphis found on the apple, the so-called Apple Aphis, although it resembles it superficially.

DUST SPRAYING.

While not wishing to be understood as unqualifiedly endorsing dust spraying, the method certainly has advantages, and is becoming so prominent, particularly through work in Missouri and Illinois, that the process is certainly worth discussing here. The principle of dust spraying lies in the fact that lime is the conveyor of the insecticide or fungicide, not water.

Its advantages lie in the fact that

(a) there are no barrels of liquid to be hauled; it is excellent, therefore, where it is hard to carry water or to obtain water;
(b) that the cloud of dust envelopes immense numbers of trees, sometimes covering almost an entire orchard;
(c) one cannot get too much of the spray;
(d) it costs less than the liquid both in labor and material.
(e) It seems to be the best method of spraying cabbages, strawberries and small plants generally.

Its special disadvantages lie in the following facts:

(a) When a strong wind is blowing it cannot be well used; one is obliged to keep to windward side of trees constantly.
(b) It is best used, apparently, when the dew is on the trees or plants, thus relegating the work to the morning hours.

(c) It is not especially effective against the Codling Moth for obvious reasons.

(d) One must carefully avoid the dust, and see that it is not allowed to settled on the horses.

(e) Nothing can be used in dust form so good for sucking insects, such as plant lice, as kerosene emulsion.

(f) Arsenate of lead, which is coming into universal favor as a safe remedy against biting insects, cannot, of course, be used as a dust spray.

It would seem that it will never replace liquid spraying, yet since it is in many ways as good and in a few points superior to the former, it cannot be entirely disregarded.

Fig. 96.—The Leggett London Purple Gun.

Successful application calls for special machinery. The dust sprayer shown in Fig. 96 is Leggett's London Purple Gun, which has long been on the market and in use for applying London Purple or Paris Green in a dry form, when mixed with lime or a cheap grade of flour, and for the application of hellebore. While

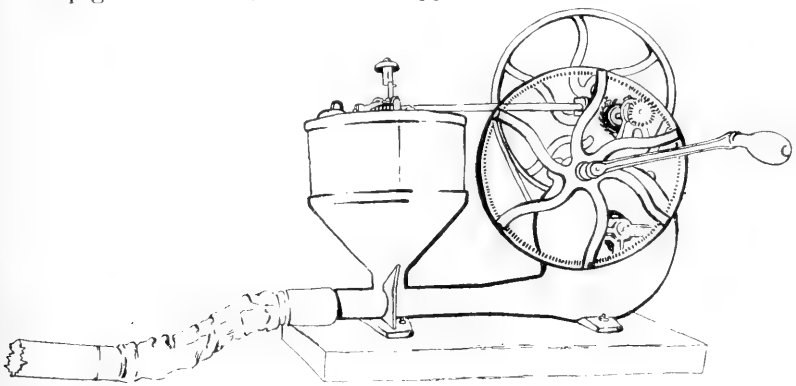

Fig. 97.—The Cyclone Sprayer.

this machine is excellent for what it was planned for, viz., spraying small trees, bushes and plants, manifestly, when large trees or whole orchards or large fields of plants are to be treated, a

machine on a bigger scale is called for. This demand is met in the so-called Cyclone Sprayer, Fig. 97, put on the market by a Kansas City firm. This machine is mounted on a cart and is capable of spreading an enormous cloud of dust over an orchard or field.

The following data regarding materials used in making the so-called dust sprays may be of use:

1. One barrel of quicklime will make two and one-half barrels of dust.
2. Five pounds of Paris Green to every barrel of lime is the proper proportion for the ordinary biting insects which are found on fruit trees, where the spraying is repeated several times.
3. For Canker Worms use 10 pounds of Paris Green to every barrel of lime.
4. For Potato Beetles and Cabbage Worms, 25 pounds to every barrel gives best results. When flour is used as a vehicle in the case of these insects, use one pound Paris Green to every four pounds of flour. Apply when the dew is on. This strength (one pound Paris Green to four pounds of flour) easily kills Currant Worms, if applied when the dew is on.
5. One barrel of dust, it is claimed, will spray 500 large trees thoroughly. One hundred trees can be sprayed in one hour at an average cost of one cent or less per tree.
6. One method of preparing the lime for use as a dust spray (see also page 102) is as follows: Break one barrel of fresh lime into small pieces and put in box three feet by six feet. Slack with water, when Paris Green is to be used. Dissolve 25 pounds of bluestone in six gallons of boiling water, and keep for use. Dissolve five pounds lye in five gallons hot water. Keep these solutions separate for use with the lime as a fungicide. When wanted for use sprinkle on quicklime. If not enough to slack the lime, use water. Five pounds of powdered sulphur can be mixed with the lime. See in this connection the recipe for making "Dry Bordeaux," on page 102 of this report.

In the issue of "The Country Gentleman" for April 2, 1903, Mr. Stedman of the Missouri Station, where considerable work has been done in this line, gives the following recipe for preparing and using the dust: "Take 10 pounds of fresh stone lime and break up the lumps so they will be about the size of hen's eggs. Place these in a sieve, the bottom of which can be made out of a common wire mosquito netting, and sprinkle water over this slowly, so that the lime will take up all the water.

When it begins to slack stop pouring and begin again when necessary to keep up the slacking; the idea being not to allow the water to drop down through the sieve or to put on enough water to cause the lime to become putty. * * * About 3 quarts of water is required to properly slack the 10 pounds of lime. After the lime is all slacked and has been sifted through, cover the box into which the lime has fallen and allow it to heat for a time. * * * This may be now kept indefinitely in a dry place. When one wishes to spray for a biting or chewing insect, all that is necessary is to thoroughly mix a pound of Paris Green with 20 to 40 pounds of the powdered lime. Fill the machine and apply."

A more simple way of slacking the lime may suggest itself to any party intending to use the dust spray.

Fig. 98.—An old-fashioned dust sprayer.

A TROUBLESOME MITE.

In March we were appealed to by a firm dealing in wholesale groceries, which was troubled by a small mite affecting boxed figs from California and evaporated apples from the east, stored in the firm's warehouse. A visit was made to the establishment and boxes of the above named fruit found swarming with this pest, which is shown much enlarged in Fig. 99.

This is not an insect, but belongs to a different class called *Arachnida* along with the spiders, scorpions and ticks, and to an order known as *Acarina*. Mr. Banks of Washington, a specialist in Arachnids, identified it as *Carpoglyphus passularum*, Hering, originally a European species, but which has been found, so I was informed from Washington, in California. The supposition is, therefore, that the figs were originally infested and that the mites spread from them to the apples.

After looking over the situation I advised placing the infested boxes in an air tight room and using 1 part bisulphide of carbon for every 6,000 parts of atmosphere. It was further suggested that when the boxes were returned to the warehouse a good

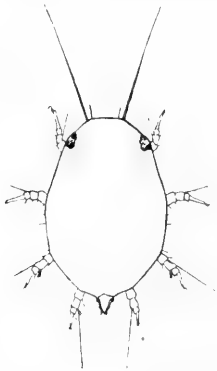

Fig. 99.—*Carpoglyphus passularum*, Hering. Enlarged about 64 times. Original.

grade of powdered sulphur be sprinkled over their tops and on the floor of the room. It was stated clearly to the representative of the firm that one treatment would not necessarily eradicate the mites, and that the gas did not kill the eggs to the best of my knowledge, and that several treatments might be necessary. This fumigation was undertaken, not under the direction of the Entomologist, but following his suggestions as nearly as possible. Upon the first trial 5 pounds of bisulphide were used with an exposure of 26 hours, but the mites were alive when the apartment was opened. A second trial was made, but was a failure because of a leakage of gas. This was remedied and a third trial was given, using 10 pounds of bisulphide and 48 hours' exposure to the fumes. When the room was opened the

mites appeared to be dead, but within two hours many showed activity. The firm further stated thaat in their opinion the process was not a proper one commercially for evaporated fruit, since the odor of the gas was perceptible on the apples first treated after more than two weeks of good ventilation.

I am forced to ascribe the failure of this third treatment to an incorrect estimation of the cubic contents of the room used, and hence the use of a wrong amount of CS_2. I was informed that estimating the amount of bisulphide was left to the druggist from whom it was purchased.

It may be of interest to add here that information has just reached this office that the trouble under discussion disappeared and has not been apparent since.

REMEDIES FOR THE SQUASH BUG AND MEANS OF PREVENTION OF INJURY.

The Entomologist has been repeatedly asked for remedies for this well known pest, and inserts here the standard method of combating the insect:

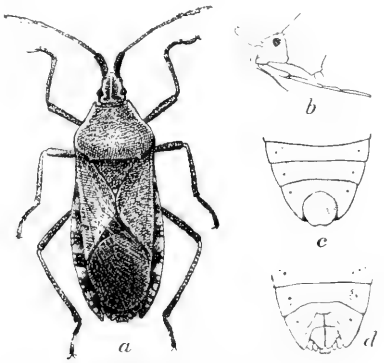

Fig. 100.—Squash Bug. *Anasa tristis.*

1. Protection of young plants by coverings.
2. Planting an excess of seed in order to distribute the attack.
3. Hand picking early in the morning.
4. Hand picking the large, yellowish brown eggs, which can be found without much difficulty on the under side of the leaves.
5. Strewing some repellant on soil close to plant, such as lime, or gypsum, or sand saturated with kerosene or turpentine. This is of questionable efficacy.

6. As this insect hibernates in rubbish on field, it is of the utmost importance that all vines should be destroyed immediately after gathering the crop, thus killing the immature bugs which are still on the vines. One should burn in the fall all rubbish likely to afford winter quarters for this pest.
7. It is claimed that this bug will not touch cucumbers if there are squashes in the neighborhood; that it prefers squashes to pumpkins and pumpkins to cucumbers and melons; hence, if one wished to raise cucumbers or melons, he might (if the above statements are correct) plant squashes or pumpkins near them as a catch crop.

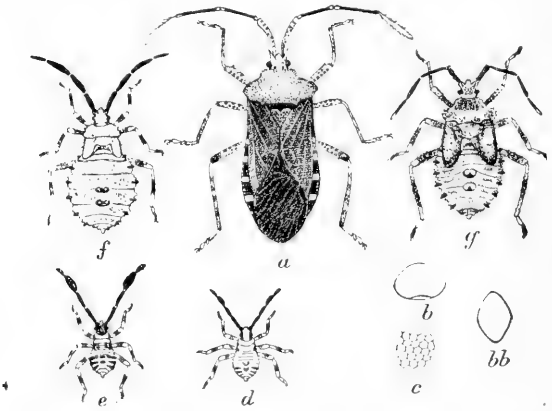

Fig. 100½.—*Anasa armigera*, Say. Also called Squash Bug.

This bug, when mature, cannot be killed by any insecticide which will not injure the plant. See also page 125.

A beetle, frequently, though wrongly, called "Squash Bug," is rightly known as the Striped Cucumber Beetle, shown in Fig. 100¾. This beetle, which bites the surface of the plant, differs so markedly in its feeding habits from the true Squash Bug, which sucks the juices from below the surface, that it calls for a different method of treatment as regards insecticides.

Paris Green may be dusted dry on the plants, mixed with slaked lime or cheap flour, about 1 part of Paris Green to 50 or 60 parts of flour or lime. At least one party has obtained relief by dusting the pure Paris Green sparingly upon the plants, the plants not having been burned thereby. Tobacco dust scattered about the young plants is said to keep the beetle away for quite a while. One should always burn the plants in the fall immediately after gathering the crop, thereby killing a large number

of insects as well as destroying probably some eggs which have not hatched, thereby lessening the beetle crop for next year. Planting a much larger number of seeds than are actually needed is also practiced. This beetle, its back striped with yel-

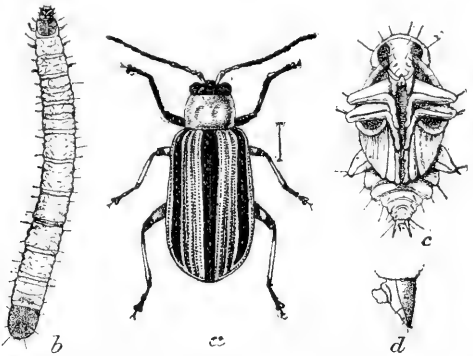

Fig. 100¾.—*Diabrottica vittata*, Fab. Div. of Entomology, U. S. Department of Agriculture.

lowish or greenish and black, about ½-inch long, can be readily distinguished from the two bugs pictured at the beginning of this article, both of which are called Squash Bugs.

CUTWORM REMEDIES.

Cutworms are the larvae of moths belonging to the family Noctuidae. These moths are night flyers; their eyes shine in the lamp light and hence they are sometimes called "Owlet Moths." The eggs are laid by the female moth for the most part on leaves or the soft parts of plants. Land recently in sod is likely to be infested, and the crop following sod is pretty sure to suffer if attractive to these pests. Some cutworms climb fruit trees and eat the buds. See, in this connection, page 69.

Late fall plowing by turning up the pupae of cutworms, where a varying temperature has a chance to work on them, and crows, blackbirds and other birds have an opportunity to eat them, is an excellent thing.

Many growers of melons, squashes and cucumbers protect their young plants by cylinders of tin (tomato cans with ends melted out are good) or cardboard or even brown paper, a

cylinder surrounding each plant and planted a few inches (2 or 3) in the soil. Poisoning bundles of clover with a solution of Paris Green and strewing the same amongst the plants to be protected is one good method. Both of these the Entomologist has tried with some success. Paris Green, it must be remembered, is a slow acting poison comparatively, and one must not expect worms which have eaten it to die at once. Planting an excessive number of seed or plants is sometimes resorted to. The writer has found the guilty worm frequently concealed an inch or two in the soil in the morning, not far from the plant injured during the night. He has also trapped them successfully by placing cabbage leaves, or any large leaf or board, among plants needing protection, finding the worm under there in the morning. See also page 70.

POTATO BEETLES.

Complaint reaches this department to the effect that sprinkling potato plants with Paris Green for this pest does not give satisfactory results, either failing to kill the beetles or, if efficacious in this, injuring the foliage of the plants. While this burning may be in part due to an excess of arsenic in poor Paris Green (see article on page 33), it may be the result of improper mixing and application. One pound of good Paris Green in 150 gallons of water (or a smaller quantity of the poison and water in the same proportion) should do good work if frequently stirred while being used. It must be borne in mind that Paris Green settles rapidly in water, and the liquid should be kept stirred; otherwise the plants or trees receiving the liquid from the bottom of the containing vessel will be badly burned. A quart of lime water, or of "milk of lime," poured into a pailful of the Paris Green mixture, will help prevent the burning.

In this connection we must mention arsenate of lead, see page 99, which can be used practically any strength without injury to the foliage.

EXPERIMENTS WITH COCKROACHES.

As a result of some personal experiments against these pests the Entomologist is prepared to endorse the use of borax against

cockroaches or croton bugs as being the best, if not the only, effective remedy, outside of fumigation.

Some relief was obtained by keeping in the bath room of a rented house where roaches were troublesome an atomizer half filled with kerosene, and turning a spray upon any "bug," young or old, when observed. A touch of this spray was all that was necessary, for although Mr. Cockroach ran away after being wet, subsequent observations demonstrated the fact that he could not escape his doom, and in every case was soon on his back, kicking his feet in the air, in a last struggle.

But the careful housekeeper might object to the use of kerosene on the ground of its unpleasant odor and the danger of staining the walls.

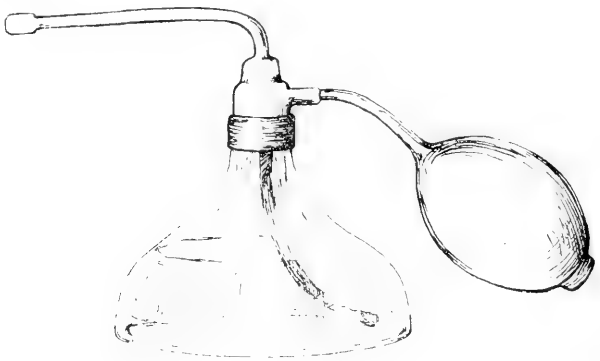

Fig. 101.—"Some relief was obtained by keeping * * * an atomizer half filled with kerosene."

Sweet oil in low glass dishes was tried with only partial success. A so-called "Electric Paste" was also used, but as far as could be observed with absolutely no results. We then turned to powdered borax, using it freely in the kitchen, with marked success. This was sprinkled in cracks about the sink, along the top of baseboards, near the sink, and elsewhere wherever there were cracks which afforded the insects a hiding place. By a generous use of this substance, persisted in for two weeks, the room, in fact, we may say the premises, were entirely freed from this disgusting pest. Others to whom it has been recommended report the same success, and in conversation with other economic entomologists we hear unqualified praise for the "borax method."

REMEDIES FOR ANTS.

For treatment of large ant hills, see page 105.

Gardeners, bee keepers and others are frequently unnecessarily alarmed at the presence of ants, ascribing injuries to them of which they are not guilty. For instance, ants in our judgment do not injure peonies, albeit they are seen on the stems and buds sometimes in large numbers. A sweet "varnish" covering the buds attracts them, and as far as I can observe they very

Fig. 102.—"Ants do not injure peonies."

rarely bite the petals. Nor need the bee keeper be annoyed, ordinarily, by observing ants going in and out of his beehives, provided that the colonies of bees so visited are not weak. The ants seek the home of their cousins, the bees, for the sake of the warmth of the hive, rarely, according to the observations of practical bee keepers, touching the honey. The bees, jealous of their store, are quite able to make the ants cry for quarter should the latter take undue liberties.

Unprotected honey or very weak colonies may possibly sometimes suffer at the hands or rather at the mouths of the ants; but unprotected honey should be put out of the way of ants, and weak colonies should be treated in the various ways known to the wide awake bee keeper.

Ants seen ascending and descending fruit and other trees are not injuring the tree, or, at least, only indirectly. They are after the plant lice which will almost invariably be found on trees frequented by ants. These plant lice yield a sweet honey dew, of which the ants are very fond. Indeed, so partial are they to this sweet liquid that they have been known to care for some species of plant lice, taking their eggs below ground at the approach of cold weather. We have therefore spoken of them as only indirectly injurious in that they are inclined to care for an insect, the plant louse, which is decidedly destructive.

While it is perfectly easy to take care of ants on the lawn or in the garden, treatment for the small ants which enter the house and attack sweet foodstuffs, such as sugar or syrup, is a more difficult matter. The trouble in such cases lies in the difficulty of getting at the nest. When the nest cannot be located, temporary relief can sometimes be obtained by placing pieces of sponges, which have been moistened with sweetened water, in places frequented by ants, collecting same several times during the day, and killing the ants collected thereon by throwing the pieces of sponge into hot water.

Some relief is obtained by changing the location of the sugar or the syrup can or molasses jug. The odor of camphor is said to be obnoxious to them, and it is claimed they can be kept away by bits of camphor placed in the pantry and elsewhere where they are troublesome. Placing the legs of the table or cupboard holding the substance attractive to ants in pans of water, the water preferably covered with a little kerosene, has been practiced with success.

To insure permanent relief, however, the nest must be found. If the ants can be traced to an out-of-door nest, that can be easily destroyed by the method mentioned. If, however, the nest is located in the walls of a house or under flooring, as is sometimes the case, the matter is more difficult, sometimes calling for the removal of a portion of the floor. Bisulphide of carbon

or kerosene should be injected into the nest when found. In the use of bisulphide of carbon care must be observed not to bring it near a light of any kind.

A prominent confectioner who was very much annoyed by the presence of ants in his factory used kerosene oil at our suggestion, putting it in cans ordinarily used in oiling machinery, and thus was able to squirt the kerosene into cracks and crevices and along baseboards, etc., wherever the pest appeared. This had to be repeated, however, at intervals. When last heard from he had been enjoying immunity from the pest for two or three months.

THE CLOTHES MOTH AND THE CARPET BEETLE.

Housekeepers found remedies for both of these pests discussed in last year's report, page 56, and nothing further is called for here. We picture below, Fig. 103, the egg of a clothes moth in woolen cloth, very much enlarged.

Fig. 103.—Egg of Clothes Moth. *Tinçola biselliella*, much enlarged. Original.

This egg is visible to the naked eye, and it can be dislodged by shaking or brushing the cloth. Kept under observation in the laboratory, they hatched in six and seven days, one female laying several eggs. An egg, measured under the microscope, was found to be 2-100 inch by 1-100 inch. The young worm, shown in Fig. 104, was 1-20 of an inch long when about 24 hours old. The species figured, apparently quite common in Minnesota, is *Tinçola biselliella*, Hummel, and not *Tinca pellionella*, Linn.

The writer has observed this moth in his residence as early as March 6th. It undoubtedly lays its eggs before that, since full grown larvae were found March 16th.

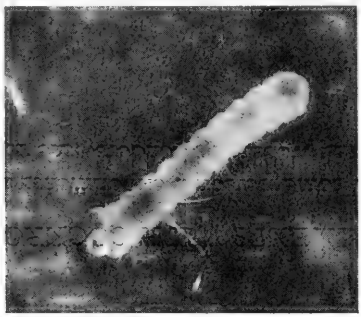

Fig. 104.—Larva of Clothes Moth, much enlarged. Original.

This Clothes Moth not only attacks woolens, but also feathers, and the careless fisherman who does not take proper precautions with his fly book at the end of the fishing season is apt to be met with something like this, Fig. 105,

Fig. 105.—Trout flies eaten by Clothes Moth. Original

when the book is again opened.

AN OAK LEAF MINER.

Fig. 106.—Oak leaf infested with *L. hamadryadella*, Clem. Original.

Fig. 106 illustrates the appearance of the leaves of the White Oak infested this season with a leaf miner, known as *Lithocolletis hamadryadella*, Clem. The linear serpentine blotches are not made by this species, but by another miner.

Leaves of oaks, notably the White Oak, suffered materially this season in this way. Curiously enough, the entomologist only noticed it in the vicinity of the Twin Cities, though it was looked for in other parts of the state. The larva, figured below, which lives in the mine, passes the winter in the leaf as it lies on the ground. Raking up and burning the leaves, therefore, is a good preventive measure, lessening the number of moths which would otherwise issue the following season.

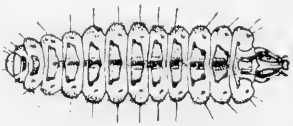

Fig. 107.—Larva of the above miner, enlarged 8 times. Original.

THE CONFUSED FLOUR BEETLE.

Tribolium confusum, Duv.

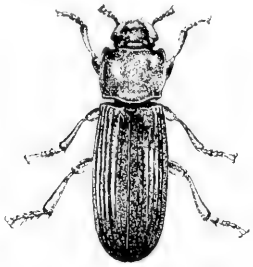

Fig. 108.—*Tribolium confusum*, Duv. Original.

This little brown beetle, about 1/8 of an inch long, gets its name from being confused with an allied form. It is a serious pest sometimes in flour, cornmeal, oatmeal and patented cereals generally. In the American Miller of Jan. 1, 1896, it was reported as having probably cost the millers of the United States $100,000 in 1895 on account of its depredations. It is said to be practically omnivorous, having been found in ginger, cayenne pepper, baking powder, orris root, snuff, slippery elm, peanuts, peas, beans and various seeds, according to a report from the U. S. Department of Agriculture.

Specimens were sent to us last season from a mill. During the course of some laboratory experiments with this insect, many escaped, and one was later found attacking a dried insect specimen in an imperfect insect box, a habit previously noted.

MOSQUITOES.

In last year's report, the following species of *Culicids* were listed as occurring in Minnesota:

Culex consobrinus, C. impiger, C. pungens (*pipiens*), *Anopheles* 4—*maculatus* (*maculipennis*), with the statement that there were doubtless other species in the state not yet described. Time for extended collection in this group was not at our disposal, but the following additional forms were met with: *C. stimulans, C. restuans* and *Wycomyia smithii*, the latter in rain water in pitcher plant (*Sarracennia*), in the northern part of the state, in May.

Many more species, native to Minnesota, are undoubtedly yet to be heard from.

The following observations may be of interest: *C. stimulans* and *A. maculipennis* abundant at Basswood Lake, Lake county, May 18th; individuals of the latter species numerous near the lake, while the former were more abundant inland in the swamps. *C. consobrinus* was fairly abundant April 26th, as was also *C. impiger*. Both *stimulans* and *impiger* were captured June 13th in Douglas county. *C. impiger* was abundant in Itasca county June 20th.

While in camp at Basswood lake in May the writer made a few observations, necessarily somewhat crude, on the rate of digestion in *Anopholes maculipennis*, which may be of interest to the readers of this report. Mosquitoes which were allowed to gorge themselves with blood and were then placed in a glass jar, stoppered with absorbent cotton, required from 19 to 68 hours to take care of what they had eaten. At the expiration of these widely varying periods their abdomens had practically shrunk to their normal size and the insects were ready for business again. None of the mosquitoes could be induced to bite a second time. As is well known, one can allow this malarial mosquito to bite one with impunity provided it has not previously drawn the blood of some victim of malaria.

The growing interest in the anti-mosquito crusade, particularly in the east, where associations are being formed for their extermination and large sums appropriated for the work, indicate that people are thoroughly appreciating the fact that mosquitoes are disease carriers and can be, in some localities, exterminated or materially reduced in numbers.

The writer has stopped experimental work in a St. Paul suburb in this connection, deeming the work to have got beyond the experimental stage, and calling for funds other than the state's money for its prosecution. It might be said in reference to this particular case that the area affected was so extended, and some of it so difficult of access, that, under the existing conditions, only partial immunity could be assured without more extensive drainage, or the employment of a considerable force of men and the expenditure of a large sum of money for labor, apparatus and oil.

IMPORTANT NOTICE.

SENDING INSECTS THROUGH THE MAILS IS PERFECTLY LEGAL.

While it has been a common practice to send specimens to the Entomologist through the mail, our constituents have been unaware, probably, that, in accordance with Sec. 494, of the Postal Laws and Regulations, this has been prohibited.

Largely through the influence of Dr. L. O. Howard, the United States Entomologist, who realized how this would seriously interfere with agricultural work, the Postmaster General has amended that portion of the law, as evidenced by the following order:

Office of the Postmaster General,
Washington, D. C., Dec. 16, 1903.

Order No. 1269a.

Modify the Postal Laws and Regulations, edition of 1902, as follows:

Section 494, paragraph 1, line 3; omit the word "insects."

Section 496. Omit paragraph 7 and insert in lieu thereof the following:

7. Queen bees and their attendant bees, the "Australian Lady Bird," insects (live or dried), and dried reptiles may be sent in the mails when so put up as to render it practically impossible that the package shall be broken in transit, the persons of those handling the mails injured, or the mail bags or their contents soiled. (See paragraph 1 of this section.)

H. C. PAYNE,
Postmaster General.

It will be seen from this that it is now *perfectly legal* to send through the mail insects properly inclosed (a tin or wooden box is best), and correspondents are urged to always send specimens of pests doing damage, with letter asking for advice.

It is very difficult for an entomologist to discuss a pest which he has not seen, for without a specimen there is always room for some doubt as to what a correspondent is referring to. Postage upon such packages is 1c. for each ounce or fraction thereof.

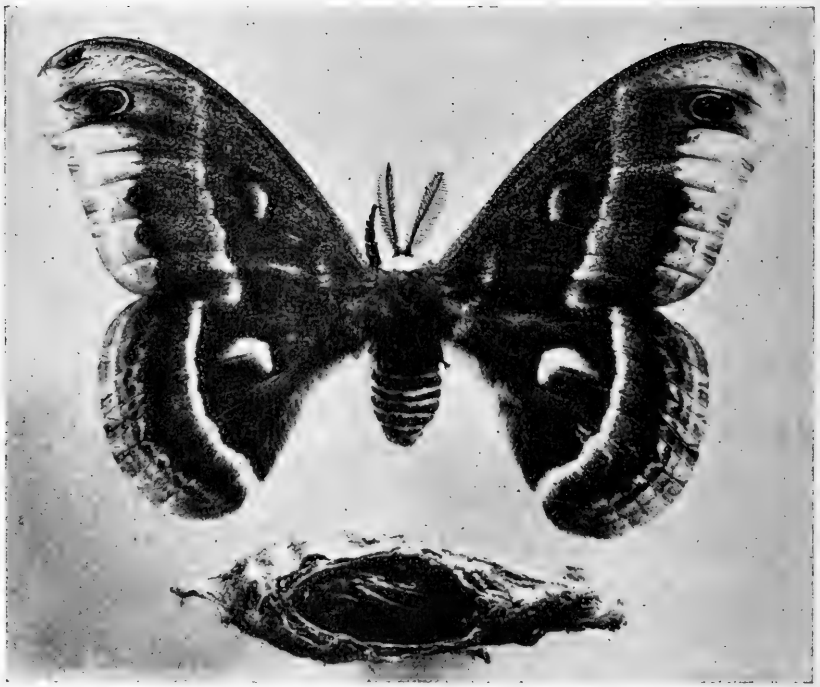

Fig. 109.—Cecropia Moth and Cocoon, somewhat reduced. Lugger. See Fig. 1 of colored plate.

Fig. 110.—Three Sphinx Moths. The middle one is the Blind-eyed Sphinx. Lugger. See Fig. 2 of colored plate.

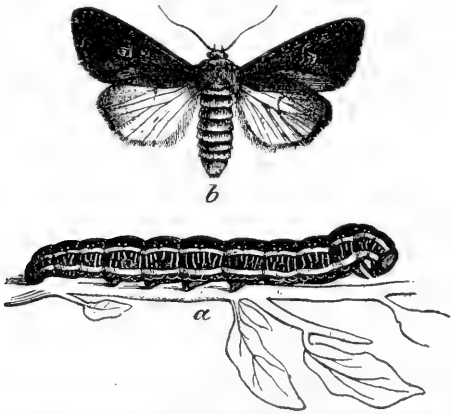

Fig. 111.—Zebra Caterpillar and Moth. From Div. of Entomology, U. S. Department of Agriculture. See Fig. 3 of colored plate; also Fig. 118.

Fig. 112.—Eight Spotted Forester. Lugger. See Fig. 7 of colored plate.

Fig. 113.—Mourning Cloak Butterfly. Original. See Fig. 8 of colored plate.

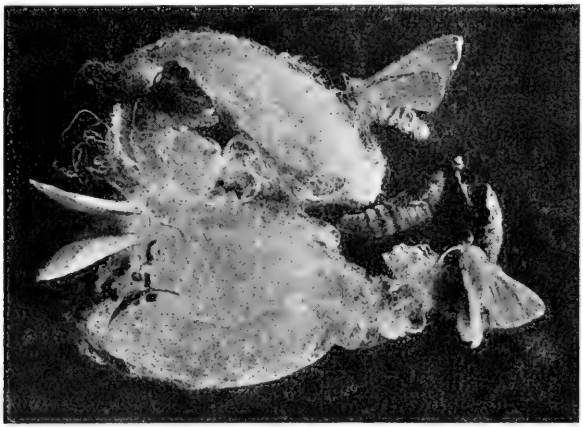

Fig. 114.—Forest Tent Caterpillar, moths, pupa and cocoon. Lugger. See Fig. 11 of colored plate.

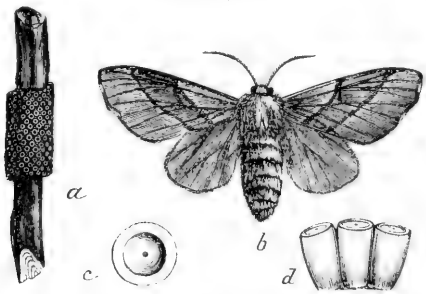

Fig. 115.—Forest Tent Caterpillar. *a*, egg mass; *b*, moth; *c*, top of egg enlarged; *d*, three enlarged eggs. After Riley.

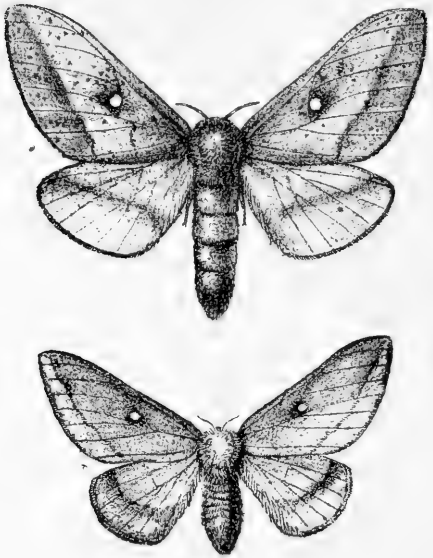

Fig. 116.—Male (smaller) and female moths of Orange-striped Oak Worm. Lugger. See Fig. 12 of colored plate.

Fig. 117.—Moths and larva of the Lime Inch Worm, or Lime-tree Winter Moth. The female, which is wingless, shown below. From Div. of Entomology, U. S. Department of Agriculture. See Fig. 13 of colored plate.

Fig. 118.—Different stages of imported Cabbage Butterfly and some other insects which affect cabbage; *a*, *b*, adults of the Imported Cabbage Butterfly; *c*, *c*, *c*, different stages of the caterpillar; *d*, the chrysalis; *f*, *e*, Zebra caterpillar and moth; *g*, *h*, *i*, various stages of Cabbage Plutella; *k*, *Limneria tibiator*, Cr., a parasite of the Cabbage Plutella. Lugger. See Fig. 12 of colored plate.

Fig. 119.—Moth of Spotted Cut Worm, natural size. Original. See Fig. 6 of colored plate.

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