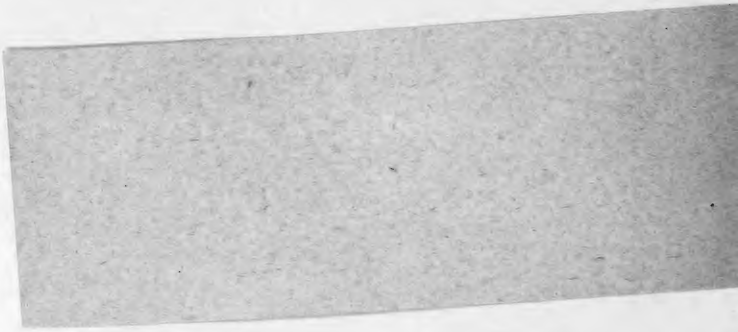
With the compliments of

F. L. Washburn



NINTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF

MINNESOTA

TO THE GOVERNOR

FOR THE YEAR 1904.

THIRD ANNUAL REPORT OF F. L. WASHBURN.

AGRICULTURAL EXPERIMENT STATION,
ST. ANTHONY PARK, MINN.
DECEMBER, 1904.

LETTER OF TRANSMITTAL.

STATE EXPERIMENT STATION.

ST. ANTHONY PARK, MINN., Dec. 1, 1904.

His Excellency, S. R. Van Sant, St. Paul, Minn.,

DEAR SIR: The fact that we have had little injury this year from the Hessian fly and the chinch bug need not fill our farmers with a feeling of security as regards these pests, and occasional grasshopper visitations, for with the crop conditions in Minnesota, we will undoubtedly always have the first two pests, and at times be troubled with grasshoppers. The Hessian fly has been heard from in a few counties, but there has been but little injury this year, and little or no injury from the chinch bug. I have occasionally received reports which would indicate the presence of the frit fly on wheat, though no specimens have ever been sent, and I have personally not met with the pest here.

We have been surprised by the introduction of the European willow and alder borer attacking our Carolina poplars, introduced in this country many years ago, and gradually working its way westward. This beetle is treated of on page 115.

Your Entomologist has deemed it advisable to insert in this report a key to insects affecting the blackberry, raspberry, strawberry, currant, gooseberry, grape and melon, for the use of market gardeners—this key being a continuation of the one published last year on insects affecting fruit trees. It is to be hoped it will be useful. In this connection I wish to call attention to the fact that reports of the State Entomologist are planned to form a series of references for farmers, fruit growers, market gardeners and others, and to be of special use should be preserved so that they can be referred to from time to time when conditions call for reference. I have aimed in this report, as in previous reports, to keep in mind the fact that these publications are for the use

of our farmers, and hence have given practical suggestions in a simple form, publishing my own experience as far as possible, or that of other workers who have met success in the same lines.

During the past year the State Entomologist has delivered eleven lectures to farmers and others at Wrenshall, Starbuck, Battle Lake, Alexandria, New London, Madison, Willmar, Brandon, Braham, Renville, Warren and elsewhere. These lectures were free to citizens, costing only the expense of providing a place for the lecture. In almost every case the lecture was illustrated with lantern views, and we are especially well prepared, through the purchase of a fine lantern, to continue this work, which appears to be thoroughly appreciated, during the coming winter.

A number of press notices have been mailed during the year; a special report upon the Flour Moth, conditions seeming to require this, was issued on February 29th, and Press Bulletin No. 19, dealing with the food habits of some of our common birds, was printed on May 14, 1904. It is the intention of a joint committee from the Audubon Society, the State Horticultural Society and the Board of Education to place this bulletin in the hands of the teachers of our common schools, in order to inculcate in the young pupils an interest in birds, and a love for the useful species.

From the first day of May to the first of December, this department has written 1,076 letters, an average of about 154 a month. These letters were largely in answer to inquiries regarding insect pests. In addition many circulars and numerous postal card notices have been mailed.

In allotting the printing of reports we have felt it incumbent upon us to place the business with a printing house where we are certain not only of reasonable prices, but also of excellence of work and material, and dispatch in the completion of the job, believing it poor economy to have the work done by some house where protracted delays seem inevitable, where the material used is of an inferior grade, and the execution poor, although such house may offer the lowest bid.

Believing that this office is established for the best good of the farmers, we have seen fit to include in this report a chapter dealing with gophers, field mice, rabbits, etc., which are always a menace to the farmer and the fruit grower. The need, too,

of more thorough knowledge regarding the food habits of our birds has prompted the Entomologist to include Press Bulletin No. 19. We have also included an article on the common American toad, which is, without doubt, one of the most useful factors available for the farmer and gardener in keeping down injurious insect pests upon his place. The useful habits of this little animal are far too little known and appreciated, and instead of its being an object of aversion or persecution, its presence in our garden should be encouraged in every possible way. Since the publication of the special report upon the Mediterranean Flour Moth, further work has been done by the Entomologist with this destructive pest, and the report as revised is included herewith.

Carrying out the plan outlined in last year's report, we have inaugurated a campaign against the destructive leaf hopper, and results of the work are given in this volume. We have also found the Plum Curculio attacking apples, in some orchards causing a loss as high as ninety per cent of the crop, and, therefore, this insect, which is commonly associated with the plum, has been discussed in connection with its work on apples.

The Cottony Maple Scale has been extremely abundant and destructive this year, attacking our shade trees in the Twin Cities and the suburbs, and in various towns throughout the state, and in neighboring states. Directions are given herein for controlling this pest.

So many letters are received, asking for suggestions for combating certain common pests of the vegetable garden, such as cabbage maggots, cut worms, cabbage butterflies and the like, that the writer has thought it expedient to include herewith the latest remedies for these various pests which are so abundant everywhere. The Entomologist's own experience in his flower garden has suggested to him also the advisability of placing in the report a short chapter of suggestions to those raising flowers, as to the best way to control certain insect pests, which are apt to be unwelcome visitors in the flower garden.

Additions have been made to the museum collection of insects during the year, and as this letter is dictated we have just received two boxes of insects from Japan, sent by a friend there, who has had our wants in view even in the midst of other engrossing in-

terests. The entomologist has maintained a small apiary at the Station for experimental purposes.

The director of the Experiment Station has been asked to allow the department a small orchard and garden space for experimental purposes. The needs of my department in these particulars are again emphasized. The department also needs an insectary, a small glass building resembling a greenhouse somewhat, and costing, with heat and water connections, about $2,500, such as one finds at all well equipped experiment stations, where the life histories of Minnesota insect pests may be studied and remedies tested. It is to be hoped that relief from the crowded condition in our rooms may be obtained before long, either by being given adequate quarters in the new general building, or by being allowed a modest building for the sole use of this department. Considerable time of the Entomologist and assistant in late fall and winter is taken up with teaching. A course in entomology for the graduating class of the Agricultural School is carried on between October and Christmas, and at the same time a course in economic and forest entomology for college students. In addition we lecture to a class of farmers in the short course on insect enemies of agriculture.

The expense of printing the annual report of the state entomologist has been materially reduced since 1902, at which time the present incumbent was elected to the chair of entomology in the University by the board of regents. This is shown by a decrease in the printing bills, notwithstanding a very large increase in the mailing list.

I wish to call attention to the reports from correspondents on page 121, as affording me means of keeping in touch with the insect conditions in various parts of the state during the summer months. I wish further to call your attention to the excellence of the illustrations in this report. We believe it will rank in this respect as equal to most of the reports from similar offices in this country, and as the superior of many. This is due largely to the effective efforts of a well qualified artist, and to the excellence of the photographs, made for the most part by our assistant, Mr. A. G. Ruggles, in whose hands we have left practically the entire work of photography. I wish further to ac-

knowledge courtesies from various departments of the station, which were very generously offered to further this work; to various farmers, nurserymen and other citizens, who have done all they can help the Entomologist; to the Department of Agriculture at Washington; to those few who have so generously responded in loaning me cuts or illustrations for use in this report, and to the loyalty and painstaking efforts of my office force. Acknowledgments are also due the Great Northern, Northern Pacific, Great Western, Minneapolis, St. Paul & Sault Ste. Marie, Minneapolis & St. Louis, Chicago, St. Paul, Minneapolis & Omaha and the Duluth & Iron Range Railroads for courtesies in the shape of transportation for the Entomologist and his assistant. The Art Engraving Company of St. Paul is to be congratulated on its fine work in connection with the photographs in this report. Finally, my dear sir, permit me to say in this, my last report to your Excellency, how much I have enjoyed the work under your administration, how proud I am of the opportunities afforded, of the appreciation of the work as shown by citizens of Minnesota, and of your kindly interest and helpfulness during the past three years.

Most sincerely and respectfully yours,

F. L. WASHBURN,

State Entomologist.

FINANCIAL STATEMENT FOR FISCAL YEAR, AUG. 1, 1903, TO AUG. 1, 1904.

1903.		Amount.	Requisition No.
June 2.	Adam Decker & Co	$1.25	2006
July 31.	Western Union	.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. Mattisen, oil	4.50	....
Aug. 22.	American Entomological Co	25.05	2414
Aug. 18.	Yawman & Erbe	1.44	2414
Aug. 8.	Dust Sprayer Mfg. Co., Cyclone sprayer	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, traveling expenses, Stearns, Meeker and Chisago counties	39.51	....
Sept. 1.	H. G. Todd	31.00	....
Sept. 1.	A. G. Ruggles, traveling expenses, Clay, Marshall and Polk counties	21.51	....
Sept. 1.	A. G. Ruggles	83.33	....
Aug. 15.	Pittsburgh Plate Glass Co	20.00	2415, 2416
Sept. 1.	Twin City Tel. Co	3.00	....
Sept. 3.	American Entomological Co	2.15	2414
Sept. 9.	I. A. Root Co	5.35	2412
Aug. —.	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, expenses in Winona, Wabasha, Otter Tail, Douglas, Clay and Polk counties.	29.55	....
Sept. 30.	Express and stamps, J. A. Vye	9.31	....
Oct. 5.	A. G. Ruggles	83.33	....

1903.		Amount.	Requisition No.
Oct. 5.	A. G. Ruggles, traveling expenses, Washington county	1.20	....
Oct. 5.	H. G. Todd, stenographer	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. —.	Express	5.15	....
Sept. 30.	Western Union Telegraph Co	4.28	....
Oct. 9.	W. J. Gerhard	5.00	2417
Oct. 15.	E. G. Cresson, Amer. Ent. Soc	1.50	2417
Oct. 27.	Edith Reed, drawings for report	8.85	2409
Oct. 31.	A. G. Ruggles, field work in Clay and Marshall counties	15.85	....
Oct. 31.	A. G. Ruggles	83.33	....
Nov. 1.	H. G. Todd, stenographer	30.00	....
June 8.	Harrison & Smith	5.00	....
Aug. 26.	J. A. Schlener & Co	1.00	....
Sept. 30.	E. A. Holt, field work	5.00	....
Oct. 22.	Bausch & Lomb	9.00	....
Oct. 24.	Macmillan Co	7.51	....
Oct. 24.	G. E. Stechert	34.25	....
Oct. 27.	A. C. McClurg & Co	6.69	....
Nov. 1.	Twin City Telephone Co	3.00	....
Nov. 5.	W. R. Ansell	35.00	....
Nov. 6.	E. R. Williams	1.50	....
Nov. 7.	Andrews & Church	10.00	....
Nov. 27.	Edith Reed	7.25	....
Nov. 30.	F. L. Washburn, traveling and miscellaneous expenses for October and November	102.80	....
Nov. 30.	A. G. Ruggles	83.33	....
Dec. 1.	H. G. Todd	30.00	....
May 8.	E. R. Williams	3.50	....
Dec. 1.	J. A. Schlener	2.00	....
Dec. 1.	Bausch & Lomb Optical Co	1.13	....
Dec. 3.	Standard Oil Co	8.74	....
Dec. 5.	A. I. Root Co	1.20	....
Dec. 31.	H. G. Todd	32.90	....
Dec. 31.	A. G. Ruggles	83.33	....
Dec. 18.	Edith Reed	4.50	....
Dec. 23.	Stamps	20.00	....
Dec. 23.	Express	3.95	....
Dec. 23.	Western Union Telegraph Co	1.45	....
1904.			
Jan. —.	Express and freight	10.24	....
Jan. —.	Western Union Telegraph Co	1.60	....
1903.			
Dec. 28.	A. G. Ruggles, traveling expenses to Hanska	8.75	....

1904.		Amount.	Requisition No.
Feb. 1.	A. G. Ruggles	83.33	....
Feb. 1.	H. G. Todd	23.00	....
1903.			
Dec. 1.	Twin City Telephone Co	1.50	....
1904.			
Jan. 11.	Colt & Co	15.65	2422
1903.			
Dec. 28.	Continental Colortype Co	175.00	2420
Dec. 19.	O. H. Peck Co	13.22	2422
1904.			
Jan. 1.	O. H. Peck Co	12.80	2422
Jan. 8.	O. H. Peck Co	2.23	2422
Jan. 22.	O. H. Peck Co	9.21	2422
Jan. 5.	F. C. Long	4.00	2422
1903.			
Dec. 26.	Andrews & Church	10.00	2422
1904.			
Jan. 27.	W. G. Johnson	1.25	....
Jan. 25.	Art Engraving Co	38.50	2426
1903.			
Dec. 28.	H. G. Doble	8.99	2419
1904.			
Jan. 14.	Southern Printers' Supply Co	2.80	2426 2489
Jan. 6.	J. A. Schlener & Co	3.60	1986
1903.			
Aug. 6.	Southmayd, Ellingson Co	8.84	....
Feb. 1.	F. L. Washburn, traveling and miscellaneous expenses, November, December, 1903, January, 1904	73.85	....
1904.			
Feb. 1.	Twin City Telephone Co	5.30	....
Feb. 12.	Entomological News	3.00	2001
Feb. 29.	Edith Reed	12.90	....
Jan. 26.	Yawman & Erbe	4.05	1986
Feb. 17.	M. V. Slingerland	11.00	2422
Mar. 1.	A. G. Ruggles	83.33	....
Feb. 2.	O. H. Peck Co	1.90	2422 2412 2419
Jan. 27.	N. Y. Entomological Society	2.00	2005
Feb. 2 and 11.	J. A. Schlener	3.50	1986
Feb. 29.	Hope Willis, stenographer	33.45	....
Feb. 16.	Lyman-Eliel Drug Co	2.08	1986
Feb. 16.	Expressage	3.90	....
Feb. 16.	Western Union Telegraph Co	3.32	....
Feb. 16.	Stamps, 10c and 6c, for mailing Annual Report	60.00	....

1904.		Amount.	Requisition No.
Jan. 22.	Concilium Bibliographicum	8.01	1986
Feb. 29.	F. L. Washburn, trip to Duluth, lecture to farmers Lac qui Parle, etc	29.75	....
	Post cards	3.00	....
Mar. 11.	W. M. Simms	7.00	2422
Feb. 20.	James S. Hine	1.50	2427
Feb. 29.	Pioneer Press Co., printing 18,000 copies Annual Report	1,303.58	....
Jan. 1.	H. H. Newcomb	3.00	2001
Feb. 22.	Southern Printers' Supply Co	.45	2427
Mar. 8.	Yawman & Erbe Co	2.38	1986
Mar. 18.	M. V. Slingerland	12.00	2427
Jan. 22.	Art Engraving Co	3.10	2427
Mar. 31.	Hope Willis	30.00	....
Mar. 31.	Express	5.30	....
Mar. 31.	F. L. Washburn, lectures and miscellaneous expenses in Pope, Douglas, Otter Tail and Isanti counties	39.55	....
Mar. 31.	Stamps	10.00	....
Apr. 30.	A. G. Ruggles	83.33	....
Apr. 18.	American Entomological Co	12.60	2428
Apr. 30.	Hope Willis	30.00	....
Apr. 15.	Noyes Bros. & Cutler	1.15	1986
Apr. 19.	Noyes Bros. & Cutler	4.02	1986
Apr. 29.	Edith Reed	19.70	2409 2427
Apr. 11.	The Deming Co	16.58	1986
May 2.	A. G. Ruggles	83.33	....
Feb. 2.	A. C. McClurg	21.45	2427
Mar. 22.	John Schlener	.75	2428
Apr. 6.	John Schlener	2.15	1986
Mar. 27.	American Entomological Co	6.00	1986
	J. A. Vye, express, freight, telegraph, telephone for March	8.49	....
May 28.	A. G. Ruggles	83.33	....
May 11.	John Schlener	1.80	....
Jan. 30.	O. H. Peck Co	4.45	....
May 20.	Interstate Clipping Bureau	1.10	2430
Apr. 21.	J. B. Colt Co	100.70	2427
Apr. 20.	Kny-Scheerer Co	2.00	1986 2412
May 9.	A. Hoen & Co	225.00	2426
Feb. 27.	Bausch & Lomb	.90	....
May 31.	Hope Willis	30.00	....
	J. A. Vye	19.81	....
	F. L. Washburn, traveling and miscellaneous expenses	15.72	....

1904.		Amount.	Requisition No.
June —.	Express	15.80	....
June —.	Western Union Telegraph Co	2.79	....
June 1.	Twin City Telephone Co	3.00	....
May 23.	Bowker Fertilizer Co	5.25	1986
May 24.	Harrison & Smith	6.25	1986
May 31.	W. J. Gerhard	4.00	....
June 6.	Spencer Lens Co	16.00	2430
June 8.	Deming Co	24.30	1986
June 17.	Remington Typewriter Co	1.50	2426
June 23.	Edith Reed, drawings for report	25.40	....
June 30.	Hope Willis	30.00	....
June 30.	A. G. Ruggles	83.33	....
June 30.	F. L. Washburn, traveling and miscellaneous expenses	53.32	....
July 31.	F. L. Washburn, traveling expenses in Rice, Steele, Freeborn, Faribault, Martin, Jackson, Nobles and Rock counties	33.54	....
	W. M. Simms	13.50	1986
June 27.	The Deming Co	2.95	1986
June 6.	James Vick's Sons	7.35	1986
June 24.	Electrical Engraving Co	1.06	2427
July 30.	A. G. Ruggles	83.33	....
June 30.	W. R. Ansell	10.00	2412 2430
July 1 and 16.	E. B. Meyrowitz	16.03	2412 2419 2422
July 30.	Hope Willis	31.00	....
July 2.	Ed. Gruenhagen	2.50	1986
July 21.	H. G. Doble	17.31	....
July 20.	G. A. Hauge	55.00	2430 1986
July 20.	Crane & Co	2.00	2431
July 30.	A. G. Ruggles, traveling expenses in Kandiyohi and Wright counties	7.20	....
July 30.	F. L. Washburn, traveling expenses in Wabasha, Winona, Houston, Fillmore and Freeborn counties	19.51	....
	Western Union Telegraph Co	2.95	....
July 21.	Robert Wedge, work against leaf hopper	25.00	....
June 30.	Kny-Scheerer Co	130.30	....
July —.	Pioneer Press, for Press Bulletin No. 19, $50, and Flour Moth Report, $65.06	115.06	....
		$5,056.41	
Credit by cash received for nursery inspection		101.98	
Total		$4,954.43	

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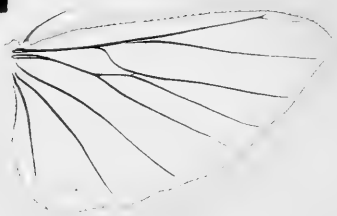

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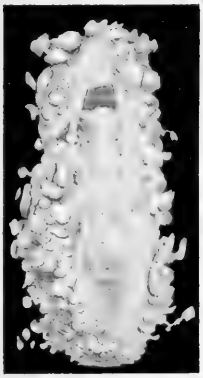

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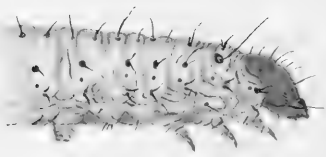

4

EDITH REED, DEL. ET PINX.

A. HOEN & CO., LITH., BALTO., MD.

THE MEDITERRANEAN FLOUR MOTH.

INJURIOUS INSECTS OF 1904.

BY F. L. WASHBURN, State Entomologist.

THE HESSIAN FLY.

This pest, destined to be with us always in greater or less abundance, which was so troublesome last year, has hardly been heard from during the season just closed. An assistant found some July 21st on rye in Kandiyohi county, and rumors of its occurrence in Marshall, Morrison, Big Stone and Lac qui Parle counties reached us during the summer, but there has been practically no injury whatever in Minnesota to wheat this year by this fly. Owing to its very general absence in localities infested last year, we have been unable to secure pupæ ("flaxseeds") in volunteer wheat, as we did last year, showing the occurence of an extra brood in this state. Two lots of volunteer wheat plants, from eight to ten inches high, were sent us in November; one lot from Marshall county and one from Big Stone county, in both of which counties the fly was thought to be present. Several hundred of these plants were carefully examined, but, contrary to last year's experience, we found no puparia.

Why this pest should have been so extremely abundant last year, causing losses variously estimated at from 10 per cent to 50 per cent and in a few cases 100 per cent, and so extremely scarce this year is easily accounted for. Several minute parasites, also insects, attack it, and as the fly became more abundant, naturally, from the practically unlimited amount of food the numbers of the parasites increased, and finally became so large that the fly succumbed, and in the year following the one in which the flies and also their parasites were exceedingly abundant, we see none. But this great reduction in the numbers of the Hessian Fly removes the food of the parasites, and consequently their numbers decrease also, and this gives the fly a new start, its numbers increasing each year, if climatic conditions are favorable, until the culmination is reached in a year when great damage is done, owing to their excessive numbers. The following year, for the reasons given above, but few are seen. We will prob-

ably have a little trouble with them next summer, and still more the summer following.

The life history, remedies and means of prevention of injury of this pest were fully discussed in the Entomologist's report for 1903.

THE FRIT FLY.

Oscinis soror, Macq.

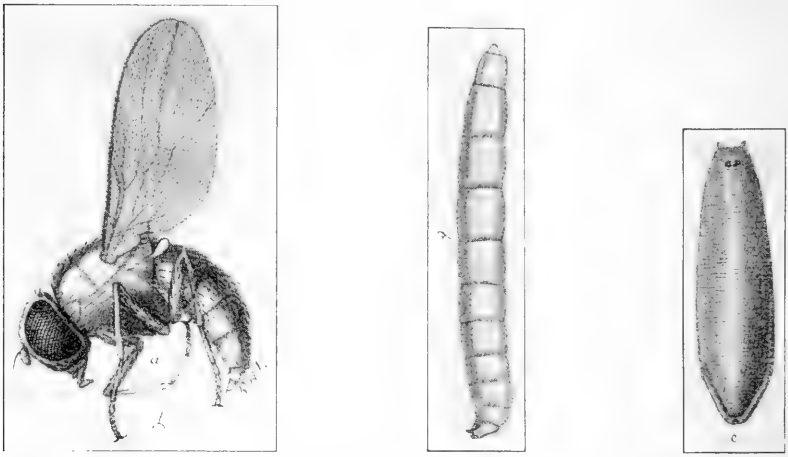

Fig. 1.—Frit Fly: *a*, adult; *b*, larva or maggot; *c*, puparium. Much enlarged. Lugger.

This and the next described species are, without doubt, present in this state. The writer has reason to believe, from various reports of certain injuries to wheat through unknown causes, that both are here in greater or less numbers, though he has not personally met with either one of them.

The Frit Fly, subject of this sketch, is a very small two-winged insect, whose larva or maggot, *b*, is found in the stem of wheat just above the first or second joint. The larva when full grown encases itself in a brown covering, and then resembles somewhat the "flax-seed" of the Hessian Fly. In fact the life history of this pest, and the result of its work so closely resembles that of the Hessian Fly, particularly in the "crinkling down" or falling over of the wheat, that being the first apparent evidence of its presence, that we suspect some of

its work is laid at the Hessian Fly's door. Our illustration will give an idea of the appearance of the larva, puparium and imago or adult insect.

The general remedies given for the Hessian fly will apply in the case of this pest.

THE WHEAT STEM MAGGOT.

Meromyza americana, Fitch.

This insect was reported by Lugger as being abundant here in 1896. In 1895 from 5 per cent to 10 per cent of the crop was ruined in some places, the maggots, according to Lugger, being common from the Red River Valley to the central part of Minnesota. From occasional reports of "white heads" or "bald heads" among the grain this year and last, the Entomologist has every reason to believe they are now with us. These "bald heads" in the wheat are seen when the heads are green, and it should not be difficult for a farmer to tell at once whether the pest is present.

The adult fly is about $\frac{1}{20}$ of an inch long, yellowish, with bronze colored eyes; the back is banded, the underside and legs greenish. The larva or maggot hatching from the whitish egg is pale green, a quarter of an inch long. The transformations are undergone inside the stem.

THE CHINCH BUG.

The Chinch Bug has been conspicuous by its absence this year. Barring an occasional report of a few seen in various localities, no mention of this odorous pest has been made. In Kandiyohi county, on July 21st, we found it working in rye and wheat and in *macaroni wheat*. Early last fall in the Station grounds we found large numbers of dead Chinch Bugs, their demise evidently having been caused by attacks of a fungus, the growth of which was encouraged by the damp weather prevailing at that time. I believe the general prevalence of this condition over the Chinch Bug area in Minnesota has been, in part at least, responsible for our immunity this year. They will be with us again.

In October a report reached this office that a farmer near St. Peter was finding thousands of them on his place, and was killing all he could with kerosene. Inquiry from this office resulted in speci-

mens being sent, which proved to be not Chinch Bugs, but a species of Lug belonging to the same family resembling the Chinch Bug some-

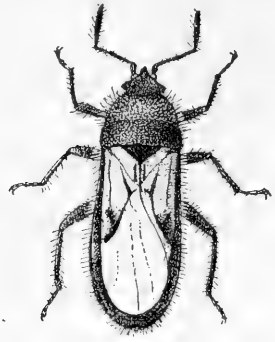

Fig. 2.—Chinch Bug, long winged form. Webster.

Fig. 3.—*Trapezonotus nebulosus*, Fab. Lugger.

what, even having the same bed-buggy odor. This bug is a species of *Trapezonotus*, which feeds for the most part upon weeds, hence is not generally injurious. In some seasons it appears in enormous numbers, filling the minds of the farmers, who think they are the genuine article, with much alarm. We figure a Chinch Bug and a species of Trapezonotus side by side for comparison. Pictures of two other bugs sometimes mistaken for Chinch Bugs are also given,

Fig. 4.—*Lygæus turcicus*, Fab. Lugger.

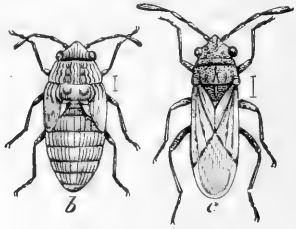

Fig. 5.—*Nysius angustatus*, Uhler. From Riley.

Fig. 4 illustrating *Lygæus turcicus*, and Fig. 5 showing *Nysius angustatus*. The latter is frequently called "The False Chinch Bug" and at times is quite injurious.

The life history of the Chinch Bug and methods of combating it have been fully discussed in our preceding Annual Reports.

THE MEDITERRANEAN FLOUR MOTH.

Ephestia kuehniella, Zell.

Millers have every reason to dread this insect, since it sometimes completely stops the machinery of a flour mill, and when present always calls, sooner or later, for the expenditure of much effort and much money before a mill can be free from its depredations.

The fact that a mill is new is no safe-guard against contamination from returned sacks or the introduction of eggs of the pest in second-hand machinery coming from an infested mill. Nor is a clean mill exempt for the same reason, though regular cleanings have much to do with checking its increase.

In view of the lack of definite information upon this subject among many of our millers, who do not know the best means of fighting the moth, and in consideration of the fact that it is a pest which may appear sooner or later in any flour mill, the Entomologist has included here a chapter on the Flour Moth, fully illustrated, giving its life history, habits, and chief sources of infection, the best remedies and means of prevention.

My predecessor, Dr. Lugger, has never included this pest in any of his bulletins. In April, 1900, he printed in the Northwestern Miller a popular account of the insect, with illustrations. In this article he advised fumigation with bisulphide of carbon, a process which millers do not apparently find satisfactory. Since that time considerable advance has been made in our knowledge of methods of control, which the present report aims to place before the millers of the Northwest. There have been some experiments on the part of the Entomologist bearing upon the effect upon the insect and its eggs of exposure to certain temperatures for a definite length of time, upon the effect of liquid bisulphide of carbon, and of the gas, upon the eggs, and upon the effects upon the larvæ of exposure to a known volume of the gas of C. S_2 for a definite time. The colored plate, excellently true to life, was made under the writer's direction, from actual specimens, as were the original photographs which appear here. The best remedial and preventive measures have been obtained by interviews with practical millers, who have used said measures successfully, the writer

taking the liberty to make certain suggestions as the result of some personal observations and knowledge of the insect's habits. It has seemed desirable also to append short descriptions of some other pests found in flour mills and granaries, most or all of which, when found in mills, are killed by the same treatment which has been found effectual against the flour moth.

Description of Moth, Larva and Egg; Its Life History and Habits.

This moth, named *Ephestia kuehniella*, by Professor Zeller in 1879 in honor of Professor Kuhn of the University of Halle, Germany, is from 2/5 to 3/5 of an inch long, measuring from 3/5 of an inch to 1 inch from tip to tip of expanded wings. Its general color, when freshly emerged from pupa, is blackish gray, the front

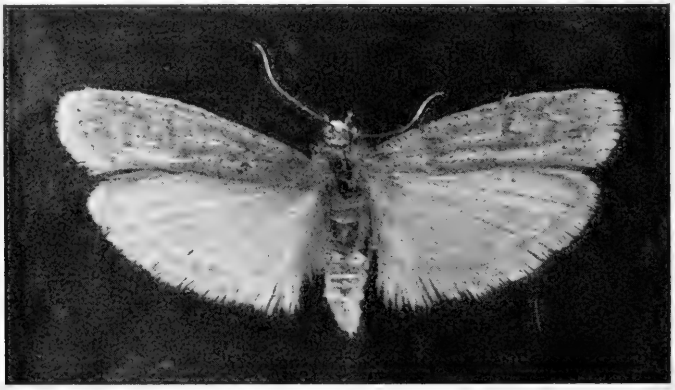

Fig. 6.—Mediterranean Flour Moth, three and three-fourths times enlarged. Original.

wings being gray, spotted with black scales, and irregular, angular black lines crossing the wing near the tips. A characteristic W shaped black line will be noted crossing the wing about half way between the tip and base; see colored plate. Fig. 1 on colored plate represents the moth enlarged three times; Fig. 2, the larva which produces the moth, also three times enlarged; Fig. 3, the pupa found in the cocoon, same enlargement; Fig. 4, the head and anterior segments of the larva to show details, enlarged six times; Fig. 5, the posterior segments to show details, enlarged six times; Fig. 6, the dorsal view of head and thoracic segments, showing details of shield, enlarged six times; Fig. 7, abdominal

foot, twelve times enlarged, showing crown of hooks; Fig. 8, freshly made cocoon, formed in flour, showing larva within, three times enlarged; Fig. 9, one fore wing, showing venation, six times enlarged; Fig. 10, a hind wing, showing venation, six times enlarged; Fig. 11, a freshly laid egg, enlarged twenty-five times. The hind wings are thin, translucent and silvery. Both fore and hind wings are heavily fringed. All the above figures refer to the colored plate, not to the illustrations in text.

The females are a little larger than the males, but the coloration of the wings of both sexes is alike. The females have a characteristic habit, upon emerging from the pupa, of remaining for hours with tip of abdomen and head raised above the level of the rest of the body; see Fig. 15 in the text. Egg laying, which lasts several days, takes place, as a rule, immediately after copulation, each female averaging about 200 eggs. These eggs may be placed anywhere, in cracks, in flour, in spouts, purifiers or other machinery, in sacks containing flour or meal, in any place, in fact, to which the moth has access.

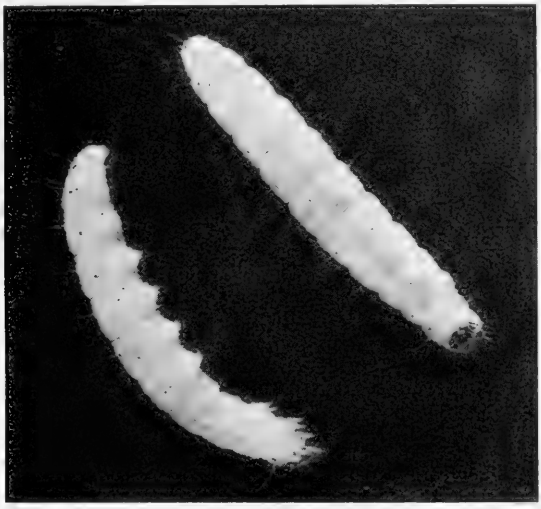

Fig. 7.—Larvæ of Mediterranean Flour Moth, four times enlarged. Original.

The larva, sometimes called "the worm" (see colored plate, also Figs. 7 and 15 in the text), is about 1/25 of an inch when first hatched, from white to pink in color, with a reddish brown

head; a few very small hairs are scattered over the body. The larval life is about forty days, and when full grown it measures from 1/2 to 3/5 of an inch in length. The color becomes more pronouncedly pink than in the young larva. We have noted in the laboratory that individuals vary in color, some even appearing to have a greenish tint. There are six true legs near the anterior end of the body, and four pairs of rather long fleshy legs on the abdomen. With a lense one can see that each one of these abdominal legs is provided with a circle of small hooks at the end (Fig. 7, colored plate). There is also a pair of so-called caudal legs at the extreme posterior end of the larva.

Little blackish or brownish spots, each bearing one or two hairs, are formed over the body, three on a side in each segment. At the anterior and posterior ends, the spots which are lower down on the side are larger and more conspicuous than the others. One spot on each side, just back of the head, is formed by an incomplete ring, its circumference being broken toward the head. A careful study of the colored plate (Figs. 4 and 5) will help one in recognizing these details. Just back of the head (see Fig. 6 of colored plate) is a conspicuous reddish brown plate or shield, divided into two parts by a middle pale line.

The larva has a pernicious habit of secreting a silken thread wherever it goes. When traveling back and forth over a smooth surface this results in a sheet of silken tissue of considerable strength, much like that seen in Fig. 6 in text, which illustrates the work of the worms on a piece of bolting cloth covering a breding jar in our laboratory. When, however, the larvæ are crawling through flour or meal the result is, as many millers know to their cost, a mass of flour held together by countless threads, forming a webbing which clogs spouts, elevator legs and other machinery to such an extent frequently as to completely stop the work of the mill. (See Fig. 10 in text.)

This larva may find its way into a perfectly clean mill in returned sacks, unless said sacks are treated in some way before being placed in mill. Second-hand machinery from an infested mill may harbor larvæ or eggs. When full grown, which takes, as we have said, about forty days, the larva crawls about restlessly until it finds a place to spin its cocoon, about 1/2 inch long, within which it transforms

to a pupa (Fig. 8 of colored plate; see also *b* of Fig. 15). If this cocoon is spun in flour or meal it is matted with the fine particles, as shown in the colored plate. (See also Fig. 9 in text of report.) The pupa is reddish brown, a little less than 1/2 inch long, and about 1/10 of an inch wide. The last segment of the body of the pupa is provided with a few short hairs. The length of the pupal stage within the cocoon is evidently from ten to twelve days.

The time elapsing between laying of egg, hatching of same and transformation of larva into a pupa, and the emergence of the moth, is evidently between sixty and seventy days, or an average of nine weeks for one generation.

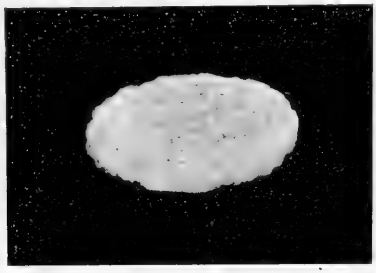

Fig. 8.—Egg of Mediterranean Flour Moth, fifty times enlarged. Original.

The egg, oval in shape, when first laid white and almost smooth, later becoming brownish and wrinkled, is just visible to the naked eye. The eggs hatch in nine or ten days. Two freshly laid eggs, measured in the laboratory, were each .6 millimeters long by .35 millimeters broad, or about 1/42 of an inch long by 1/63 of an inch broad. We figure one of these enlarged twenty-five times on colored plate (Fig. 11). Also same egg in text, Fig. 8, enlarged fifty times.

Eggs, as well as larvæ, may be brought into a perfectly clean mill in infested material, thus sowing the seed of trouble; sacks, barrels, and second-hand machinery from some infested mill being the chief sources.

One female which we had under observation in the laboratory at St. Anthony Park began egg laying February 9th, continuing until and including February 14th, five days, laying during that period 247 eggs. Copulation lasts a long time and evidently one

female may mate with several males, laying eggs between the different matings.

As regards the food habits of this insect; rice flour is a dainty dish for the larvæ, as is flour made from buckwheat. Any infested mill which keeps flour in sacks before shipping may hear sooner or later from the consumer or retailer that "the flour is wormy." This is caused by the female moth pushing her ovipositor through the sack and laying her eggs in the flour inside. Crackers, germea, rolled wheat, oatmeal and corn meal are all said to suffer.

The moth is evidently a continuous breeder in warm localities, in warm mills for instance. It is a well known fact that cold retards and warmth hastens its development, millers sometimes taking advantage of the first point to keep the pest in check.

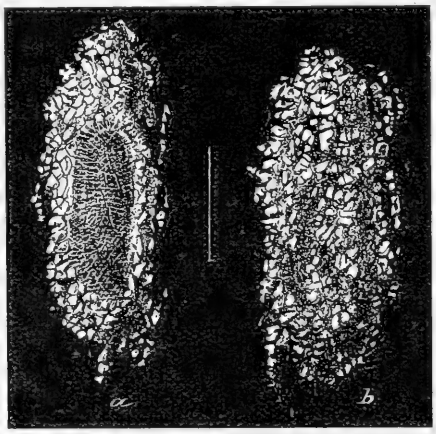

Fig. 9.—*a*, cocoon from below showing pupa through the thin silk attaching cocoon to some surface; *b*, same from above, enlarged.—Riley and Howard in Insect Life.

Dr. Fletcher of Canada, says in connection with the outbreak there, that there are probably two normal broods, one in the spring, another in the autumn, but he thinks he raised as many as three distinct broods in a warm room during the winter. F. H. Chittenden, of Washington, claims that in the warmest weather in that locality the life cycle occupies only five weeks.

Preventive Measures.

Cleanliness:

Because a mill is clean or new is no reason why the moth cannot be introduced, if sacks containing eggs or larvæ, or second-hand machinery from an infested mill are allowed to enter. At the same time, scrupulous cleanliness has much to do with immunity, for eggs and larvæ are dislodged by processes involved in the term, and not allowed to develop. Every mill, it would seem, should, and many do, have cleaners or sweepers, whose sole duty

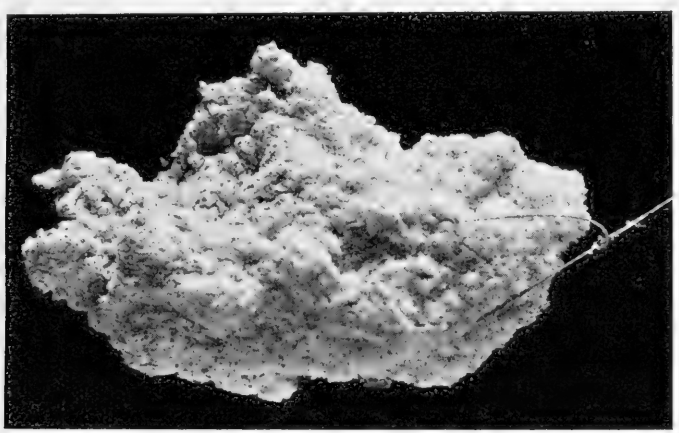

Fig. 10.—Flour matted together by web spun by larvæ, one-half natural size.—Lugger.

it is to see that every floor and all machinery, purifiers, spouts and elevators are kept clean. Naturally such an employe or employes should have some knowledge of insects found in flouring mills.

Fumigation House:

The writer is convinced, from talking with millers who have had experience with this pest, that the chief source of contagion lies in receiving into the mill returned sacks, and also second-hand machinery from an infested mill, which may harbor the eggs or

larvæ. Some mills, in order to avoid infection, will not take back old sacks. If a milling company must do this *such material should be thoroughly treated before being allowed in the mill.* A fumigation house, or room, might be constructed, where sacks or machinery could be fumigated. If sacks have been in transit for more than nine days, and during that time free from all sources of contagion,

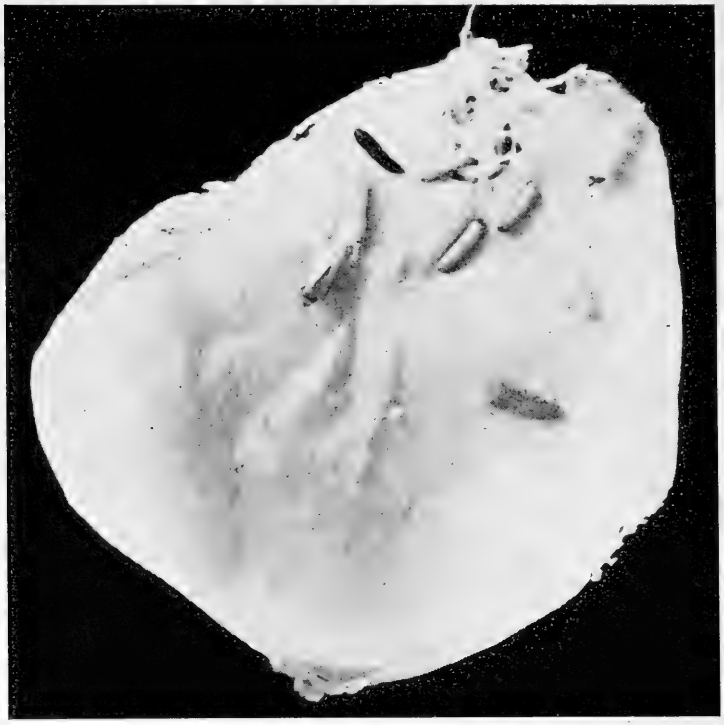

Fig. 11.—Silk felt spun by larvæ in crawling across bolting cloth on top of breeding jar; showing also larvæ, pupa, cocoons, and moths somewhat reduced. Original.

all eggs which may have been originally in the package have hatched, hence, one need not seek for a treatment which will kill them (the eggs), but only for such as will kill the worms which have hatched from the eggs. Carbon bisulphide is the best and safest fumigating material at our disposal, and could be well used

in this instance. The gas generated by this liquid, when mixed with air, is highly explosive, and no lighted match or lamp, or lighted cigar or pipe should be brought near it. As it is definitely known just how much of this liquid is required to create a "death atmosphere," the cubical contents of this room, or better, house, should be accurately determined. From experiments tried with this gas by the writer, he would suggest one part of liquid for every one thousand parts of atmosphere. To determine, if possible, whether this strength of gas would penetrate to the center of the bale in killing quantity, the Entomologist inclosed "worms," pupæ, and moths in vials loosely stoppered with cotton. These vials were placed in a flour sack, which was tightly rolled up. This bundle was placed in a second flour sack, which in turn was tightly rolled, and the package placed in a burlap sack and rolled again. This compact bundle with the worms in the very center was then exposed for three days, in a tight iron box, to fumes of carbon bisulphide, one part of the liquid to 1,000 parts of atmosphere. This killed every "worm," pupa and moth. The fumigation house or room *must be absolutely tight to retain the gas.* The liquid should be placed in shallow trays, and the room closed for at least three days if the sacks are left in the bale. A longer time than that, under such conditions, would be highly desirable. If the worm cannot be reached in the bale by fumigation for three or five days with the above strength, millers should be willing to open up the bales. This involves extra handling, and means added expense, but might be an imperative necessity, for *work not thoroughly done in this connection represents time and money thrown away.* After fumigation the house or room should be thoroughly aired before allowing a light of any kind inside.

The gas from bisulphide of carbon will sink through a mass of wheat in a large bin, and also through a chestful of woolen clothing, if in each case the liquid is placed in shallow dishes on top of the wheat, or clothing. It is probable, therefore, that it will penetrate a loose bale of sacks. Possibly heat alone might be profitably used in this connection.

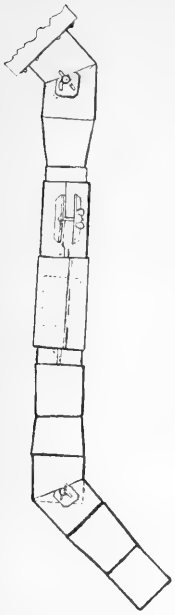

Fig. 12.—Adjustable metal spout. —From W. G. Johnson's Report.

Cylindrical Metal Spouts:

L. C. Schroeder of Olean, N. Y., has invented and patented a metal spout, shown in Fig. 12, which is reported as giving satisfaction, since it presents a smooth surface within, and no corners, thus being a great improvement, as regards the flour moth, over the wooden spouts which afford such an excellent opportunity for the larvæ and the laying of eggs. It is claimed that the metal spouts cost less than those made of wood. This principle, for reasons which will at once be obvious to practical mill men, cannot well be applied to the elevator legs, although it is said that the same party has patented a metal elevator leg.

Belt Brushes:

Since metal elevators cannot be economically introduced into our mills as they are now constructed, an excellent device for keeping the wooden elevators clean, if we are to believe statements of those who have used them, consists of an elevator brush as shown in Fig. 13, constructed as follows:

"To make the brush, take a piece of 1 1/2-inch plank of the same dimensions as the elevator cups, and fasten bristles to three sides. The side A is fastened to the elevator belt with flat-headed bolts running through the plank, as shown at B, B, the bolts being 1/4 or 3/8 of an inch. The bristles on the sides C, C should be 3/4 of an inch long, but those at D should be longer, so that they will give a good brushing to the outer side of the elevator. The brush is easily made, and the miller can make it of any size to fit his elevators."

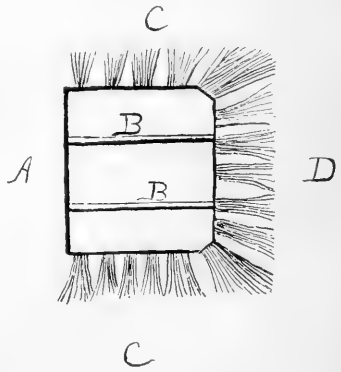

Fig. 13.—Elevator Brush.—From W. G. Johnson's Report.

Co-operation:

Co-operation on the part of all millers, particularly where mills are in the same district, *seems absolutely necessary.* If one fumigates returned sacks, and goes to the expense of freeing his mill of this pest, all should. Otherwise, moths from the untreated mills are almost sure to enter a cleaned mill, rendering the work of the more careful miller, in this connection, of little value. Screening windows and doors might be resorted to, and form at least a partial protection, though occasioning additional expense. Observations at the Experiment Station indicate that the moth cannot pass through the mesh of ordinary wire mosquito netting (144 meshes to the square inch).

Freezing:

This most excellent and inexpensive method is available for Minnesota millers during almost any winter. The spouts, elevator legs, purifiers and all machinery should be first freed from masses of webbed flour, etc., left open (this does not mean the unscrewing of the sides of the elevator legs or spouts), and then all windows thrown open for a period of four or five days, after which windows should be closed and heat turned on. The importance of exposure to heat after the freezing must not be underestimated. The owners of one infested mill stopped their machinery this winter, opened all machines, spouts and elevators to allow access of cold air, and then kept their windows open for a period of four days. This was done in a time of extremely severe weather, the thermometer ranging at the time from ten degrees below zero to thirty-two degrees below, the average temperature of the mill during that period being five degrees below zero. At the expiration of this period windows were closed and heat turned on. Some larvæ ("worms") and moths collected, and, subjected to examination for several days, did not revive, killed by the extreme cold, aided possibly by the sudden change from warm to cold and cold to warm. Eggs subjected to the above freezing, and kept under observation for fifteen days and over, did not hatch; nor did the weevils, and other pests found with the Flour Moth, survive this treatment. These statements were made to the writer; they are not his observations.

However, while millers in Minnesota can secure at some time, during almost any winter, a temperature sufficiently low to kill by freezing, yet such a condition is not always present, even in Minnesota, when wanted (if outbreak occurs in early spring and summer for instance), and surely millers in the South could rarely, if ever, take advantage of this method. The bisulphide method (not fumigation) must of necessity have to be resorted to, when temperature conditions are not favorable for freezing.

In one or two mills subjected to this freezing process fire had to be kept in the basement, and a sufficiently low temperature could not be secured, the treatment in consequence resulting unsatisfactorily. See also results of experiments by the Entomologist on pages 29 and 30. In one mill, however, where the entire mill was exposed to severe cold for eight days or more, the process was an absolute success. It must be noted, however, that if millers in close proximity do not co-operate in work against this moth, the pest will reappear even if it is to all appearance eradicated from a mill. Further, as noted below, eggs are not always killed by low temperature.

Observations and Results of Experiments by the Entomologist.

Mating and egg laying; time elapsing between laying of egg and hatching of same.

Pairing is evidently protracted, one isolated pair under observation remaining *in copulo* four days. Ovipositing in one case lasted six days, a female beginning egg laying on February 9th and continuing until the 15th, on which date she died. During this time *the one female* laid 247 eggs. These eggs began hatching on the 18th, nine days after the first were laid, a recording thermometer registering an average temperature of 70 degrees Fahr. in the room during that time. Two freshly laid eggs were measured, each measuring .6 millimeters in length by .35 millimeters in breadth, or, in round numbers, 1/42 of an inch long by 1/63 of an inch in breadth. Three other laying females deposited respectively 242, 157 and 239 eggs.

The flight of the Moth: The question as to whether moths would fly from one mill to another suggested observations along this line. The insects if left to themselves did not fly in the morning. Late in the afternoon and in the evening after the light was turned on, an assistant reports them flying freely across the room, although not attracted to the lights, but rather avoiding them. Observations elsewhere indicate that they will fly at least 110 feet, and probably farther.

Can the Moth get through wire mosquito netting? Moths confined for several days in a cage made of wire netting, 144 meshes to the square inch, did not escape, dying within the cage.

Effect of liquid Carbon Bisulphide on eggs, larvæ, pupæ and moths: One contact for a few seconds with this liquid killed eggs, young and full-grown larvæ and moths. The pupæ were not killed immediately, but died later.

Least volume of Carbon Bisulphide (CS_2) and least time of exposure necessary to kill full-grown larvæ and moths by fumigation:

Condition of Insect.	Strength of Gas.	Time Exposed	Results.
Full-grown larvæ..	1 Part liquid CS_2 to 1,500 parts atmosphere	1 hr. 40 min.	Killed.
Full-grown larvæ..	1 Part CS_2 to 3,000 parts atmosphere..	1 hr.	Killed.
Full-grown larvæ and moth.....	1 Part CS_2 to 6,000 parts atmosphere	2 hrs.	Killed.
Full-grown larvæ and moth.....	1 Part CS_2 to 12,000 parts atmosphere.....	3 hrs.	Killed.

Effect of exposure of moths, eggs, larvæ and pupæ to known low temperatures for definite lengths of time:

Lot No. 1. Exposed out of doors in breeding jar, for three days, to a temperature ranging from 18 degrees above to 12 degrees below zero. All killed.

Lot No. 2. Placed in cold storage at 32 degrees for four days. Living at expiration of that time.

Lot No. 3. Placed in cold storage at 14 degrees above zero for four days. A few worms survived.

Lot No. 4. Placed in cold storage at 6 degrees for four days. "Worms" survived.

Lot No. 5. Placed in cold storage at 1 degree above zero for four days. All killed.

Lot No. 6. Placed out of doors for four days, temperature ranging from 18 above to 21 below zero. One or two worms survived.

It would seem, then, from the above, and from the experience of millers cited on page 28, that the "freezing process" to be thoroughly effective must be most thorough. Mills should be so constructed that all water pipes can be emptied, allowing all parts of the mill to get extremely cold. Further, since we know that a long continued even cold temperature is not always fatal to insects (note the hibernation of Minnesota insects, for example), but that exposure to cold and thawing alternately is fatal, we would suggest that millers in this

work arrange to alternate the extremely cold temperature with warm, that is, after the first exposure to cold for a few days, allow the mill to become warm and follow this with another cold exposure. Repeat the operation two weeks later. The above lots, Nos. 1 to 6, were masses of matted flour containing the worms, the latter being thus somewhat protected.

The Entomologist also tried the following experiments:

EGG.

Effect of exposure to fumes of Carbon bisulphide.

- Exposure to fumes of CS_2 (1 part liquid CS_2 to 10000 parts atmosphere) for 42 hours failed to kill eggs.
- Exposure to fumes of CS_2 (1 part liquid CS_2 to 1000 parts atmosphere) for 42 hours failed to kill eggs.
- Exposure to fumes of CS_2 (1 part liquid CS_2 to 5000 parts atmosphere) for 6 hours failed to kill eggs.

Effect of exposure to fumes of Carbon bisulphide.

- Exposure to fumes of CS_2 (1 part liquid CS_2 to 5000 parts atmosphere) for 12 hours failed to kill eggs.
- *Exposure to fumes of CS_2 (1 part liquid CS_2 to 5000 parts atmosphere) for 24 hours failed to kill eggs.

Effect of Low Temperature.

- 6½ days' exposure to 12 degrees above zero did not kill all the eggs.
- 6½ days' exposure to 3 to 5 degrees above zero killed all eggs.
- 36 hours' exposure to 3 to 5 degrees above zero killed all eggs.
- 36 hours' exposure to 3 to 5 degrees above zero failed to kill all the eggs.

These eggs were kept under observation for two to three weeks. In every case control sets were preserved.

LARVÆ or "Worms."

Effect of exposure to fumes of Carbon bisulphide.

- *Exposure to fumes of CS_2 (1-5000) for 24 hours killed larvæ.
- Exposure to fumes of CS_2 (1-10000) for 42 hours killed larvæ.

Effect of Low Temperature.

- 6½ days' exposure to 3 to 5 degrees above zero killed larvæ.
- 6½ days' exposure to 12 degrees above zero killed larvæ.
- 36 hours' exposure to 3 to 5 degrees above zero ("worms" just hatching) killed larvæ.

Newly hatched larvæ will live from two to three days without food.

PUPÆ.	
Effect of exposure to fumes of Carbon bisulphide.	*24 hours' exposure to (1-5000) killed pupæ.
Effect of Low Temperature.	6½ days' exposure to 3 to 5 degrees above zero killed pupæ. 6½ days' exposure to 12 degrees above zero killed pupæ.
MOTHS.	
Effect of exposure to fumes of Carbon bisulphide.	*24 hours' exposure to (1-5000) killed moths. 6 hours' exposure to (1-5000) killed moths. 42 hours' exposure to (1-10000) killed moths.
Effect of Low Temperature.	6½ days' exposure to 3 to 5 degrees above zero killed moths. 6½ days' exposure to 12 degrees above zero killed moths.

CONCLUSIONS AND SUGGESTIONS.

From the result of these experiments, the following conclusions are drawn:

Spraying eggs, larvæ, pupæ and moths with liquid CS_2 is fatal.

Attempting to kill eggs by exposure to fumes of CS_2 is apparently not practical. Hence when fumigation of a mill is resorted to (unaccompanied by spraying) the process should be repeated ten days or later after first fumigation in order to kill the larvæ hatching from eggs which went safely through the first fumigation.

Full grown larvæ and moths (and probably pupæ) can be killed by exposure for 42 hours to fumes of CS_2 (1 part liquid CS_2 to 10000 parts of atmosphere).

Larvæ, pupæ and moths in the center of tightly baled sacks can be killed by 24 hours' exposure of fumes of bisulphide of carbon (1 part liquid CS_2 to 5000 parts of atmosphere). Forty-eight hours' exposure where possible would be the preference of the writer. Fumigation is, therefore, practicable treatment for infested sacks in bale.

*In this experiment, eggs, larvæ, pupæ and moths were enclosed in the very center of a tightly packed bale of flour sacks before being placed in fumigation box, simulating as nearly as possible the conditions which would exist in fumigating sacks in bale. As noted, this kills moths, pupæ and larvæ, but not the eggs.

An exposure of 6½ days to a temperature of 3 to 5 degrees above zero kills eggs, larvæ, pupæ and moths. In view, however, of certain experiments in mills where there are many protected corners and cracks, and where eggs, worms and pupæ are found in matted flour, any attempt to use the "freezing process" in a mill calls for from six to eight days' exposure to a temperature as low as it is posible to obtain, certainly as low as zero in every part of the mill, to be perfectly successful. As intimated above, if alternate freezing and thawing, followed immediately by a second freezing, can be secured, the best results will be obtained.

Spraying with Bisulphide of Carbon.

This method, which has been very successfully practiced, consists in forcing the liquid by a syringe made for the purpose into all the machinery infested, inside of spouts, etc. Parts of the mill or fittings which do not come in contact with grain or products made from same can be well treated with kerosene, squirting it into cracks between joists, and into cracks between joists and iron braces, into cracks about windows, along baseboards, and into cracks in floor, walls and ceilings. It is evident that this must be done most thoroughly to reach all eggs or worms concealed in such places. Fig. 14 represents a syringe used for spraying the bisulphide or kerosene. It may be made of iron pipe, of brass, or of tin. It is eighteen inches long, two inches in diameter, and will hold, at those measurements, about one quart. The rose is detachable, unscrewing from the barrel, and it (the rose) is filled on the end with many very small holes, as small as the finest needle, in order that the liquid may not be wasted. In filling the syringe the rose can be unscrewed and the end of the syringe immersed in the can holding the bisulphide, or, and this is much better, a little hole covered by a screw cap, not shown in the illustration, may be made on the side of the rose and the liquid drawn in through that. This is by far the best plan, for when the rose is unscrewed and the liquid drawn into the syringe it necessitates the holding of the filled barrel upright in order to screw on the rose, under which circumstances the liquid will run out below, near the handle, unless the piston rod fits very snugly.


Fig 14.

When the syringe is used with kerosene, the rose is unscrewed and a small nozzle with one aperture, considerably larger than the holes in the rose, put on in its place. This is used when treating cracks in floors, etc.

Before the work with carbon bisulphide or with kerosene is begun, elevator legs, spouts, purifiers and all infested machinery must be thoroughly cleaned, in other words freed from all matted flour. When the spouts are lined with tin, affording a retreat for the worms beneath the tin, the wooden sides must be removed to get at the culprits. Swabs of cotton waste or pieces of old sacks should be run through the elevators (stuffing these swabs into cups), taking off caps of elevators and having men, stationed at the top, take out the ascending swabs when they reach them, and put in other swabs in the descending leg. The elevator brush, Fig. 13, might be well used in this connection, or brushes made from the same material as the belting, frayed on three sides and riveted to cups. All conveyors should be taken out and thoroughly cleaned. Purifiers and reels and insides of conveyor boxes, all machinery in fact, should be thoroughly sprayed with carbon bisulphide after having been cleaned. The cloth tubes on dust machines should be burned. In treating elevator legs with carbon bisulphide, the same method can be used as in cleaning, described above, saturating the swabs with the liquid. A swab should take up about one pint of the liquid.

All this means the expenditure of time, and money for material. An ordinary sized mill may, in this process, use from 1,000 to 1,500 pounds of carbon bisulphide, or even more, to say nothing of the large amount of kerosene employed. We are reliably informed that bisulphide of carbon can be purchased for 6½ cents per pound of a dealer in New York City and St. Louis. This price does not include container, credit for which is allowed upon its return.

Caution: The gas generated by bisulphide of carbon is inflammable. Therefore, while it is being used and until the mill has been thoroughly aired after treatment, **no light of any kind should be allowed in the mill. A lighted cigar or pipe, lantern, or lighted match, if brought into the mill when filled with gas, might cause an explosion.**

Effect of the Gas on Human Beings: This liquid can be safely handled by workmen in the mill if they will take the precaution to go at once into the open air when they feel any bad effects from inhaling the gas. The mill, during this process, should be tightly closed to make the work more effective, and in consequence is filled with fumes. If these fumes are inhaled by the men for some length of time without the precaution above mentioned of going frequently to the fresh air, temporary nausea and sickness may result, while prolonged exposure to dense fumes in a tight room might result very seriously. Nature, however, gives one warning in plenty of time to avoid danger. Then, too, in a case which came under the writer's observation, men working with the stuff became more or less immune, and one individual was hardly affected at all.

As is evident, the treatment of a mill in this way should be in charge of a reliable and competent man of intelligence, one fully posted as to the nature of the chemical his men are handling.

Methods Which Have Been Tried and Found Ineffective or Less Desirable than the Preceding.

Fumigation with Bisulphide of Carbon: Although this has been the common practice in the past, and is generally recommended in cases of attack of this insect, actual experience with its use does not bear out the recommendation, in that it does not appear to kill the moths or worms under the conditions which prevail in almost every mill. It may be effective against other insect pests with which flour mills are troubled, thus giving rise, from published report, that it is effective also against the Mediterranean Flour Moth, but we know of at least three instances where it was tried in large mills and proved valueless.

The process consists in placing pans of carbon bisulphide on the different floors, using a definite amount of the liquid (about one part to every one thousand parts of atmosphere), first making the room as tight as possible, opening up all spouts, spindles and other apparatus in which the moth or its larva is found. The chief obstacle here is the almost utter impossibility of making the large rooms air tight. Then, too, as evidenced by the testimony of a Pennsylvania miller a few years ago: "When placed in plates it

does not evaporate quickly enough to produce the death atmosphere required." This firm used three hundred soup plates half filled with bisulphide and distributed throughout the mill, besides saturating balls of cotton with the same and placing them in all reels and purifiers. The mill was left from Saturday night to Monday morning, and although thousands were found dead, many thousands more appeared from cracks and corners after a few days.

Sulphur: The burning of sulphur not practical, besides injuring the flour in sacks in the mills.

Steam: Not practical, requiring too elaborate preparation, and too frequent application; seriously injuring grain or flour, and rusting machinery.

Kerosene: Good for washing walls, machinery, floors, etc., where it cannot injure flour or grain. See reference to kerosene on page 32.

Solution of Soda and Water: Used strong for washing inside of machines.

Buhach, or Persian Insect Powder: Has been burned in a mill with only partial success, and expensive.

Ammonia: Not successful.

Hydrocyanic Acid Gas: Coming quite generally into use. Placed in this list on account of danger of application unless in the hands of experienced parties. Deadly to all animal life. Prof. W. G. Johnson, author of "Fumigation Methods," says he has freed a number of mills of the Mediterranean Flour Moth by the use of this gas.

Corrosive Sublimate: Not desirable.

Lime: Whitewash to which a little glue has been added excellent for ceilings and walls; the tendency to rub off can be stopped, it is said, by adding a handful of common salt, and a half teacupful of lard to each gallon of wash, which should be thoroughly strained before being used.

Sulphuric Acid: Not recommended.

Tobacco: Not particularly effective, either as smoke or infusion.

Flour Paste: Compound of flour, water and vinegar and boiled by steam found to attract insects when paste was at a certain stage of fermentation. Moths fall into paste and perish. Too expensive, and has to be renewed every few days.

Vinegar and Water: Not desirable.

Molasses and Vinegar: Will attract and destroy some moths.

"Tanglefoot" or Sticky Fly Paper: Something like the sticky mixture used to coat Tanglefoot fly paper can be made without much expense. Hundreds of moths have been caught in a single night on sticky fly paper. The paper should be placed in such places as are frequented by moths for egg laying, notably on piles of sacks filled with flour, etc. It is evident that if one can catch many female moths before egg laying, the process is well worth the expense incurred, and is a desirable measure.

Coal Tar: Not desirable.

Coal Tar and Vaseline: Better than coal tar alone. This and preceding used in the same manner as "Tanglefoot."

Hand Picking: Not feasible.

Hay Ropes: A German miller is the authority for the statement that ropes of new mown hay placed about the mill in coils afford attractive retreats for the moth. These coils were burned with the contained moths each week.

High Temperature: Exposure to a temperature of 120 to 130 degrees Fahr. for two or three hours is claimed to be fatal to the larvæ in the flour, and the same temperature for five or six consecutive hours is said to kill the eggs. This may prove of practical utility.

Natural Enemies of the Flour Moth.

Mr. Johnson describes in the American Miller for November, 1895, the discovery of one parasite in America, *Bracon hebetor*, Say. In Europe *Bracon brevicornis* and *Chremylus rubiginosus* are mentioned as parasites. In 1901 and 1902 Dr. Fletcher bred two parasites from the Flour Moth, *Idechthis ephestiæ*, Ash., and one unnamed. Poultry, seemingly fond of the "worm," has been kept in warehouses with some good effect, though the hens appeared to tire of the diet. Mr. Johnson records the eating of a large number of pupæ by a mouse, but no millers care to introduce mice into their mills for this purpose. Mice, as all entomologists know, readily eat insects, whether alive, or dead and pinned.

Tribolium confusum, a little brown beetle, a common pest in flour mills, and discussed in this connection elsewhere in the report, has been known to devour the pupæ of the flour moth.

The so-called "bolting-cloth beetle" (*Tenebroides mauritanicus*) of California eats larva and pupa of flour moth and larva and adult of *Tribolium*.

History of the Moth and Its Geographical Distribution.

The origin of this pest cannot be stated definitely. It is probable that it always has been a widespread species, but not arousing attention until, atracted by flour and related products in mills, it changed its habits and became prominent as a menace to the flour milling industry. When first named by Zeller it was supposed by him to have been introduced from America, and it was so stated, but it was found by him in an inland town of Germany, Halle, before he knew of it at any seaport, and the same thing could be said of its first officially reported appearance in France. One miller has said with emphasis that he knew of its occurrence in Paris as early as 1840, and another claims that it was in Constantinople in 1872, both statements, coming from different sources, affording additional proof that it is not of American origin, where it was not officially reported until 1889 (Canada). There is evidence that it was in America a few years previous to this date, not, however, until long after it was known in Europe. In 1885 it was declared to be a dreaded pest in many Mediterranean ports, though no statement was made as to how long it had existed in those places. It is reported from Chili, from Mexico, New Mexico, from the island of Jamaica, and in 1890 what was evidently this species was reported from South Africa. A practical miller, who has since had experience with the pest in California, asserts that it was in Schleswig-Holstein, Germany, in 1858, although the first recorded observation from Germany is in 1877. Freight cars and ships may easily be the means of carrying it, either as egg, worm or moth, to regions remote from the scene of its earlier appearance.

It would be impossible to review in this publication the extensive literature upon this pest, nor is it necessary to list the bibliographical references. In order, however, to give an idea of its spread which is approximately correct, we list the following dates taken chiefly from Johnson's bibliographical list, and under each date insert the locality or localities where the moth appeared that

year, as far as reported. In some instances, the outbreak may have been one or two years preceding the report.

1877.

Outbreak at Halle, Germany.

1879.

Outbreak of 1877 referred to and insect named by Zeller.

1884.

Belgium. Supposed then to have been introduced in an American cereal. Reported also on lower Rhine.

1885.

Reported at Bremervörde, Germany.

1886.

Appeared in England.

1887.

London. Trieste. In the 39th Annual Report of New York State Museum of Natural History, J. A. Lintner publishes his reply to an inquiry of the German consul general at New York City, asking for information about the Flour Moth. He states that he (Lintner) knew of no such insect in America. This is believed to be the first published statement in America regarding the pest.

1888.

T. D. A. Cockerell in the Entomologist for November, 1888, page 779, declares that certain larvæ found in flour which came from America may have come from infested Trieste flour in the same warehouses.

1889.

First report of its occurrence in North America, in Canada. May have been present a few years earlier. Reported as being in very destructive numbers in England.

1890.

Still present in England and spreading. A pest reported from South Africa which, from its habit, must have been this insect.

1892.

California.

1893.

On the increase in California.

1894.

Still present in California. Reported from New York State, from North Carolina, and said to have been found in meal and bran from Mexico on exhibition in Chicago.

1898.

New York State. Pennsylvania. (Reported as having been present there for three years.) New outbreak in Canada.

1899.

Wisconsin.

1900.

Wisconsin.

1901.

Minnesota.

1903.

Minnesota.

1904.

New localities reported in the following states: California, New York, Indiana, Illinois, Iowa and Pennsylvania.

The Flour Moth is found, in addition to the above localities, in Colorado, Montana and other states; it is, in fact, of very general distribution.

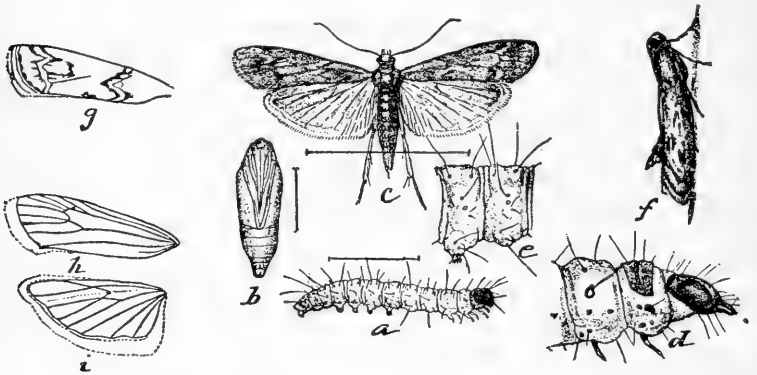

Fig. 15—Mediterranean Flour Moth; *Ephestia kuehniella*, Zell.: *a*, larva; *b*, pupa; *c*, adult, enlarged; *d*, head and thoracic joints of larva; *e*, abdominal joint of same, still more enlarged; *f*, moth from side, resting; *g*, front wing, showing more important markings; *h*, venation of fore wing; *i*, venation of hind wing, somewhat enlarged. (*a*, *b*, *c* and *e*, Riley & Howard in Insect Life; *d*, *f*, *g*, *h* and *i*, after Snellen.)

SOME OTHER INSECTS FOUND IN FLOUR MILLS OR AFFECTING STORED GRAIN.

Many of the following insects are also found in flour mills, and are frequently spoken of collectively as "weevils," which term is also sometimes, though not often, applied to the Mediterranean Flour Moth. That this is a wrong appellation is evinced by the fact that only two of the insects listed below are true weevils.

Treatment which is successfully directed against the Flour Moth will kill any of the following insects, when occurring in the mill treated.

The Granary Weevil.

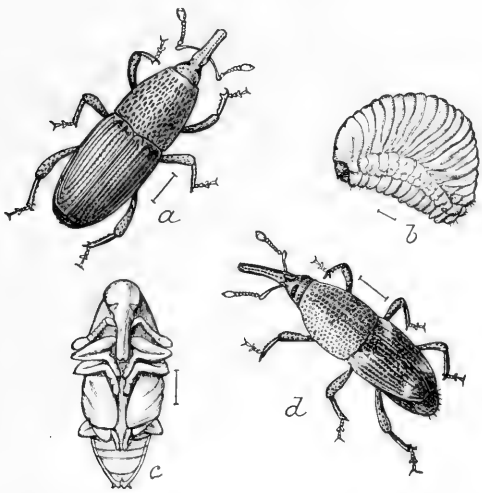

Fig. 16.—*a, b, c,* different stages of the Granary Weevil (Calandria granaria), *d,* Rice Weevil (C. oryza).—F. H. Chittenden, Division of Entomology, U. S. Department of Agriculture.

Fig. 16 illustrates this species and its congener, the Rice Weevil. The hair lines by each show the natural size of the insect. The female Granary Weevil punctures a grain of wheat with her snout and lays an egg in the opening, the larva after hatching feeding upon the interior of the kernel. There may be from four to six broods of the Granary Weevil during the year, depending on the temperature. It is estimated that one pair, under favorable circumstances, will produce six thousand descendants in a year. This beetle is of a shining brown color. It cannot fly. Its cousin, the Rice Weevil, is a dull brown, its back provided with four reddish spots. It has well developed wings. In the southern states this latter weevil is a serious pest.

The Angoumois Grain Moth.

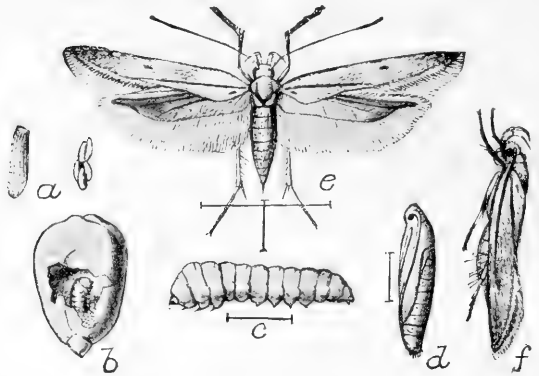

Fig. 17.—Angoumois Grain Moth, *Sitotroga cerealella*: *a*, eggs; *b*, larva at work; *c*, larva, side view; *d*, pupa; *e*, moth; *f*, same, side view.—F. H. Chittenden, Division of Entomology, U. S. Department of Agriculture.

This pest is shown in Fig. 17. It is named from a province in France, where is has been known since 1736. It is claimed to have been found in America since 1728. More injurious in the South than in the North, it attacks not only wheat in the field and bin, but is partial to all the cereals. It is a brownish moth, resembling in a general way the Clothes Moth in size and appearance.

The Indian Meal Moth.

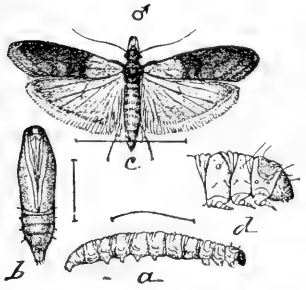

Fig. 18.—*Plodia interpunctella*: *a*, larva; *b*, pupa; *c*, adult male, enlarged; *d*, head and thoracic joints of larva, still more enlarged.—Riley and Howard in Insect Life.

This insect, resembling somewhat the Mediterranean Flour Moth, not only feeds upon grain, flour, meal and bran in mills, but is seen in stores and elsewhere, where it affects spices, herbs, roots, seeds, dried fruit, etc.

The larvæ or "worms" which produce these moths fasten together the kernels of grain, or the seeds or other material upon which they are feeding, with silken threads. These masses, fouled with their excrement, greatly impair the value of the infested foodstuffs. It is said to have from four to six or nine broods annually, depending upon the temperature of the rooms where it is found. It is shown in its various stages in Fig. 18.

The Meal Snout Moth.

This is a brownish moth, having darker brown patches at the outer edges of the front wings. Fig. 19 gives a very good idea of its appearance; the wavy white lines bordering the dark spots

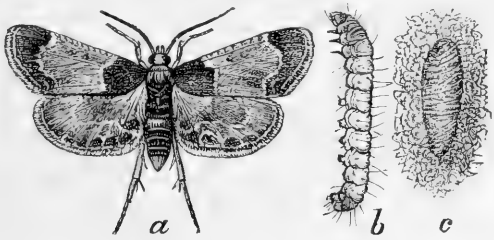

Fig. 19.—*Pyralis farinalis*: *a*, adult moth; *b*, larva; *c*, pupa in cocoon, twice natural size.—F. H. Chittenden, Division of Entomology, U. S. Department of Agriculture.

are characteristically striking. The larva makes tubes of silk, to which kernels of grain (if the worm is working in grain) adhere. (See Fig. 20.) Grain kept in dry and clean places is not likely to be affected.

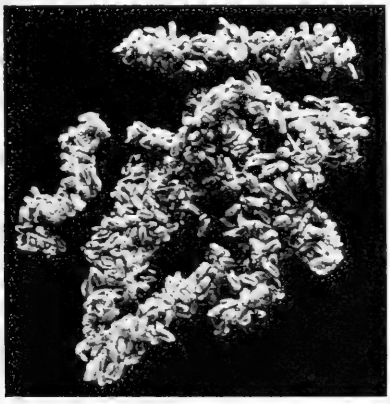

Fig. 20.—Silken tubes covered with wheat made by larvæ of *Pyralis farinalis*, half natural size.—Lugger.

The Confused Flour Beetle.

The accompanying figure (21) gives an excellent idea of this little pest, common enough in our flour mills. The beetle is dark brown, and practically omnivorous, attacking, according to Chittenden, flour, baking powder, red pepper, beans, peas, rice chaff, ginger, slippery elm, nuts and seeds of various kinds. We have

found it attacking dried insects in our cabinets. Like the other insects under discussion, a high temperature invites more rapid reproduction than when the temperature is low. It is said to attack and eat the larvæ of the Mediterranean Flour Moth.

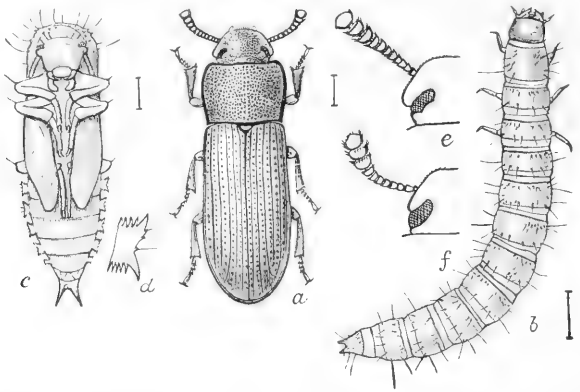

Fig. 21.—*Tribolium confusum*: *a*, beetle; *b*, larva; *c*, pupa, all enlarged; *d*, lateral lobe of abdomen of pupa; *e*, head of beetle showing antenna; *f*, same of *T. ferrugineum*, all greatly enlarged.—F. H. Chittenden, Division of Entomology, U. S. Department of Agriculture.

The Slender-Horned Flour Beetle.

This insect is more common in the south, but deserves a place here. Indian corn is its special food. The beetle is brown, having

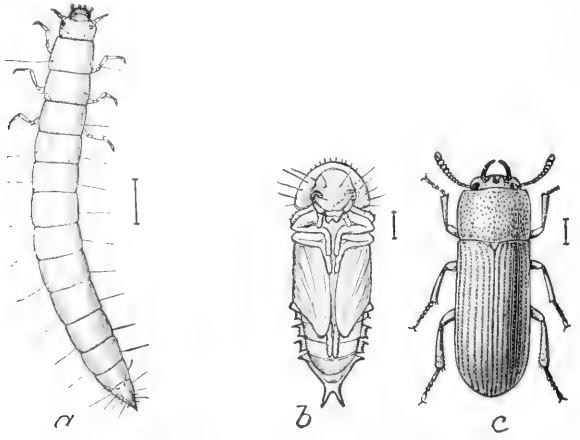

Fig. 22.—*Echocerus maxillosus*: *a*, larva; *b*, pupa; *c*, adult male, all enlarged.—F. H. Chittenden, Division of Entomology, U. S. Department of Agriculture.

on its head between its eyes, two small projections, readily seen in the illustration, Fig. 22. The Broad-horned Flour Beetle, and

the Small-eyed Flour Beetle should be added here; the first more abundant on the Pacific coast, the second abundant and injurious in bakeries, feed stores and mills.

The Yellow Meal Worm.

This, Fig. 23, is one of our more common pests in Indian meal and found in almost any mill products allowed to accumulate in neglected places. The "worm" is round, smooth, waxen as to its surface, and nearly an inch long and yellow. The adult beetles fly and are attracted to lights. Another allied form common in Ame

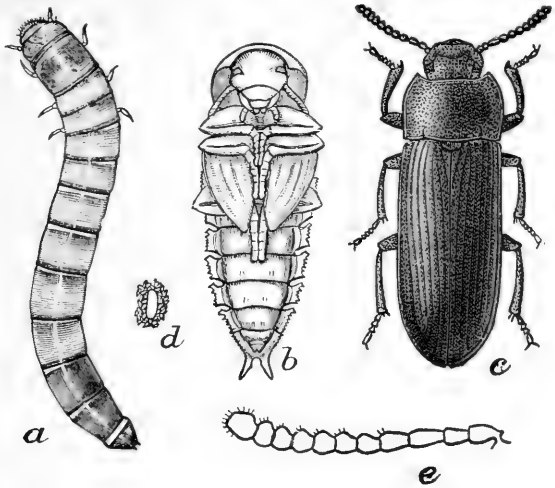

Fig. 23.—*Tenebrio molitor*: *a*, larva; *b*, pupa; *c*, female beetle; *d*, egg with surrounding case; *e*, antenna; *a*, *b*, *c*, *d*, about twice natural size; *e*, more enlarged.—Chittenden, Division of Entomology, U. S. Department of Agriculture.

ica, but probably introduced from Europe or Asia, is the Dark Meal Worm. The Yellow Meal Worm or its beetle, or both, are said to make holes in bolting cloth.

The Saw-Toothed Grain Beetle.

Very commonly, though wrongly, called "weevil." It gets its name from the little teeth on each side of the thorax. (See Fig. 24.) The beetle is reddish brown, and frequently very common in grain, also, according to Chittenden, feeding in flour, meal, dried fruits, seeds, breadstuffs, etc., and has been reported as having

been found in starch, tobacco and dried meats. One or two other allied beetles we pass over as not being abundant enough to merit discussion here.

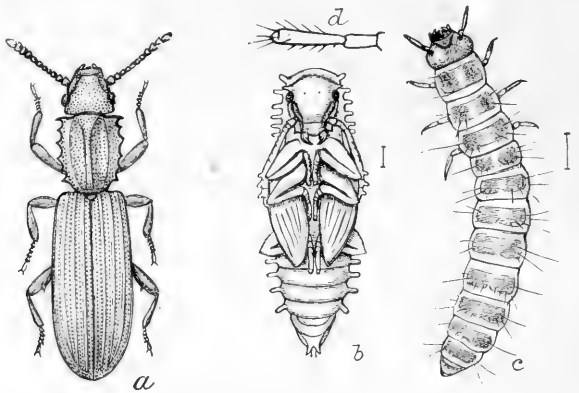

Fig. 24.—*Silvanus surinamensis*: *a*, adult beetle; *b*, pupa; *c*, larva, all enlarged; *d*, antenna of larva, still more enlarged.—Chittenden, Division of Entomology U. S. Department of Agriculture.

The Cadelle.

Sometimes called "The Bolting Cloth Beetle," living upon grain, is blackish, one-third of an inch long, and comes from a

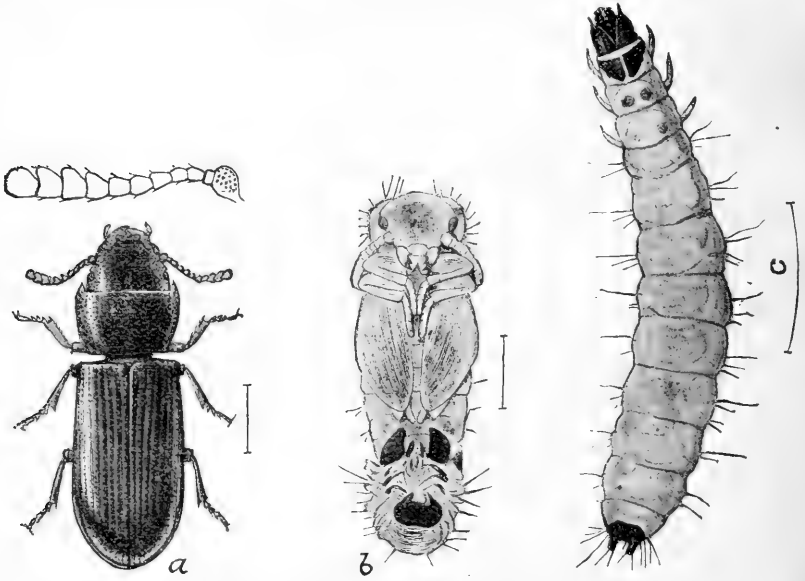

Fig. 25.—*Tenebroides mauritanicus*, Linn.: *a*, adult beetle with greatly enlarged antenna above; *b*, pupa; *c*, larva, all enlarged.—Chittenden, Division of Entomology, U. S. Department of Agriculture.

fleshy, whitish larva with a brown head. (See Fig. 25.) Both beetle and larva attack and eat other grain or flour insects which are met with. They are, therefore, not an unmixed evil.

ACKNOWLEDGMENTS.

The two successful methods of combating the Mediterranean Flour Moth in mills, *freezing* and *spraying with C. S.*$_2$, were told me in detail by practical millers who had resorted to these processes with happy results. To these parties my thanks are due and cheerfully given. I have not hesitated to use information contained in W. G. Johnson's article on "The Mediterranean Flour Moth (*Ephestia kuehniella*, Zeller) in Europe and America," published as an appendix to the 19th report of the State Entomologist of Illinois. From Farmers' Bulletin No. 45, United States Department of Agriculture, "Some Insects Injurious to Stored Grain," by F. H. Chittenden, statements were obtained bearing upon the habits and life histories of insects other than the Flour Moth found in flour mills and elevators. A number of Chittenden's illustrations have also been used.

The Booth Packing Company of Minneapolis very courteously allowed the use of their cold storage rooms in connection with experiments on the effects of different temperatures on the pest under discussion.

KEY TO INSECTS AFFECTING RASPBERRIES, BLACKBERRIES, CURRANTS, GOOSEBERRIES, STRAWBERRIES, GRAPES, MELONS, SQUASHES AND CUCUMBERS.

In our last report, a "Key for Orchardists and Nurserymen" is to be found, dealing with insects affecting the orchard and nursery. It has seemed desirable, in order to meet the many inquiries regarding pests from raisers of small fruits, to conclude the work begun last year by presenting the following key for the identification of insects attacking the plants given at the head of the paragraph. It is hoped that this key will be of value to market gardeners and others, and to further this, illustrations have been freely used and remedies given in each case, except where noted. As the method of controlling insect attack varies with varying

conditions, the gardener is urged to write to the Entomologist when in doubt; the latter will give all information in his power when called upon. The key has been based upon one compiled by Mr. Lochhead in the Thirty-fourth Annual Report of the Entomological Society of Ontario, but changes have been made in the shape of eliminations and additions to make it fit Minnesota conditions. The writer has seen fit to add melon, cucumber and squash insects, which are naturally of interest to market gardeners, and to give, at the conclusion of the key, for the benefit of the same class of agriculturists, a combined treatment for melon blight and for insects feeding upon the leaves of this plant.

INSECTS AFFECTING RASPBERRY AND BLACKBERRY.

A. *Attacking the Roots and Base of Canes:*

1. Large grub over two inches long, boring large tunnels in the woody portions of main root. The canes suddenly die.

GIANT ROOT BORER OR BROAD-NECKED PRIONUS.

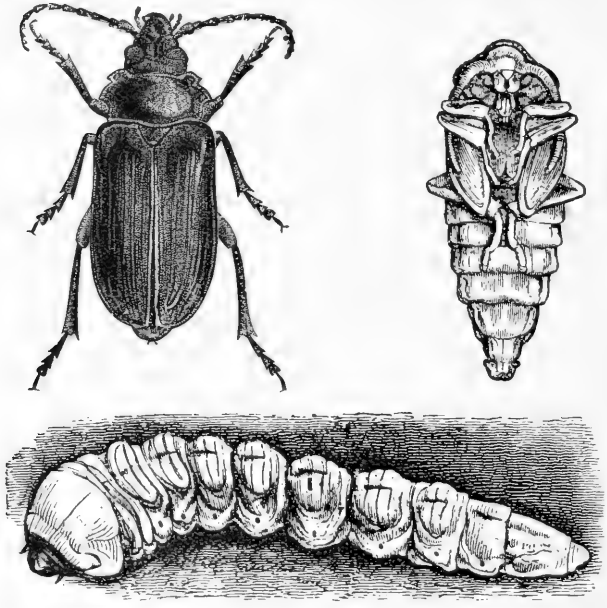

Fig. 26.—*Prionus laticollis,* Drury. After Riley.

REMEDY: Do not betray their presence until plant dies. When plant dies suddenly, or looks sickly from an unknown cause, examine roots carefully (and in case of raspberries and blackberries, the base of cane also), and if a borer is at work there, it should be sought for and killed.

2. Canes at base of main root girdled by a yellowish white caterpillar, in late summer and autumn.

BRAMBLE-CROWN BORER.

REMEDY: Canes dying or dead from an unknown cause should have their roots examined, and if this sixteen-legged grub is found it should be killed.

B. *Attacking the Canes:*

1. Longitudinal row of punctures on canes.

SNOWY TREE CRICKET.

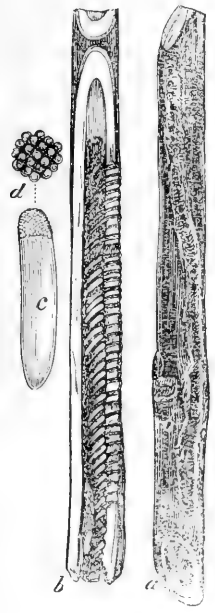

Fig. 28.

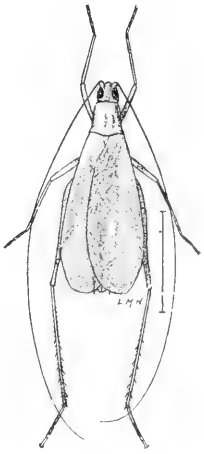

Fig. 29.

Fig. 28.—Eggs of *Œcanthus spec.*: *a*, twig showing punctures; *b*, twig split open to show eggs; *c*, a single egg; *d*, cap of egg, enlarged. After Riley.
Fig. 29.—*Œcanthus fasiatus*, male. Resembling Snowy Tree Cricket. Lugger.

REMEDY: Cut off the portions containing the rows of punctures, and burn. This is best done in early spring or late fall. Shaking the bushes will sometimes dislodge the full-grown insects.

2. Tips of shoots of raspberry wilting; two rows of punctures one inch apart at base of wilted portion, with a small hole between. Canes are burrowed to the base before autumn.

RASPBERRY CANE BORER.

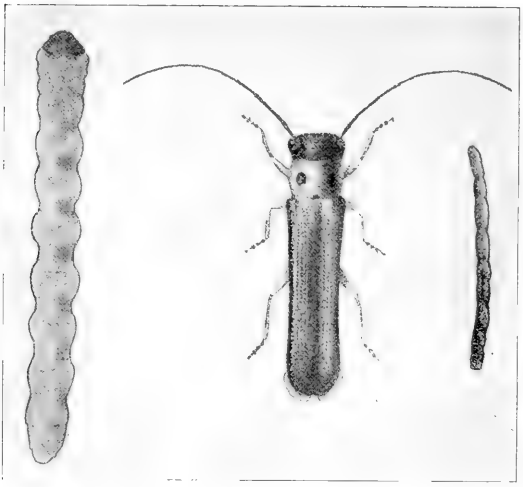

Fig. 30.—*Oberea bimaculata*, Oliv.; adult, larva and castings. After Webster.

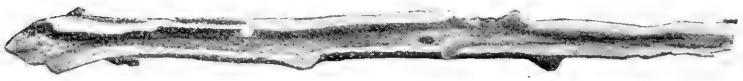

Fig. 30½.—Burrow of *Oberea bimaculata*, Oliv.

REMEDY: Look over bushes occasionally in June and early July and remove all withered tops. Be sure to cut low enough to catch the borer, and destroy the portion cut off, with contained grub.

3. Swellings on canes of raspberry and blackberry.

RED-NECKED CANE BORER.

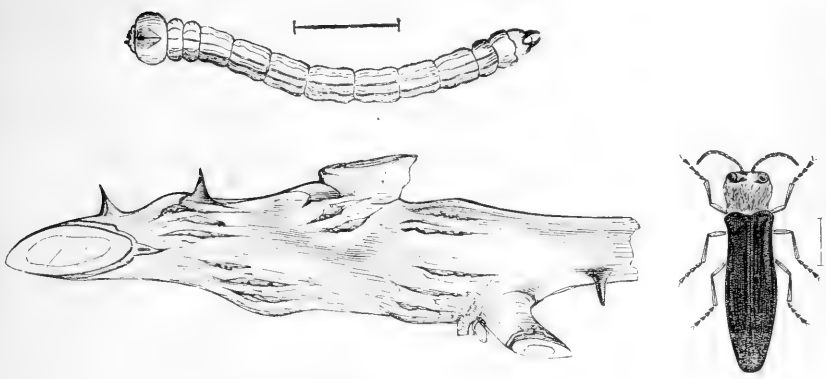

Fig. 31.—*Agrilus ruficollis,* Fab. Gall, beetle and larva. After Riley.

REMEDY: Cut out the swellings in spring and burn.

4. A brownish, purplish or pale worm in new canes, causing tips to droop. Look for opening of burrow in cane.

STALK BORER.

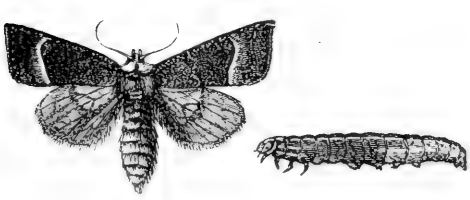

Fig. 32.—*Hydræcia* (*Gortyna*) *nitela,* Gu. From Riley.

REMEDY: Cut off affected top below burrow. Be sure to remove the worm. If the center shows evidences of his boring below the hole, work down until you find him.

C. *Injuring the Buds:*

1. A small snout-beetle, puncturing the flower stem close to the buds, and also the buds.

STRAWBERRY WEEVIL.

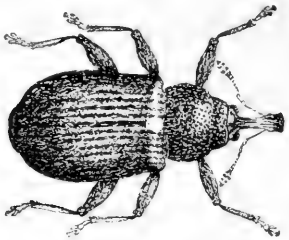

Fig. 33.—*Anthonomus signatus.* Original.

REMEDY: More injurious to strawberry than raspberry. Spraying with Paris green and Bordeaux (one pound of Paris green to every 100 gallons of Bordeaux) would probably be helpful.

2. A small yellowish beetle eating the flower buds, which fail to open, or wither.

PALE BROWN BYTURUS.

Fig. 34.—*Byturus unicolor,* Say. After Saunders.

REMEDY: Hand picking could be resorted to if it should ever become abundant.

3. A small brownish caterpillar eating the opening buds.

BUD MOTH.

Fig. 35.—*Tmetocera ocellana,* Schiff. From Saunders.

REMEDY: If any treatment is necessary, spray with Paris green, one pound to 150 gallons of water, just before the buds break.

D. *Attacking the Leaves:*

1. Insect sucking the sap of young growing parts, and arresting their development.

TARNISHED PLANT BUG.

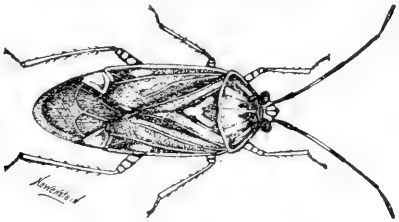

Fig. 36.—*Lygus pratensis,* Linn. Lugger.

REMEDY: Allow no rubbish to lie over winter under the vines or near them, since such cases afford a secure winter retreat for the bugs.

2. Hairy, brownish caterpillars, feeding singly on leaves.

RASPBERRY DAGGER MOTH.

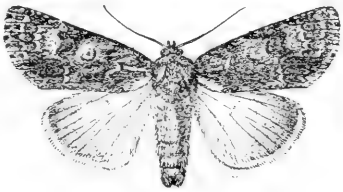

Fig. 37.—*Acronycta impressa,* Walk; moth. Lugger.

REMEDY: Paris green sprays kill all leaf-eating insects.

3. A smooth pale yellow caterpillar, about 1½ inches long.

CHAIN-DOTTED GEOMETER.

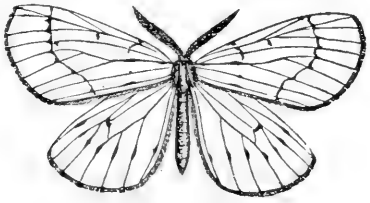

Fig. 38.—*Caterva catenaria,* Cram. After Packard.

REMEDY: Hellebore, which, though poisonous to insects, is harmless as far as man is concerned, could be dusted over the leaves for this or any other leaf-eating worm.

4. Rolling tender leaves and feeding within, a greenish or yellowish worm ¾ of an inch long.

OBLIQUE-BANDED LEAF ROLLER.

Fig. 39.—*Cacœcia rosaceana.* Lugger.

REMEDY: Hand picking early in season and sprays will keep in check if remedy is necessary.

5. A yellowish brown beetle ⅓ of an inch long, feeding upon the leaves.

LIGHT-LOVING ANOMALA.

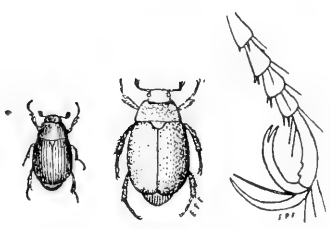

Fig. 40.—*Anomala marginata,* Fab.: *A, lucicola,* Fab., and enlarged tarsal claws. After Lintner.

REMEDY: Dangerous when in large numbers only. Spray leaves with Paris green (one pound in 150 gallons of water) or use hellebore.

E. *Attacking the Fruit:*

1. A looping worm feeding on fruit of raspberry and blackberry.

RASPBERRY GEOMETER.

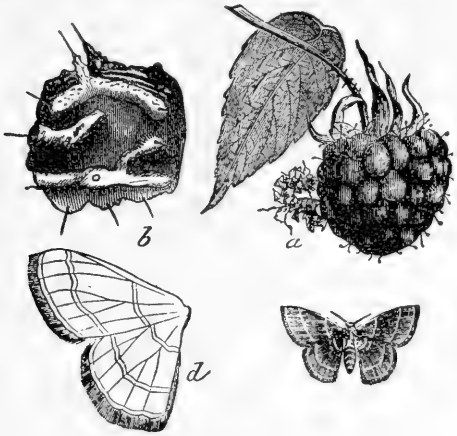

Fig. 41.—*Synchlora glaucaria*, Gu.: *a*, caterpillar; *b*, one segment of same; *d*, wings enlarged. After Riley.

REMEDY: Hand picking is only remedy which can be suggested.

2. Laying eggs on fruit, causing "buggy" taste, a black bug.

FLEA-LIKE NEGRO BUG.

Fig. 42.—The Flea-like Negro Bug. Original.

REMEDY: No remedy called for.

3. A small white grub found inside the raspberry when picked.

RASPBERRY FRUIT-WORM.

See Fig. 34.

REMEDY: Not common in Minnesota.

The following also attack the raspberry and blackberry. Isabella tiger moth (young shoots); the Hickory and Checkered Tussock Moth; the Waved Lagoa; the Saddle-backed Caterpillar; the Unicorn Prominent; the Smeared Dagger Moth; the Raspberry Plumed Moth; the Raspberry Leaf-roller; the Blackberry flea louse; the Long-horned Prominent; the Eye-spotted Bud Moth; the Apple-leaf Miner; the Blackberry-leaf Miner, and others.

CURRANT AND GOOSEBERRY INSECTS.

A. *Attacking the Canes:*

1. Center of canes tunneled by a white caterpillar.

IMPORTED CURRANT BORER.

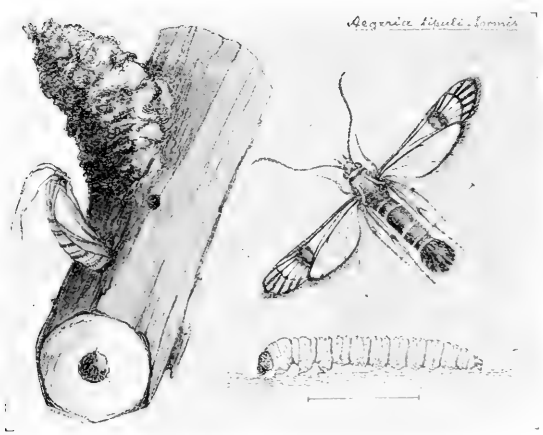

Fig. 43.—*Sesia tipuliformis,* Linn. Lugger.

REMEDY: Prune the sickly looking canes, cutting them off below the lowest part of the tunnel made by the worm.

2. Small, flat, circular scales, black or gray, with a depressed ring about a central nipple in black forms.

SAN JOSE SCALE.

(Not known to be in Minnesota at this date.)

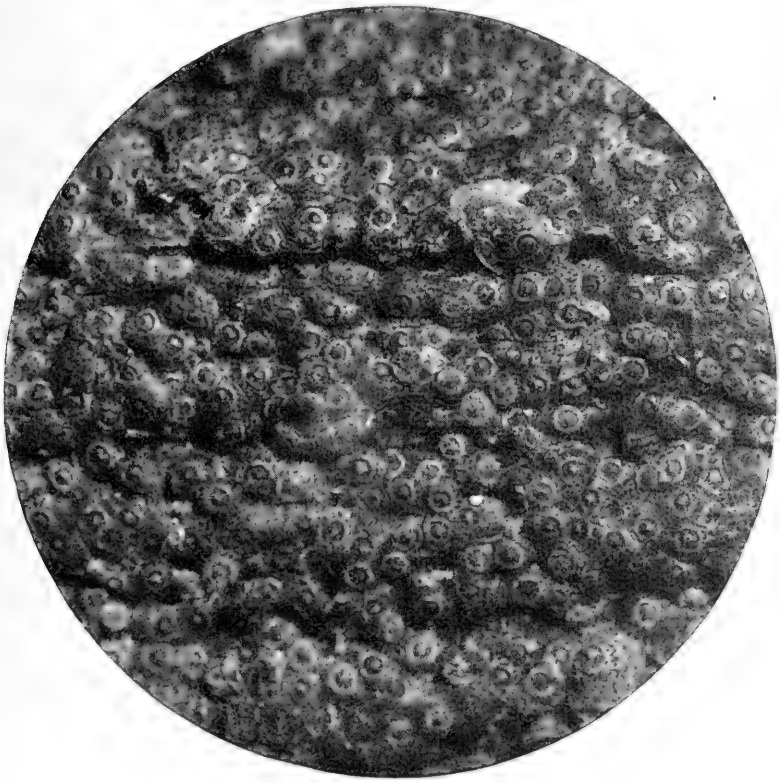

Fig. 44.—San Jose Scale on bark of apple. Garman.

3. Oval, hemispherical scales.

CURRANT LECANIUM.

REMEDY: Not common. See Remedies Nos. 28, 31 and 35, on pages 110, 113, 114, Bulletin 84, from this department.

B. *Attacking the Leaves:*

1. Larvæ, 20-legged, dull white when young, then greenish, with black spots, finally greenish yellow, eating holes in the leaves in early spring.

IMPORTED CURRANT WORM.

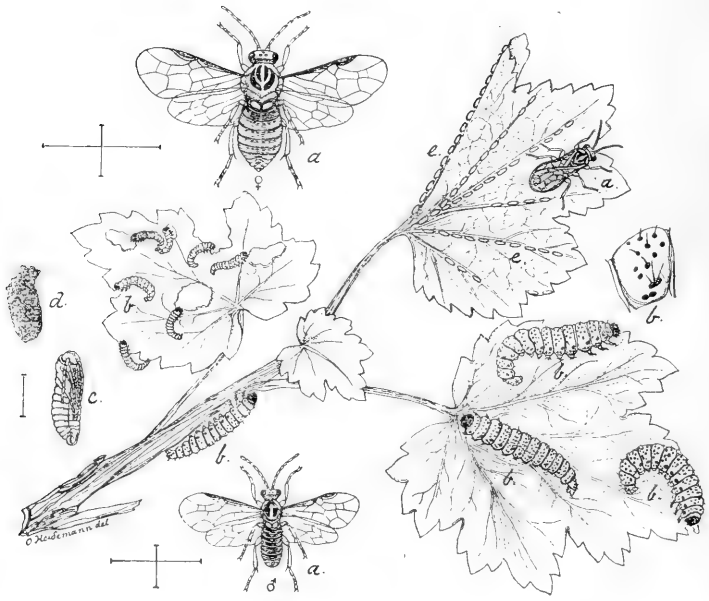

Fig. 45.—*Nematus ventricosus,* Klug: *a,* male and female saw flies; *b,* larvæ of different sizes; *d,* cocoon; *e,* eggs. Lugger.

REMEDY: 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, one ounce to each pailful.

2. Leaves paling, through attacks of green sucking insects on under side.

LEAF HOPPER.

Fig. 46.—Currant leaf infested with *Empoasca albopicta,* Walsh. Lugger.

REMEDY: Currants badly infested before fruit is ready to pick should be treated with a fine spray of kerosene emulsion, throwing as much as possible on under side of leaves.

3. Leaves curled, blistered, and with a reddish appearance on upper surface, caused by yellowish plant lice.

CURRANT PLANT LOUSE.

REMEDY: Same as above.

4. A small brownish bug, sucking sap from leaves.

TARNISHED PLANT BUG.

See Fig. 36.

REMEDY: Allow no rubbish to collect under which the bugs may hibernate. Possibly a kerosene emulsion spray would kill many young.

5. Leaves turning brown and dying.

FOUR-LINED LEAF BUG.

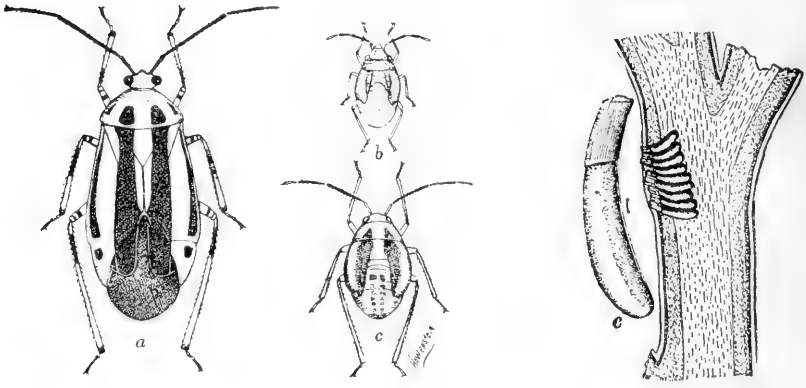

Fig. 47.—*Pœcilocapsus lineatus*, Fab.: *a*, adult; *b*, *c*, immature. Lugger. Eggs after Slingerland.

REMEDY: If troublesome, use kerosene emulsion (one part emulsion to eight of water) several times during May and June.

6. Measuring worm, feeding on leaves of gooseberry and black currant.

CURRANT SPAN-WORM.

REMEDY: All leaf-eating Caterpillars may be killed with Paris green sprays or hellebore. This worm has a habit of lowering itself, and hanging by a thread when disturbed, hence strike the bush affected, then pass a stick all around under it, thus catching the threads on which the Caterpillars are hanging; lift these out from under the bush and step on them.

7. Brown or yellow spiny caterpillar, feeding on leaves of currant and gooseberry, two-brooded in Minnesota.

SPINY CURRANT CATERPILLAR.

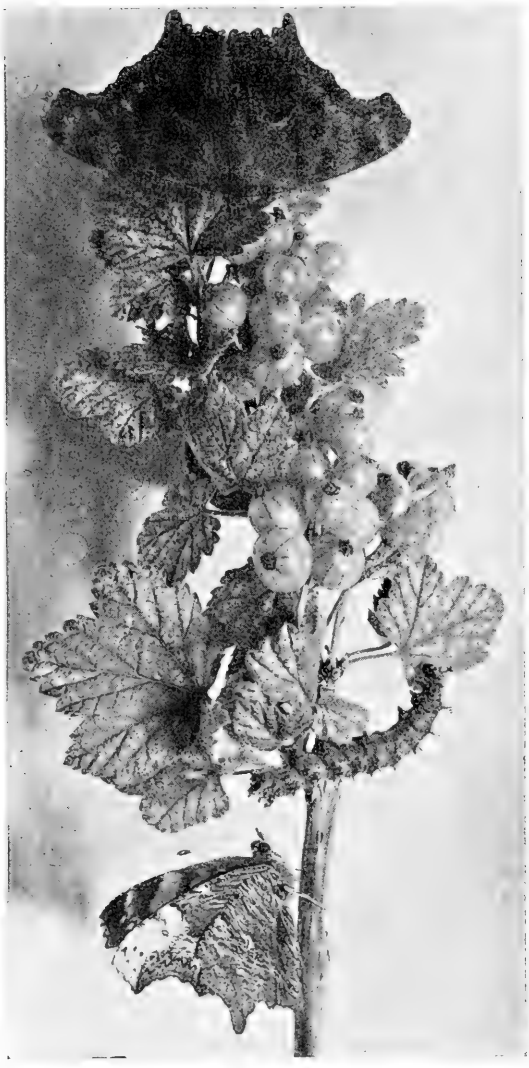

Fig. 48.—*Grapta comma*, Harr., showing two butterflies, caterpillar and empty chrysalis. Lugger.

REMEDY: Use Paris green sprays or hellebore if remedy is necessary.

8. Feeding on leaves during summer, a yellowish (bluish white when young) hairy caterpillar.

COMMON YELLOW BEAR.

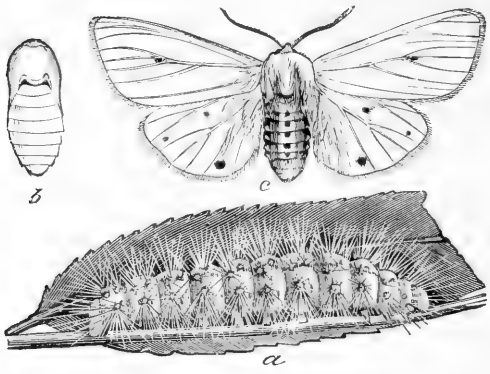

Fig. 49.—*Spilosoma virginica*, Fab.: *a*, caterpillar; *b*, pupa; *c*, adult. After Riley.

REMEDY: Same as preceding; also hand picking.

C. *Attacking the Fruit:*

1. Greyish or greenish caterpillar boring into young fruit, and eating out its contents. Sometimes fasten berries together.

GOOSEBERRY FRUIT WORM.

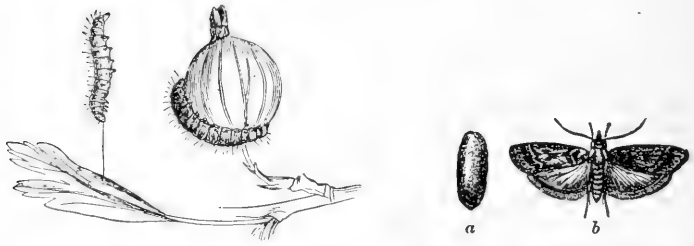

Fig. 50.—*Zophodia grossulariæ*, Pack.: *a*, cocoon; *b*, moth. After Saunders.

REMEDY: Let chickens run among the bushes after fruit is picked. Remove and burn all rubbish in fall.

2. A pale or greenish caterpillar ½ inch long, injuring fruit of currant. Not common in Minnesota.

CURRANT FRUIT WORM.

Fig. 51.—*Eupithecia interruptofasciata,* Pack.

3. Small grub feeding in fruit of currant and gooseberry, causing it to turn red prematurely.

CURRANT FLY.

REMEDY: Same as for Gooseberry Fruit Worm.

The following insects also work on currants, and to some extent on gooseberries:

American Currant Borer; Native Currant Borer; Saddle-backed Caterpillar; Io Emperor Moth; Currant Endropia; Currant Angerona; Pepper and Salt Currant Moth; Oblique-banded Leaf Roller, etc.

GRAPE INSECTS.

A. *Attacking the Roots:*

1. Producing little irregular spherical galls on rootlets and larger roots, causing death. Have not met with it in Minnesota.

GRAPE-VINE PHYLLOXERA.

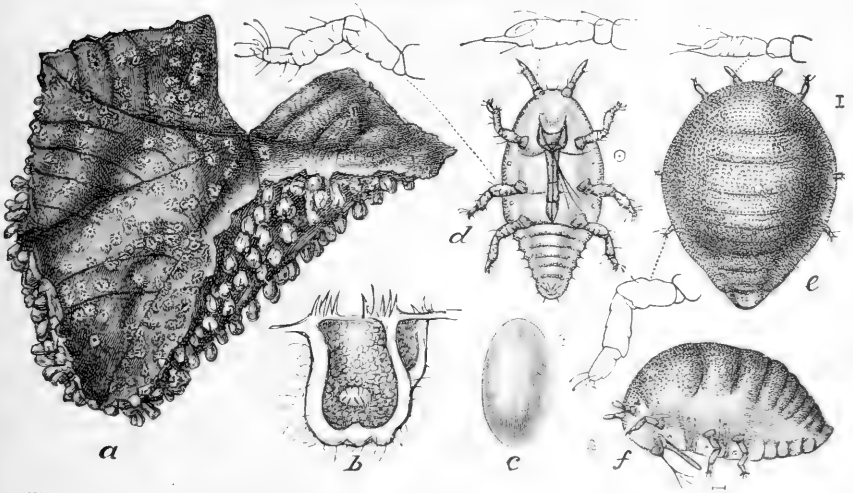

Fig. 52.—*Phylloxera vastatrix,* Plach.: *a*, leaf with galls; *b*, section of galls showing mother louse at center with young clustered about; *c*, egg; *d*, larva; *e*, adult female; *f*, same from side—a, natural size, rest much enlarged. From Marlatt, Dep. of Agriculture.

2. Large borer, cutting a tube through the root near the surface.

BROAD-NECKED PRIONUS.

See Fig. 26.

REMEDY: See same insect under "Insects Affecting Raspberry and Blackberry," page 48.

3. Grub eating the bark of both the large and small roots. Beetles eating holes in leaves.

GRAPE-VINE FIDIA.

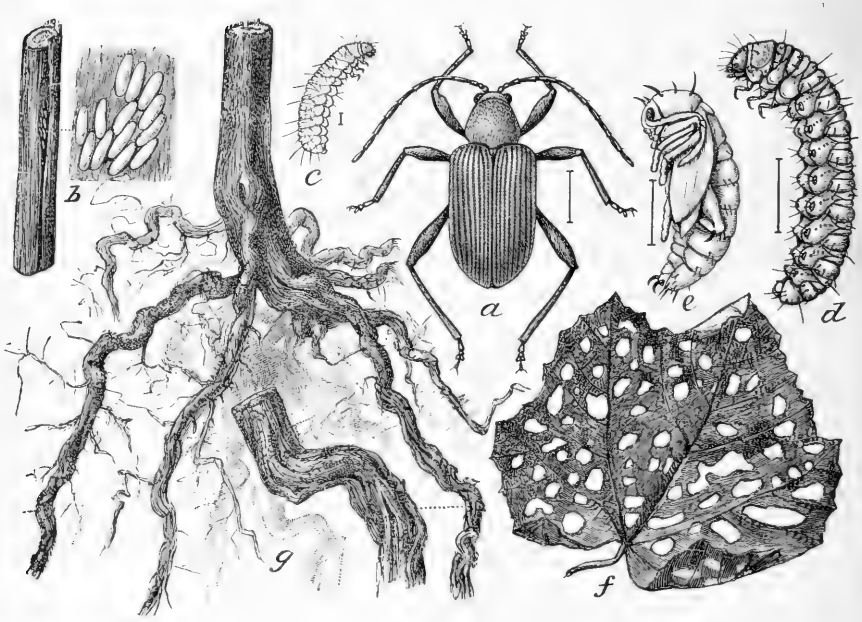

Fig. 53.—*Fidia viticida*, Walsh. From Marlatt, U. S. Dep. of Agriculture.

REMEDY: The adult beetle can be jarred from the leaves into sheets placed beneath the grapevines in June and July.

4. A yellowish-white worm working in the roots.

GRAPE-VINE ROOT BORER.

(Rare in Minnesota.)

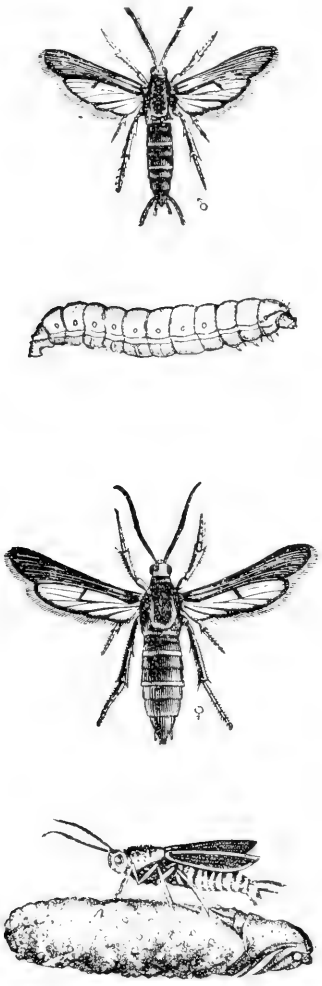

Fig. 54.—*Sciapteron polistiformis*, Harr.: Larva, cocoon, male and female. After Glover, U. S. Dep. of Agriculture.

B. *Attacking the Branches:*

1. Young shoots suddenly break off or droop in spring; a small hole just above the base of the shoot leads into a burrow.

APPLE-TWIG BORER.

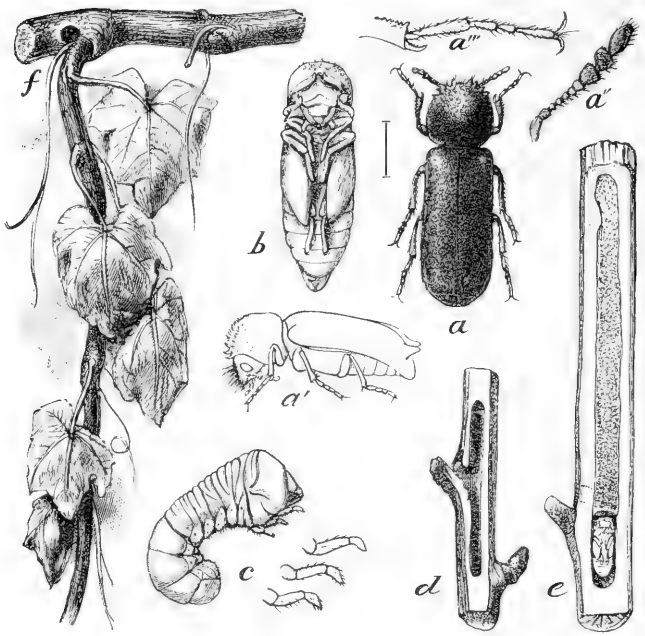

Fig. 55.—*Amphicerus bicaudatus*, Say. From Marlatt, U. S. Dep. of Agriculture.

REMEDY: Removing and burning twigs with burrows of this Beetle will check the ravages somewhat.

2. Canes show roughened longitudinal rows of perforations.

SNOWY TREE CRICKET.

See Fig. 29.

REMEDY: See under "Insects Affecting Raspberry and Blackberry," page 49.

3. Canes exhibiting white, cottony masses attached to a reddish brown scale.

COTTONY MAPLE SCALE.

REMEDY: Not abundant on grape. Can be easily scraped off, or touched with a feather dipped in kerosene.

4. Canes exhibiting white frothy masses which resemble spittle.

SPITTLE INSECT.

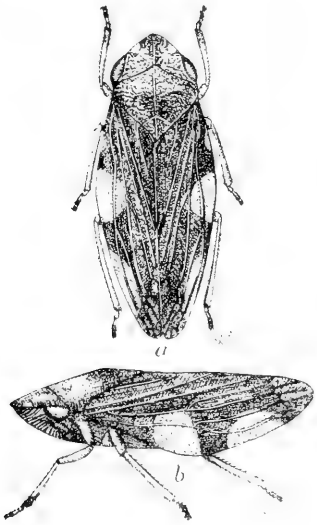

Fig. 56.—*Aphrophora 4-notata*, Say.: *a*, from above; *b*, from side. Lugger.

REMEDY: If sufficiently abundant to be injurious, can be crushed by the hand.

C. *Attacking the Leaves:*

1. Leaves riddled with irregular holes about midsummer, by a little beetle.

GRAPE-VINE FIDIA.

REMEDY: See page 64.

(Another leaf beetle, *Adoxus obscurus*, is sometimes troublesome in Minnesota.)

2. A yellowish-brown beetle ⅓ of an inch long, feeding on leaves.

LIGHT-LOVING ANOMALA.

REMEDY: See page 54, under "Insects Affecting Raspberry and Blackberry."

3. Boring into buds in spring, also eating small holes in expanding leaves, small shining blue beetle.

GRAPE-VINE FLEA BEETLE.

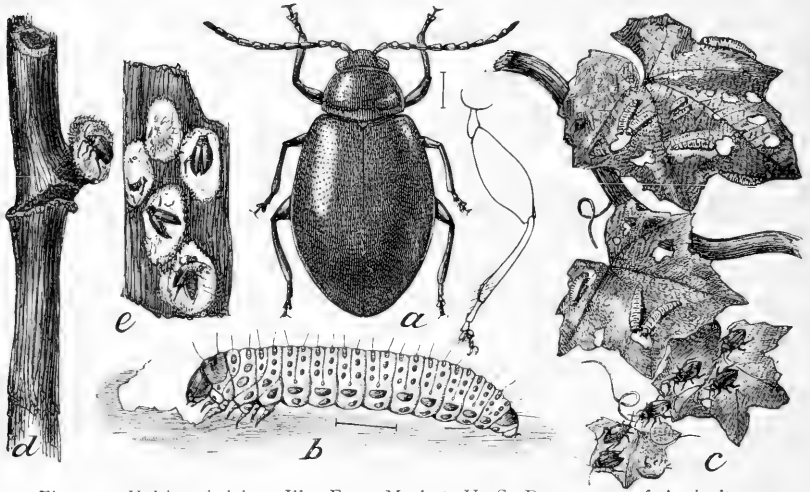

Fig. 57.—*Haltica chalybea*, Ill. From Marlatt, U. S. Department of Agriculture.

REMEDY: The winter is passed under leaves beneath the vine, or in the ground near the roots. Therefore, allow chickens to scratch among the vines in fall after grapes are picked, and later remove and burn all rubbish, and scatter some air slaked lime or unleached ashes on the earth. It is claimed that on chilly mornings these Beetles are not active, and can be jarred from the leaves.

4. Long legged, brownish beetles eating the blossom, leaves and fruit.

ROSE CHAFER.

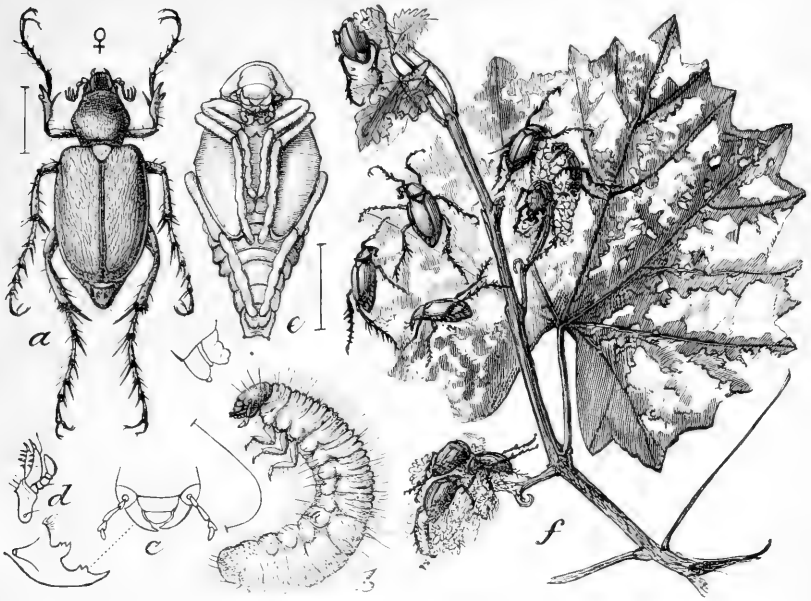

Fig. 58.—*Macrodactylus subspinosus*, Fab. From Marlatt, Division of Entomology, U. S. Department of Agriculture.

REMEDY: Can be jarred on sheets in the cool of the morning.

5. Greenish caterpillar feeding within a folded leaf and skeletonizing it, about midsummer.

GRAPE-LEAF FOLDER.

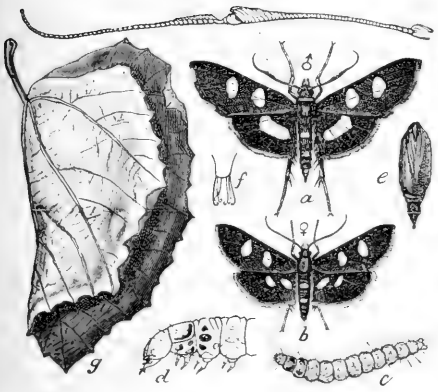

Fig. 59.

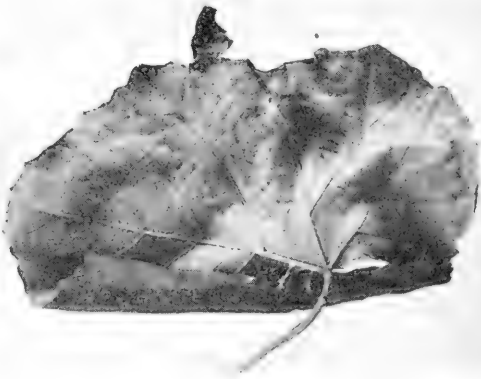

Fig. 60.

Fig. 59.—*Desmia maculalis*, Westw.: *a*, male moth; *b*, female; *c*, larva; *d*, head and thoracic segments of same enlarged; *e*, pupa; *f*, tip of same enlarged; *g*, leaf folded by larva. From Marlatt, Dep. of Agriculture.

Fig. 60.—Grape leaf folded by this insect. Original.

REMEDY: Caterpillar can be destroyed by crushing the rolled leaf. The writer has picked the rolled leaves from his own vines and burned them or crushed them, being careful not to let the worm slip out of the leaf.

6. Leaves blotched and scorched, finally curling up and falling, by little jumping insects.

GRAPE THRIP OR LEAF HOPPER.

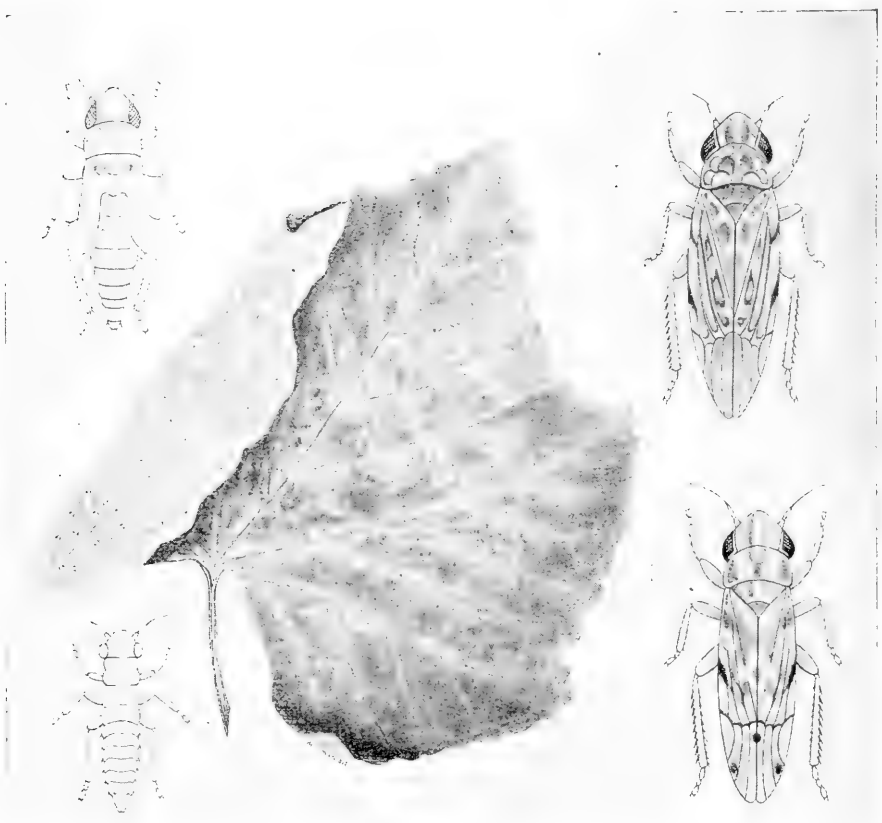

Fig. 61.—Grape vine leaf infested with *Typhlocyba* species, Lugger.

REMEDY: Remove all rubbish in the fall, and disturb the ground by raking.

7. Large greenish caterpillar, with a pale yellow stripe down each side, and a horn near tail.

GRAPE-VINE SPHINX.

Fig. 62.—*Ampelophaga myron*, Cram., caterpillar. After Riley.

REMEDY: Hand picking is best remedy. Small parasites help us in combating this pest.

8. Black beetle eating the tissues on the upper surfaces of the leaves, and discoloring them.

RED-HEADED SYSTENA.

REMEDY: Paris green sprays would be effective.

9. Large reddish yellow beetle, with six black spots on wing-cover, eating holes in leaves.

SPOTTED PELIDNOTA.

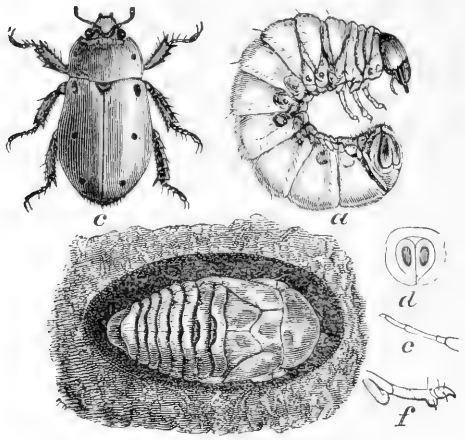

Fig. 63.—*Pelidnota punctata*, Linn. After Riley.

REMEDY: Not common in Minnesota. Hand picking if necessary.

10. A purplish or orange colored worm with dark markings, feeding on leaf of grape and woodbine.

EIGHT-SPOTTED FORESTER.

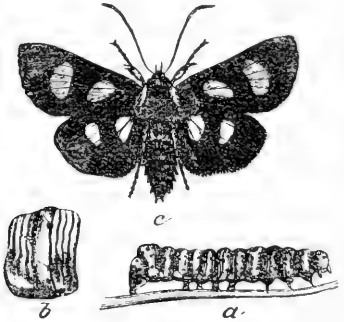

Fig. 64.—*Alypia octomaculata*, Hbn.: *a*, caterpillar; *b*, one segment of the same; *c*, adult. After Riley.

REMEDY: Hand picking, or Paris green or hellebore when necessary.

D. *Attacking the Fruit:*

1. Ripening fruit discolored, and burrowed by a whitish caterpillar.

GRAPE BERRY MOTH.

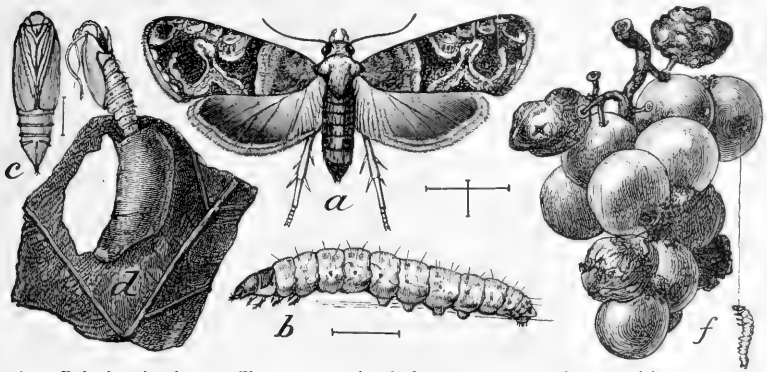

Fig. 65.—*Polychrosis viteana*, Clem.: *a*, moth; *b*, larva; *c*, pupa; *d*, case with empty pupa, all enlarged; *f*, grapes with worm natural size. From Marlatt, Dep. of Agriculture.

REMEDY: Rake up and destroy the fallen leaves and rubbish under the vines in the fall. Early gathering and shipping are recommended. All fallen fruit should be destroyed. Bagging grapes as soon as fruit sets would be effective, but not practical on a large scale. A new parasite (*Thymaris slingerlandana*, Ashm.) has recently been bred from this pest.

2. Eating holes in ripe fruit, beetle large, yellowish, hairy.

BUMBLE FLOWER BEETLE.

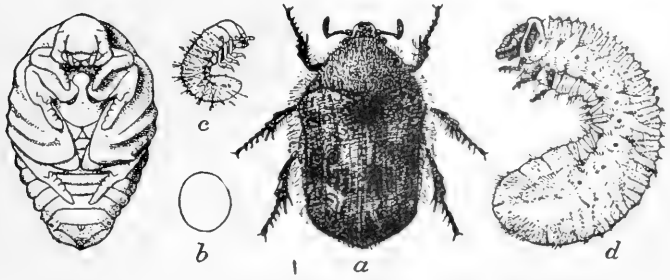

Fig. 66.—*Euphoria inda*, Linn. From Chittenden, U. S. Department of Agriculture.

REMEDY: Hand picking.

3. Eating holes in young fruit, a long-legged beetle.

ROSE CHAFER.

See Fig. 58.

REMEDY: See page 69.

4. Fruit discolored on one side by the presence within of a small yellowish-white grub.

GRAPE CURCULIO.

(Not common in Minnesota.)

Fig. 67.—*Craponius inæqualis*, Say. After Riley.

The following insects also attack the Grape: Saddle-backed Caterpillar, various tree hoppers not mentioned above; Spotted Vine Chafer; many Sphinx moths; Hog Caterpillar; Red-Shouldered Sinoxylona; False Chinch Bug; American Procris; Smeared Dagger Moth; Gartered Grape Plume; Sulphur Colored Tortrix, and others.

STRAWBERRY INSECTS.

A. *Attacking the Roots:*

1. A pinkish caterpillar boring irregular channels through the crown and larger roots, causing them to wither and die.

STRAWBERRY ROOT BORER.

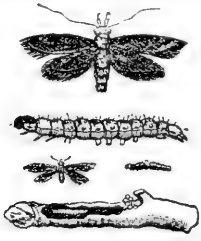

Fig. 68.—*Anarsia lineatella*, Zell. After Saunders.

REMEDY: No practical remedy. Badly infested plant should be dug up, and a new planting made.

2. A white grub boring downward from the crown.

STRAWBERRY CROWN BORER.

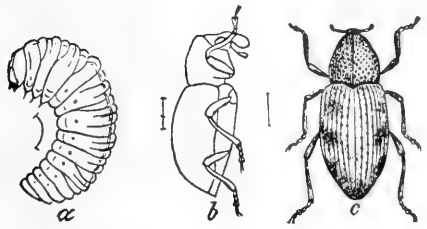

Fig. 69.—*Tyloderma fragariæ*, Ril. After Riley.

REMEDY: Old beds more likely to be infested than new beds. Dig up and burn plants after fruiting season.

3. Eating out the crown and roots, a dark brown snout beetle or its whitish grub. Quite destructive, at times, in this state.

PITCHY-LEGGED OTIORHYNCUS.

Fig. 70.—*Otiorhynchus ovatus*, Linn.

REMEDY: No remedy known beyond the digging up and destroying of old beds when infested.

4. A large white grub eating the roots.

MAY BEETLE.

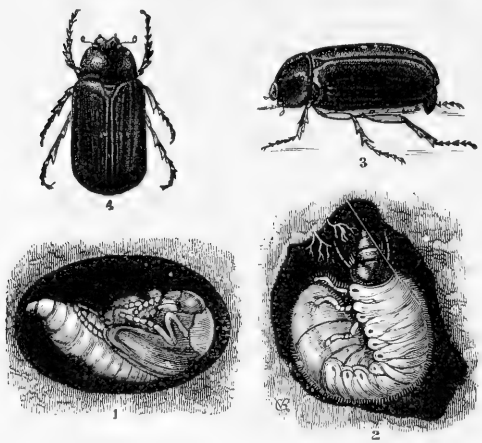

Fig. 71.—*Lachnosterna fusca*, Frœhl. From Riley.

REMEDY: Grubs eaten by fowls. Crows are fond of them. They are attacked by disease.

5. A hard yellowish or brownish worm eating the root.

WIRE WORM.

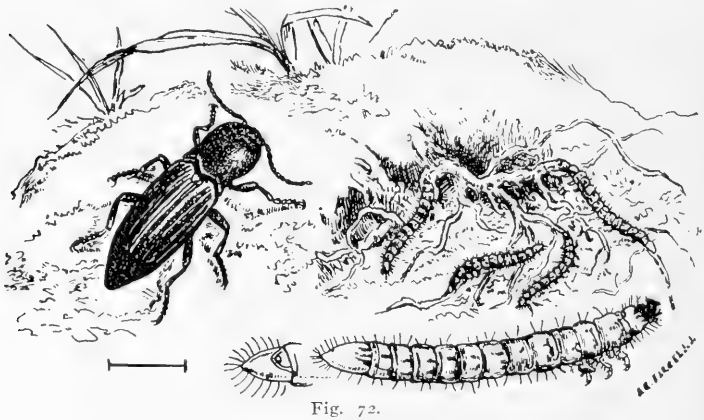

Fig. 72.

REMEDY: Plant strawberries only in land which has been in cultivation some time. Wire worms may be trapped or poisoned. See page 172.

B. *Attacking the Leaves:*

1. Brownish caterpillars in June and August rolling the leaves into cases, and fastening them with silk.

LEAF ROLLER.

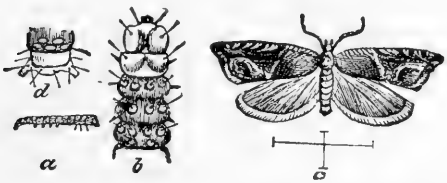

Fig. 73.—*Phoxopteris comptana,* Froel. After Saunders.

REMEDY: If bad, sprinkle with hellebore and water, or gather and burn infested leaves. See page 54.

2. Young plants gnawed off at the surface.

CUT WORMS.

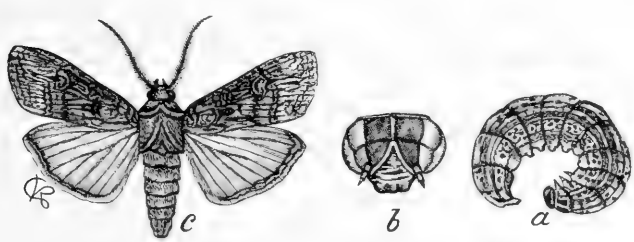

Fig. 74.—*Agrotis ypsilon,* Rott. After Riley.

REMEDY: Cut worms may be trapped or poisoned. See page 171.

3. Small, pale spotted, active beetles riddle the leaves with holes in June. The young beetle in the grub form attacks the root.

SPOTTED PARIA.

REMEDY: Use hellebore.

4. A small blackish snout beetle puncturing stems and buds of staminate varieties.

STRAWBERRY WEEVIL.

See Fig. 33.

REMEDY: No really good remedy. The burning over of old fields after crop is gathered has been suggested. Plant chiefly pistillate varieties, using only occasional rows of staminate plants. Write to the experiment station if radical measures seem necessary.

5. A small, active, jumping striped beetle, eating holes in the leaves.

STRIPED FLEA BEETLE.

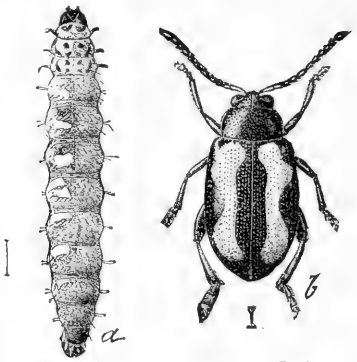

Fig. 75.—*Phyllotreta vittata*, Fab. From Riley, U. S. Department of Agriculture.

REMEDY: Same as for Spotted Paria.

6. A brownish bug, ⅓ of an inch long, sucking the sap from buds and leaves, causing them to wither.

TARNISHED PLANT BUG.

REMEDY: See page 53.

C. *Attacking the Fruit:*

1. A caterpillar feeding on the berry.

STALK BORER.

REMEDY: See page 51.

2. A minute black bug, producing a "buggy" odor when eaten with berry.

FLEA-LIKE NEGRO BUG.

See Fig. 42.

REMEDY: No remedy called for.

3. A black beetle nearly an inch long, eating the berry.

HARPALUS PENNSYLVANICUS.

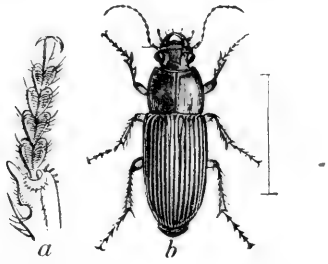

Fig. 76.—*Harpalus pennsylvanicus*, De G.: *a*, anterior tarsus and part of tibia showing notch; *b*, beetle. After Riley.

REMEDY: Bran mixed with water sweetened with molasses, and poisoned with Paris green, is said to be fairly effective. It should be placed at intervals through the strawberry patch, each portion covered with a piece of shingle or board. Pick beetles and destroy them if necessary. Traps in the shape of boards, etc., are good. Write for further particulars if troubled with this pest. See also Seventh Annual Report of Entomologist (Bulletin 77), page 39.

The following insects also attack the Strawberry: Wavy-striped Flea Beetle, Imbricated Snout Beetle, Grape-vine Caterpillar, Thread-bearing Span Worm, Rusty Brown Tortrix, Sulphur-colored Tortrix, etc.

INSECTS AFFECTING MELONS, SQUASHES AND CUCUMBERS.

A. *Attacking the Leaf:*

1. Small green bugs on under side of melon leaves.

MELON LOUSE.

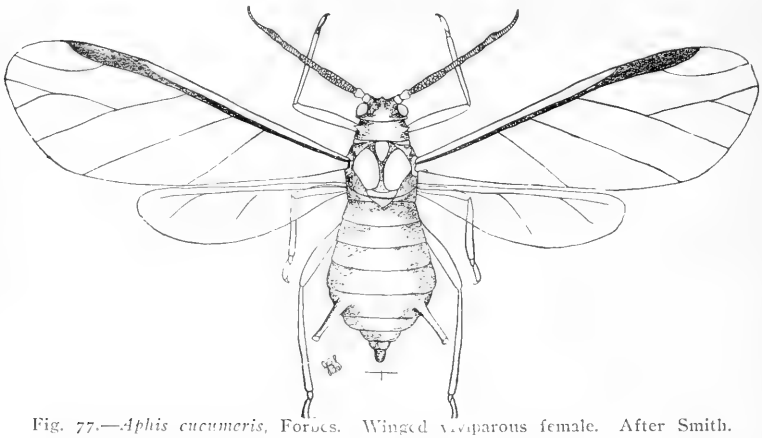

Fig. 77.—*Aphis cucumeris*, Forbes. Winged viviparous female. After Smith.

REMEDY: If melon patch is very small, spray under side of leaves with kerosene emulsion (1-12), or dust under side of leaves with pyrethrum. Whether the patch be large or small, destroy all old vines and rubbish on melon patch, and plant some crop other than melons or cucumbers there the following season. Frequently the attacks of this louse are not of long duration. Parasites kill many.

2. A brownish bug about ¾ inch long on leaf.

TRUE SQUASH BUG.

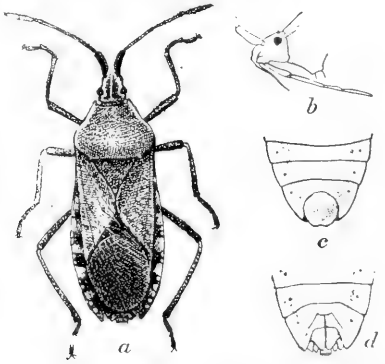

Fig. 78.—*Anasa tristis*, De G.: *a*, mature female; *b*, side view of head, showing beak; *c*, abdominal segments of male; *d*, same of female;—*a*, twice natural size; *b*, *c*, *d*, slightly more enlarged. After Chittenden, Div. of Entomology, Dep. of Agriculture.

REMEDIES: 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.

3. A yellow and black striped beetle, ⅓ of an inch long, feeding on leaf and blossom; wrongly called "Squash Bug."

STRIPED CUCUMBER BEETLE.

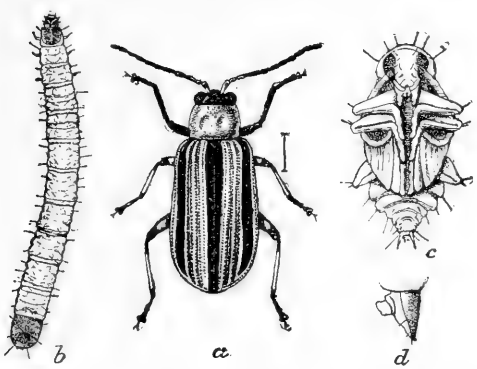

Fig. 79.—*Diabrotica vittata*, Fab. From Chittenden, U. S. Department of Agriculture.

REMEDY: Paris green may be dusted dry on the plants, mixed with slaked lime or cheap flour, about one part of Paris green to 50 or 60 parts of flour or lime. At least one party (Forrest Henry) 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, and thus lessening the Beetle crop for next year. Planting a much larger number of seeds than are actually needed is also practiced.

4. A greenish yellow beetle, same size as above, with 12 black spots, feeding on leaf of plant.

TWELVE-SPOTTED DIABROTICA.

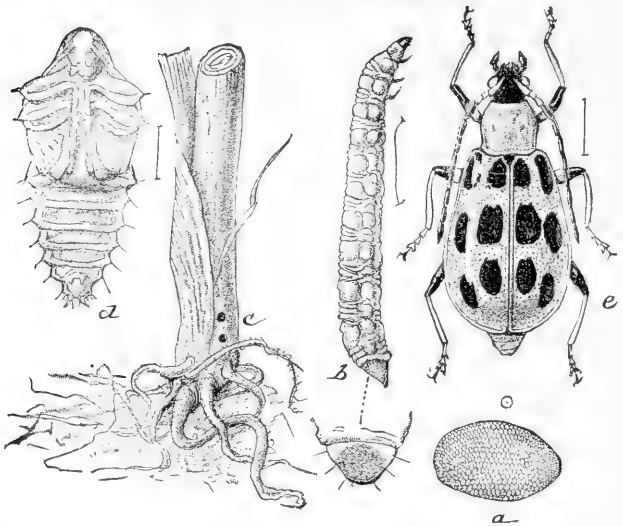

Fig. 80.—*Diabrotica 12 punctata,* Oliv. After Riley, U. S. Dep. of Agriculture.

REMEDY: Same remedies as for Striped Cucumber Beetle.

5. A black shining beetle, which jumps like a flea, found on melons and cucumbers.

CUCUMBER FLEA BEETLE.

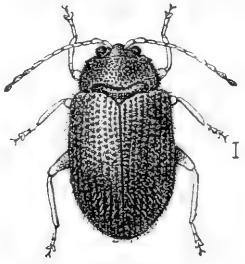

Fig. 81.—*Epitrix cucumeris,* Harr. From Chittenden, U. S. Dep. of Agriculture.

REMEDY: Really more troublesome to leaves of apple trees than to cucumbers. Would be easily kept in check by treatment for two preceding pests.

The Melon Caterpillar attacks melons, and the Neat Cucumber Moth or Pickle Worm attacks fruit of cucumber, but we have not met with these in this state.

CONTROL OF MELON BLIGHT AND LEAF-EATING MELON INSECTS.

That this troublesome fungus disease, which works on melons and cucumbers, can be combated, if treatment is begun early enough, has been practically demonstrated. Bordeaux mixture properly made and properly applied has been found successful. It must be borne in mind, however, that any application affects only the surface, and the surface must be kept coated, thus preventing the spores from germinating and starting a growth in the tissues of the leaf, for then it cannot be reached. Applications of Bordeaux mixture should be begun as soon as first leaves of plant appear, and should be repeated every eight or ten days for six or seven weeks. Fewer sprayings might possibly do, but it is better to err by giving too many than to run the risk of the fungus getting a foothold by giving too few. The melon raiser must begin spraying early, as above indicated; if he delays, *his work and material are wasted.* A Knapsack sprayer might be profitably used for the first few applications, but after the vines are larger, and call for more liquid, a spray pump and barrel are desirable. Further, the grower must distinguish between this blight and the wilt caused by a bacterial organism, since the Bordeaux does not affect the latter. Plants showing this wilt should be destroyed at once.

What is known as the 4.4.40 sol. of Bordeaux is used for this work, and it is made as follows: Dissolve four pounds of copper sulphate (blue vitriol) in four gallons of water in a tub or crock; slake four pounds of good quick lime slowly, adding water as it slakes to make four gallons. When wanted for use, and it should be used very shortly after it is made and not kept for some time, add sixteen gallons of water to each mixture, lime and blue vitriol, and then pour the two solutions together. Do not mix the solutions *before* diluting.

It is eminently essential that the Bordeaux mixture be not acid, in order that it may not burn the foliage. There are various tests to determine whether it is or is not acid:

1. If a clean knife blade held in the solution a minute or two becomes copper coated, more lime should be used.

2. If a little of the solution be poured into a shallow dish, and one gently blows across its surface, a thin film should form; if it does not, add more lime.

3. Buy a few cents worth of ferrocyanide of potash, dissolve it in water. To a little of the Bordeaux mixture in a glass or crockery dish add a few drops of the ferrocyanide of potash solution; if a brown color appears, the Bordeaux is acid, and more lime should be added, and the test repeated.

These frequent applications of Bordeaux, if it is properly made and properly applied, will keep the blight in check, and will in a great measure also prevent insect attack. The insecticidal qualities of the mixture could be bettered by adding four ounces of Paris Green (or one gallon of arsenate of lead) to every fifty gallons of Bordeaux.

PRELIMINARY REPORT UPON WORK AGAINST THE DESTRUCTIVE LEAF HOPPER.

This injurious insect and its work in nurseries were discussed in the report of last year, and it was then announced that an active campaign against it would be inaugurated in the summer of 1904. In the meantime, having met with Professor Stedman of the Missouri Station, I was struck by his description of a spraying machine, planned to spray four rows of nursery trees at the same time, which he had had made in his state. He very courteously gave me a general description of the outfit, the plans for which I have followed in Minnesota in a general way.

THE CART.

It seemed, however, desirable to bring the reservoir below the platform in order to better balance the cart, and since three or four-year-old trees in Minnesota are not as tall as trees of the same age in Missouri, we found it unnecessary to make the cart as high as the one used in the state south of us. Therefore, while Stedman's plan was followed in the main, the cart we constructed differs from his in many minor details. This outfit is intended for use in large nurseries, and on level ground.

Fig. 84 shows the cart as it was first made for use with kerosene emulsion. The wheels are 5½ feet in diameter, with 4-inch tires, and the platform, which is 8x4¼ feet square, is 14 inches above the wheels, well balanced on the axle, so that almost all the weight, practically all, comes on the axle, not on the horse. The lower hori-

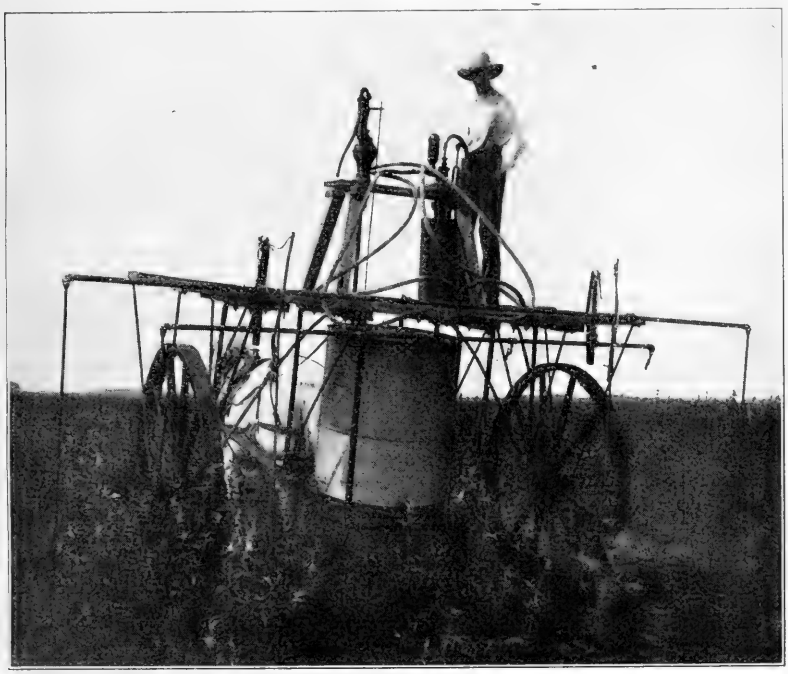

Fig. 84.—Our Spraying Outfit at work in Nursery. Fitted with one Simplex Pump and one Kero-water Pump. Only the latter in use.

zontal pipe D (see Fig. 85) is 1 inch, and 10½ feet long. Just 3½ feet distant from each other on this pipe four nozzles are attached, pointing directly downward. This spacing brings each one of these nozzles directly over a nursery row, where the rows are three and one-half feet apart, the usual distance. A nurseryman can, of course, suit this distance to the space between the rows in his nursery. Horizontal pipe D can be raised or lowered by means of chains, to suit high or low trees.

Horizontal pipe C is fourteen feet long, and projects ten inches back of the platform. The three-eighth-inch verticals from this pipe are five feet four inches long, three and one-half feet space between

them, and cross pieces at the bottom, so arranged that the nozzle at each end of each cross piece points up at an angle of 45 degrees. This spacing, with that between the nozzles on the upper pipe, results in a copious spray coming both from above on the tops of the trees, and from below against the lower surface of the leaves, the latter being a very important feature. In actual practice the trees are completely surrounded by a fine spray, so that insects, whether they be upon the upper surface of leaf or twig, or the lower surface, or whether, disturbed by the spraying, they seek to fly away, are sure to be caught by the deadly mist. A glance at Fig. 85 will enable one to appreciate these details. In this drawing the two pumps, which, as intimated

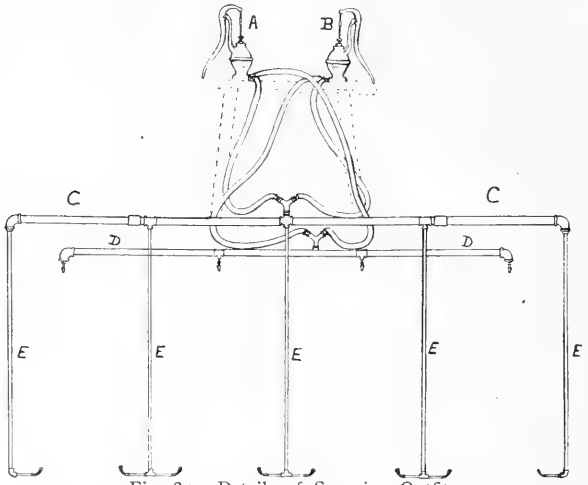

Fig. 85.—Details of Spraying Outfit.

above, were intended to be used with kerosene emulsion, are shown, and the two pieces of hose running from each to the horizontals. The double hose from one pump can be joined to either one of the horizontals, or to both, or the four pieces of hose from the two pumps can be so connected with the horizontals that the working of both pumps will contribute to the force in both pipes, and, therefore, in all the twelve nozzles. This latter arrangement seemed at first necessary, for we supposed that both pumps would be required to make all the nozzles do effective work. As a matter of fact, when emulsion was used, one pump worked by one man was all that was necessary to bring good results at the nozzles. The two pumps used with kerosene emulsion were both "Simplex" pumps and answered the purpose perfectly. It is evident that such an outfit could be used with any

spraying compound (except Kero-water), which it was desired to apply to nursery trees. Our tank, resting on a platform between the wheels, readily seen in the photographs, was made out of strong galvanized iron and was two feet ten inches in diameter and three and one-half feet high, holding about 165 gallons; a faucet at bottom behind allowed the emptying of the tank at any time. A fourteen-inch square hole on top with cover afforded opening for filling.

A heavy and steady horse was used with the cart, and an old saddle on the back of the animal seemed to relieve his back of any undue strain. However, as stated above, the weight was so well balanced on the axle that the outfit was not at all severe on the horse, and was drawn when the tank was from one-half to two-thirds full with apparent ease.

WORK IN THE FIELD.

The tree hopper was first observed this season in various nurseries early in July; on July 4th in one in Southern Minnesota, where it rapidly grew very abundant. On July 8th it was found to be doing destructive work in another large nursery in Southern Minnesota, and was abundant on the Station grounds from about July 15th. It was also found to be very bad in nurseries in Southeastern Minnesota and extremely abundant in Wright county nurseries on July 21st.

One of the large nurseries referred to above was chosen as the field of our experimental work. We had planned to spray early in July, but owing to delay in getting the cart completed, the first spraying was not given until July 14th, at least ten days later than intended. At that time kerosene emulsion was used at the rate of one part of stock emulsion to twelve parts of water. The machine worked perfectly, one man and one pump being sufficient to envelope each tree in the row in a complete fog. In this fog were thousands of hoppers flying from the trees, but unable to escape the spray.

This strength of emulsion, however, while it killed the young hoppers, did not permanently affect the adults. We therefore, on July 19th, increased the strength, using one part emulsion to ten of water. This in no way injured the trees, nor did it, unfortunately, kill the adults, which were very numerous at that date.

Learning from the Missouri Station that they were using a mechanical mixture of kerosene and water (10 per cent), with considerable success, I sent for a Kero-water pump, known as the "Peerless," which is seen in one of the photographs (Fig. 84) fitted to the

cart by the side of the "Simplex." This pump is so connected with a tank which can be filled with kerosene that every stroke of the handle not only draws water from the water reservoir through one pipe, but also, at the same time, a regulated amount of kerosene from the kerosene tank, the oil and water mixing mechanically, and issuing from the nozzles as a fine spray, the so-called Kero-water mixture. This is very effective, easy to prepare, in fact it calls for no preparation, as the kerosene emulsion does, and easy to apply. Unfortunately, the writer has yet to see one of these Kero-water machines which

Fig. 86.—Hand Dust Sprayer at work.

pumps true to the indicator. Our experience has been that if the indicator points at 10 per cent one is not at all sure of obtaining that percentage of oil in the water, in fact, he is quite sure not to. When the indicator of our "Peerless" pump "indicated" 20 per cent, we found by actual test that we were pumping 10 per cent, 25 per cent register giving 15 per cent. With the indicator at 30 per cent we obtained 25 per cent, while 50 per cent on the indicator gave nearly 50 per cent by actual test as it came from the nozzles. The indicator's 10 per cent and 15 per cent gave such a small per cent of oil, far below the figure indicated, as to be practically worthless for our purpose. We found further that when the oil in the oil tank got quite low, the per cent materially changed; for instance, with the indicator at 25 per cent we pumped 15 per cent steadily until tank was nearly empty, when test showed that we were getting only 5 per cent. This inaccuracy and variation is common to all the Kero-water pumps

with which we have had experience, and is a serious objection to their use. Nevertheless, once understood, and frequently tested in the field, these machines do good service.

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

Fig. 87.—Cyclone Dust Sprayer.

whose supervision the spraying was done, wrote this department under date of August 11th, six days after using the Kero-water spray, that he could "see no bad effect on the foliage of the apple trees sprayed with 15 per cent mixture."

We have already alluded to the statement from Missouri that 10 per cent Kero-water mixture appears to be effective against the adult hopper. In spite of Mr. Wedge's statement that 15 per cent did not appear to injure foliage, from observations along this line at the Experiment Station, the writer is induced to believe that 10 per cent is much safer than 15 per cent in this regard.

At Adrian, Minnesota, Mr. Fred Mohl, proprietor of a large nursery, has kindly co-operated with the Entomologist, and has been making a series of experiments with the dust spray. Figs. 86

and 87 show the Cyclone Dust Sprayer in operation, Fig. 86 representing the hand machine, and Fig. 87 the larger machine used on wagon. Mr. Mohl sprayed twice with the "Caustic Lime" mixture, and once with the "General Formula." At the date of my visit, in July, the trees were looking very well, though they were not free of leaf hoppers. He is of the opinion that if he had begun earlier, "before the hoppers appeared" as he expressed it, and sprayed three times, he could have kept them well under control. While the writer is quite willing to be convinced, he has not absolute confidence in the perfect efficacy of dust spraying. For many fungus diseases and some insects, and under certain conditions where liquid cannot be used, it is unquestionably an excellent thing, as shown by the vigorous appearance of Mr. Mohl's trees, but in the case of the leaf hopper we have doubts. We would be very glad indeed to have these doubts removed, and its extreme usefulness demonstrated.

Mr. Mohl is an enthusiast as regards dust spraying, as shown by the following extracts from letters from him, the first written on February 24th, and the latter, referring to the effect of spraying his orchard, on July 25th.

"I have your favor of the 23rd inst. regarding campaign against the leaf hopper and was glad to hear from you on this subject as I have for years been bothered with these leaf hoppers not only in the orchard but also in the nursery. With the old method of spraying, it has been hard to reach them as they get on the under side of the leaf, which curls up and with liquid spray you cannot get to them, unless, perhaps, by persistent early spraying, which may keep them away. This year I intend to give the dust spray a thorough test and will begin the first spraying before the leaves come out. I intend to buy another small dust sprayer in addition to the Cyclone sprayer which I have. This smaller machine can be carried about and will come handy to fight the enemy as it appears. I shall also buy the prepared dust as per circular which I enclose.

"In the orchard where we sprayed with the Caustic Lime twice and once with the General Formula, we can find scarcely any leaf hoppers, and, in fact, no insect pest of any kind. I am of the opinion that if we had begun spraying in the nursery before the enemy

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NOTE.—The "Caustic Lime" formula consists of ground lime, sulphur and concentrated lye. The "General Formula" is made of ground lime, "sal. Bordeaux," sulphur and Paris green.

appeared and sprayed with the Caustic Lime, say about three times, there would have been but a few hoppers. Some varieties appear to be more affected than others. * * * I am yet of the opinion that if the dust or dry Bordeaux is as effective as the liquid, a tree can be much more thoroughly sprayed than with liquid, and in less time and with less work." In a later letter Mr. Mohl states that he sprayed the nursery only once, with Caustic Lime, after the hoppers appeared and that it did not destroy them.

In certain experiments at the Station during the season, in connection with the leaf hopper, we found that one part of emulsion to twelve of water, when liberally applied to young nursery trees, will sometimes slightly burn some of the leaves of young apple trees if applied freely in hot sunshine. Under favorable conditions, however, we have used it as strong as one to ten without appreciable injury.

Incidentally, observations were made upon the stability of kerosene emulsion when mixed with water. We found that when one part emulsion was used to twelve of water, the separation of the oil began immediately, and the mixture could not be used safely after 15 hours; one part of emulsion to eight of water gave almost as bad results, while one part of emulsion to six of water was very much slower in separating. We found further that 10 per cent Kero-water could be used with safety as regards the foliage, was death to plant lice, and apparently fatal to old as well as young tree hoppers.

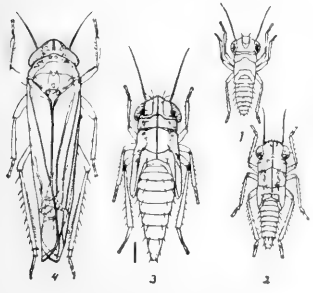


Fig. 88.—Different Stages of the Leaf Hopper, *Empoasca mali*, Osborn. Original.

Fig. 88 represents the different stages of this tree hopper from shortly after hatching to the adult stage. It has been found on a number of trees and plants other than apple. In the case of the latter tree it would appear from evidence at hand that the egg is laid by the adult in the tissue of the leaf, since young are found on the under side of the leaf, of such a tender age as to preclude the possibility of their coming from any but a nearby source. Yet in the absence of conclusive evidence the Entomologist hesitates to regard the above probability in the light of a fact.

Mr. Robert Wedge, who did considerable work against the hopper in Southern Minnesota last summer, under the writer's direction, reports that this insect's attacks are least apparent on the Northwestern Greenings, and most evident on the Repka, Charlamoff, Lyman, Minnesota and Transcendent, these five varieties being about equal sufferers. After the Repka, according to this correspondent, Scott's Winter appears to be quite badly affected, and then in diminishing ratio, Patten's Greening, Early Strawberry, Sweet Russet, Malinda, Longfield, Duchess, Hibernal, Wealthy, Whitney, Peerless, Anisim.

USES TO WHICH THE ABOVE CART MAY BE APPLIED.

The pictures of this spraying machine illustrate what may be the steps in the evolution of something of special adaptation to the needs of all tree growers. As it is now constructed it can be used with Kero-water mixture, or kerosene emulsion, or lime and sulphur spray, or resin wash, or Paris green, in short, with any of the sprays commonly used by nurserymen or orchardists against plant lice, leaf hoppers, caterpillars, scale, and other leaf-eating or sap-sucking insects. It is so large that it is adapted particularly to large nurseries on level ground. The expense of its construction would place it perhaps out of reach of the small growers, but nevertheless a number of nurserymen of the same locality could share the expense and the advantages of such a machine with considerable profit. Further, the possibilities foreshadowed in the success of this cart as a sprayer are practically unlimited. A cart to straddle one row and spray the straddled row and the two adjoining rows could, in the opinion of the writer, be easily constructed. These carts, too, including the one we are now using, could be made automatic by connecting the pumps by proper gearing with the wheels.

This work against the leaf hopper will be continued next summer, and begun at the very first appearance of the insect.

SPRAYING AND SPRAYING MACHINERY.

This is a hackneyed subject in many states where fruit raising plays an important role, but has never been thoroughly discussed in Minnesota reports in the light of what we now know upon this

important adjunct to agriculture. It is claimed that the annual loss on crops in the United States from insects and fungi ranges from $300,000,000 to $500,000,000, and that 75 per cent of this can be saved by judicious spraying. Our state is not only taking a stand as a fruit-raising state, but the conditions of raising vegetables, root crops, etc., have become such that frequently spraying is an imperative necessity. The Entomologist has been asked by agriculturists and horticulturists to discuss this subject fully, since in many instances money and time are wasted through ignorance of the essential principles of spraying, coupled with a lack of knowledge of the habits of certain insects. Some insects eat the surface of twig, or leaf, or bud, or fruit, and can be killed with internal poisons such as Paris green, arsenate of lead, London purple, hellebore and the like. But others, from the fact of their inserting a beak and sucking the sap from below the surface, cannot be reached by any arsenical or other poison applied to the surface, but must be sprayed or washed with some oily or soapy mixture, such as soapsuds, whale oil soap, kerosene emulsion, petroleum and the like, something which will stop up the spiracles (little holes along the side of the body through which they breathe), or will so irritate or burn the surface of their bodies, sometimes also stopping the spiracles, as to cause death. Such agents are found in tobacco water, pyrethrum, lime, sulphur, lime-sulphur (and salt) solution, potash, lye, etc.

We can therefore readily divide Minnesota insects into two well marked groups, those which are mandibulate or biting, and those which are haustorial or sucking. Under the first class we have cut worms, army worms, potato beetle or "potato bug," codling moth or "apple worm," currant worms, wire worms, borers, plum curculio, tent caterpillars, canker worms, pear and cherry slugs, cucumber beetle, sometimes wrongly called "squash bug," and many others; in short, all insects which have biting mouth parts when they attack our crops. Under the second class—sucking insects—we have chinch bugs, all plant lice, leaf hoppers, true squash bugs and scale insects.

Do not therefore use Paris green or any internal poison against plant lice or bed bugs, both of which mistakes on the part of our citizens have come to my notice.

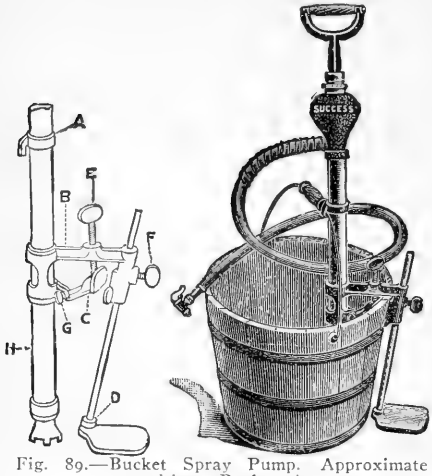


Fig. 89.—Bucket Spray Pump. Approximate cost without Bucket, $7.00.

Fig. 90.—Pump on Barrel, Showing Agitator. Approximate cost without Barrel, $16.00.

THE PUMP.

This is a very important factor in successful spraying. In purchasing a pump one will be guided by his needs; if it is wanted for a few shrubs and small trees in the yard, for use in a small vegetable garden, or for whitewashing a hen house, a bucket pump such as is shown in Fig. 89 will do, bearing in mind that the bucket or can will have to be carried from place to place and frequently filled. Hence, if a number of potato plants or other plants are to be sprayed in the vegetable garden it might pay one to get a pump which can be fastened to a barrel which could be hauled about on a wagon or stoneboat. Such pumps, with approximate cost in each case, are shown in Figs. 90 and 91.

Do NOT buy a syringe pump, which costs from $1.00 to $2.50 or $3.00 and throws only a very coarse spray, and think you have anything of value. A plant syringe is all very well in a conservatory, but valueless if any number of shrubs and trees are to be treated, and even conservatory or house use calls for something which will administer the liquid in a fine spray and with force.

Do NOT allow your home dealer to sell you a cheap pump

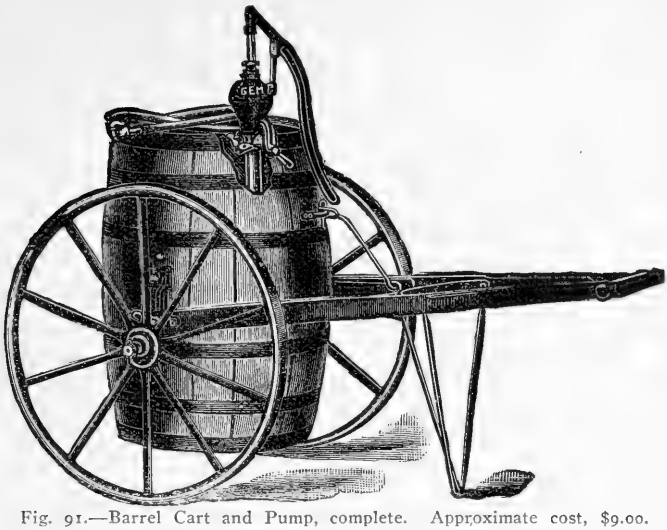


Fig. 91.—Barrel Cart and Pump, complete. Approximate cost, $9.00.

($3.00 to $8.00) for garden and orchard, on the ground that it is "just as good." It is not as good, as you will no doubt find later to your cost, should you be persuaded to purchase it. We append be-

Fig. 92.—Small Sprayer for use in greenhouse or garden. Tin, 60c.; Brass Reservoir, 85c.

low a list of manufacturers of spray pumps, and a good pump should show the name of some one of these as a guarantee of

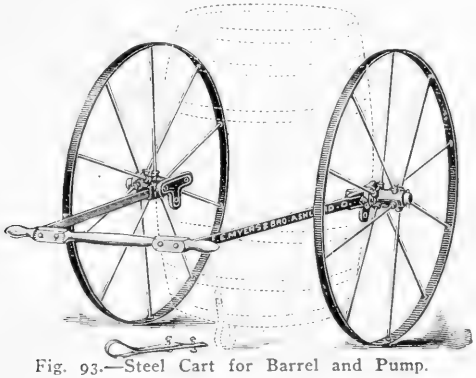


Fig. 93.—Steel Cart for Barrel and Pump.

its excellence. A good pump is one whose parts do not easily corrode. The working parts should be of brass. Leather or rubber valves are not used in the best pumps, but are replaced by brass valves. Cylinders lined with porcelain are not desirable.

A farmer or fruit grower should be willing to pay anywhere from $9 to $20 for a good pump. Automatic and power sprayers, for use in large orchards, and on extensive field crops (See Figs. 97, 98, 99, 100) come much higher. He should insist upon seeing the interior of a pump before buying. Several might unite in buying a pump, thereby being able to purchase a good article with comparatively small expense to each individual.

Fig. 94.—A Barrel Cart.

Connections of good hose are important, and poor hose should be avoided; three-ply and four-ply are generally used, but where great pressure is to be planned for, five-ply or even six-ply is desirable. Hose can be bought of any length, and where trees of some height are to be sprayed (10 to 20 feet) extensions are necessary. These can be bought of various lengths, and consist either of metal pipe alone to the ends of which the hose and nozzle is attached, or the same encased in bamboo. Drip guards which encircle the extension just below the nozzle, or just above the point where it is held will add to the

comfort of the man spraying by catching liquid which would otherwise run down the pole upon his hands. In submitting the following list of manufacturers, taken from Geneva Bulletin No. 243, we must remind our readers that some of these firms have agents in different cities in Minnesota. In such cases, the manufacturers would not quote any better price than the agents. A request for a catalogue price list, mailed to any one of the following firms, would doubtless meet with immediate attention.

E. C. Brown & Co., Rochester, N. Y.
Dust Sprayer Mfg. Co., 510 Broadway, Kansas City, Mo.
Deming Co., Salem, Ohio.
W. & B. Douglas, Middletown, Conn.
Field Force Pump Co., Elmira, N. Y.
Friend Mfg. Co., Gasport, N. Y.
J. F. Gaylord, Catskill, N. Y.
Goulds Mfg. Co., Seneca Falls, N. Y.
Hardie Spray Pump Mfg. Co., Detroit, Mich.
H. W. Henry, LaPorte, Ind.
Hillis Dust Spray Mfg. Co., McFall, Mo.
Leggett & Bro., New York.
J. J. Kiser, Stanberry, Mo.
Morrill & Morley, Benton Harbor, Mich.
F. E. Myers & Bro., Ashland, O.
Niagara Spraying Co., Middleport, N. Y.
Pierce-Loop Sprayer Co., North East, Pa.
Rochester Machine Tool Works, Ltd., Rochester, N. Y.
Rippley Hardware Co., Grafton, Ill.
D. B. Smith & Co., Utica, N. Y.
Spramotor Co., London, Ont., and Buffalo, N. Y.
Wm. Stahl, Quincy, Ill.
Wallace Machinery Co., Champaign, Ill.
R. B. Williamson, Clifton Springs, N. Y

THE NOZZLE AND THE SPRAY.

A spraying outfit without a good nozzle is like the play of Hamlet with Hamlet himself omitted; in other words, the outfit is practically worthless unless it is well equipped in this particular. This leads us to speak of a most important point in this connection, namely, the *liquid must be applied in the form of a mist, or very fine spray, and must strike the fruit, leaf or twig with force.* A nozzle *which will not do this is, with the exception noted below, of little or no value,* as far as

Fig. 95.—An Automatic Sprayer. Cask holds 10 gallons. Wheel 26 inches high, 3-inch Tire. Weight of outfit, 75 pounds. Price complete, as shown, $24.00.

treatment against insect pests is concerned. Do not think that a mere sprinkling is going to do the work. Note, in this connection, that the old-fashioned field sprinkler which used to be employed in putting Paris green solution on potato vines has been replaced by the modern cart, geared to pump automatically, and furnished with nozzles which apply the liquid in a fine spray and with force. This is economy, for when there is but a coarse spray, or if the nozzle "dribbles" the liquid is wasted. It is economy too, while seeing that every leaf and every part of the fruit or twig, whatever one is treating, is well covered, not to waste the liquid by spraying too much, that is, the liquid should not drip off, or run off the tree or plant to any great extent.

In purchasing a nozzle, get one which can be readily cleaned, for even with care in straining the liquid, some particles of foreign matter will occasionally clog the nozzle. We have found the Vermorel

Fig. 96.—Spraying Outfit for high trees.

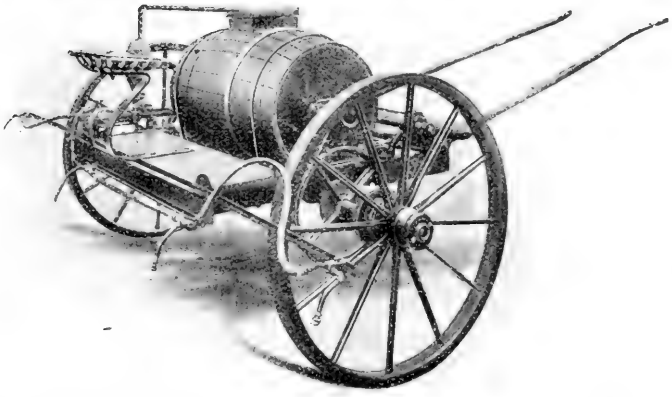


Fig. 97.—Automatic Field Sprayer, Six rows. Approximate cost, $67.50.

nozzles excellent in this particular, and making a spray fine enough and forcible enough for all purposes. When Bordeaux mixture or lime-sulphur-salt mixture, or a whitewash is to be used I change the Vermorel for the Bordeaux nozzle, which is better adapted to these compounds. This is the exception referred to above.

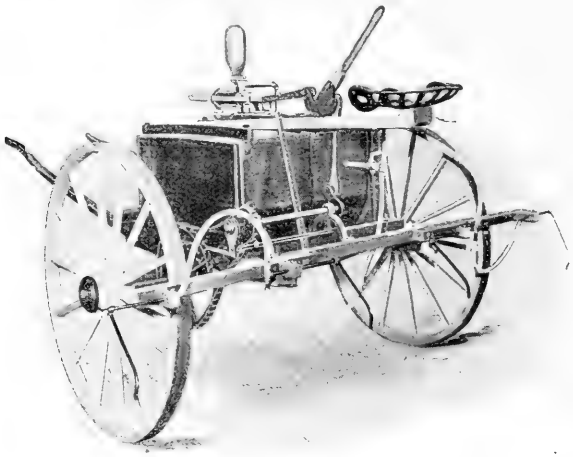


Fig. 98.—Automatic Field Sprayer, Six rows. Approximate cost, $72.50.

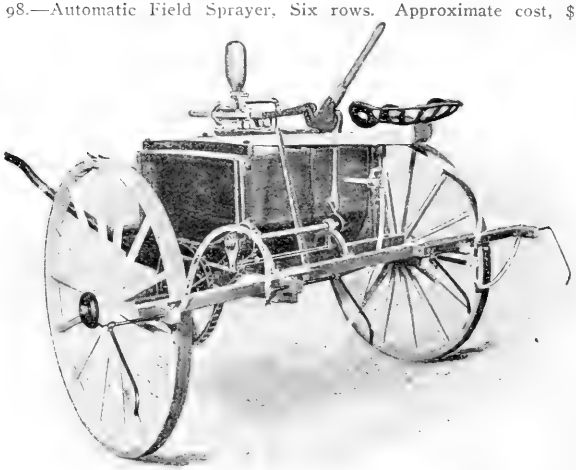


Fig. 99.—Automatic Field Sprayer, with five rows of brass piping. Approximate cost, $90.00.

STRAINERS.

All compounds used for spraying should be strained before or while being poured into the barrel or other receptacle from which they are to be drawn by the pump. If possible avoid using burlap for

this purpose, since if used lint is bound to be carried into the pump and is likely to bother you by clogging the nozzle. Brass strainers are the best, made to fit the opening through which one pours the liquid. In addition to this, every good pump has a strainer in the lower end of suction pipe or suction hose through which the liquid is drawn into the pump.

AGITATORS.

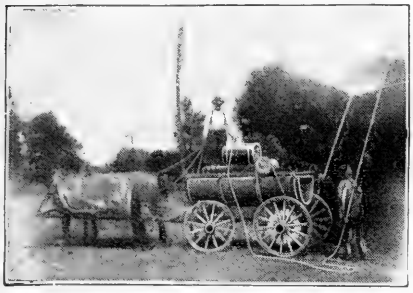


Fig. 100.—Power Sprayer mounted on Wagon.

Most pumps—all good pumps—are equipped with agitators which, as a rule, the working of the pump handle keeps in motion. These are generally paddles which keep the liquid in the barrel or other receptacle constantly stirred. *Paris green being heavier than water, sinks if the liquid is not kept constantly in motion*, the result being that the poison is unevenly distributed, and a part of the tree or a portion of the plant will be injured or killed

Fig. 100½.—Six-row Sprayer in Field.

by receiving an unnecessarily large amount of the green, while other parts will receive little or none. Should one be using Paris green in solution from a bucket, this should be borne in mind, and the solution almost constantly stirred.

TANKS FOR FIELD USE.

Fig. 101.—Three-row Sprayer at work in field of Strawberries. It is claimed that one man can drive and work the machine. Price of Hose, Piping, Nozzles and Connections (without the pump), $7.50.

These can be made of galvanized iron or pine (cypress is said to be the best of the woods for this purpose where obtainable) or cedar. When made of wood the inside should be painted. Two horses cannot comfortably draw more than 250 gallons of liquid over the field.

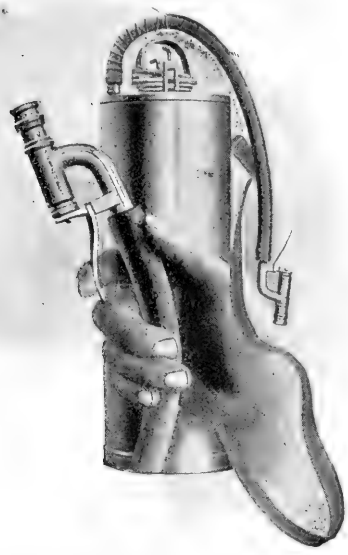


Fig. 102.—The "Auto Spray." Holds four gallons. The hand in the engraving is out of all proportion. Tank is of steel or brass. Compressed air. Weight, when loaded, 39 Pounds.

KNAPSACK SPRAYERS

Machines intended to be carried around on back, or lifted about by hand when desired, and excellent for work with shrubbery or in garden where too much ground is not to be covered. The writer speaks from personal experience when he says that after several fillings the weight tells upon one's back and shoulders. See Fig. 112.

Fig. 103.—Vermorel Nozzle. Cost, 80c.

Fig. 104.—Improved Vermorel Nozzle.

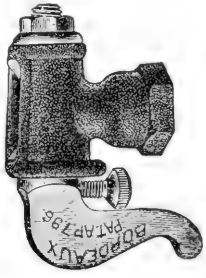


Fig. 105.—"Bordeaux" Spray Nozzle. Cost, 80c.

KERO-WATER SPRAYERS.

These are machines made both in knapsack form, Fig. 112, and to be used with barrel, Fig. 113, possessing a receptacle for kerosene so connected that every stroke of the pump handle draws some of the oil from the oil tank and it is mechanically mixed with the water, issuing from the nozzle in what we call the "Kero-water spray." This has the advantage over kerosene emulsion in that it eliminates the making of the latter, and hence is a saving of time. It is, of course, cleaner than the emulsion and easier to handle. Ten per cent of oil and 90 per cent of water, or 10 per cent Kero-water, as it is called, is very effective against many sucking insects, and ordinarily does not injure the foliage. A valve and graduated disk on these pumps is supposed to afford an opportunity to obtain 5 per cent, 10 per cent, 20 per cent of

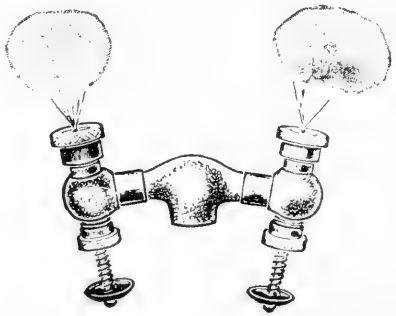


Fig. 106.—Double Vermorel Nozzle.

oil and upwards, according to the needs of the operator. Unfortunately in all the pumps with which the writer has had experience, the per cent of oil indicated is not always the per cent obtained. Further, it has been our experience in the field to find that a Kero-water pump which is delivering say 15 per cent Kero-water at one time, may drop to 5 per cent when the water or oil in the receptacles gets low. However, the first of these defects can be overcome by testing, preferably, with a glass graduate, your own machine before it is used, and making memoranda of what the indicated per cents on the disk really are in practice. We found that 5 per cent and 10 per cent could not be relied upon at all, see page ——; that 20 per cent really gave 10

Fig. 109.—Bamboo Extension.

Fig. 110.—Three-cluster painting Nozzle.

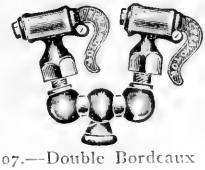


Fig. 107.—Double Bordeaux Nozzle.

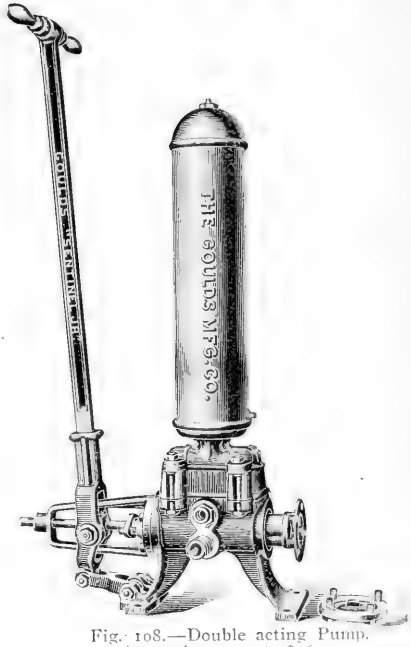


Fig. 108.—Double acting Pump. Approximate cost, $36.00.

per cent, etc. Any glass jar or bottle with straight sides can be used in this test to obtain an approximately correct reading of the proportionate amount of water and oil. Catch the spray as it issues from the nozzle, and let it stand until all the oil has gathered at the top of the water. If there is one-fifth as much oil as water, your pump is giving you 20 per cent kerosene; if one-tenth as much oil, 10 per cent kerosene or Kero-water; if one-half as much oil, 50 per cent Kero-water and so on. It has been found necessary

in the field to frequently test one of the Kero-water pumps which we are using (see page 88), in order to post ourselves as to just what strength we were giving the trees.

DUST SPRAYERS.

The simplest form of dust sprayer is found, perhaps, in the little bellows sold at drug stores, and used to distribute pyrethrum in cracks and crevices which might conceal fleas or bedbugs. A larger bellows is made for use with plants, and a still more complete machine for field use is known as the Leggett London Purple Gun, Fig. 115, with which one can distribute lime or a mixture of lime and Paris green, flour and Paris green, hellebore and like material. More recently, at least two firms have manufactured dust sprayers on a larger scale, to be placed on wagons, and intended for use in large nurseries or orchards. One called the "Cyclone Sprayer," and made in Kansas City, is figured herewith, Fig. 116. This machine and a smaller one made by the same firm are shown in use on pages 88 and 89. A dry Bordeaux and certain caustic compounds are used with these sprayers, or a combination of dry Bordeaux and Paris green are manufactured, though directions are given to purchasers whereby many of these compounds may be made at home. The claims made by the manufacturers and several of the users of dust sprays are many: They say there are no barrels of liquid to be hauled, and this is of great value where it is hard to carry or obtain water; that the cloud of dust envelopes immense numbers of trees, sometimes covering an entire orchard; that it is imposible to get too much of the spray; that it costs less than the manufacture and application of liquid sprays, etc. These advantages, barring the item of less expense, which must vary, are self-evident. On the other hand there are certain disadvantages in this method equally apparent, namely: When a strong wind is blowing it cannot well be used, one being obliged to keep to the windward side

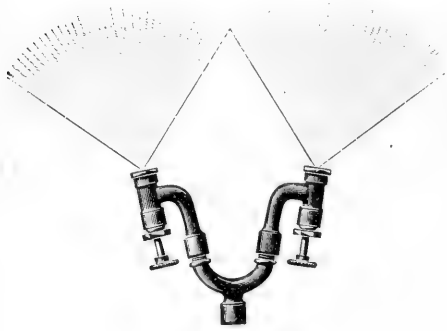


Fig. 111.—Double Vermorel with Y.

Fig. 112.—Knapsack Sprayer.

of the trees constantly; it is best used apparently when the dew is on trees and plants, thus relegating the work to the morning hours; it is not apparently effective against the codling moth; one has to personally avoid the dust and see that it does not settle on the horses; for sucking insects, in the opinion of the writer, nothing is so good for summer use as kerosene emulsion or Kero-water; arsenate of lead, which is coming into universal favor as a safe remedy for insects which eat leaf, or fruit, or twig, bud or bark, cannot, of course, be used as a dust spray.

Fig. 113.—Kero-water Pump on Barrel. Approximate cost of Pump mounted on barrel (without hose or nozzles), $21.00.

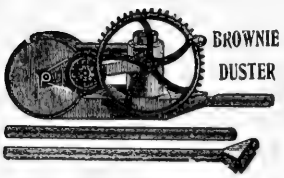


Fig. 114.—The "Brownie Duster." A small Dust Sprayer for use in conservatory, greenhouse or garden. Cost, $3.50.

I do not wish to be understood as in any way condemning the use of dust sprays, for they certainly stand for an advance in our means of attacking injurious insects, but it would be unwise not to consider the disadvantages in their use as well as the advantages. I do not believe they will ever entirely replace liquid spraying.

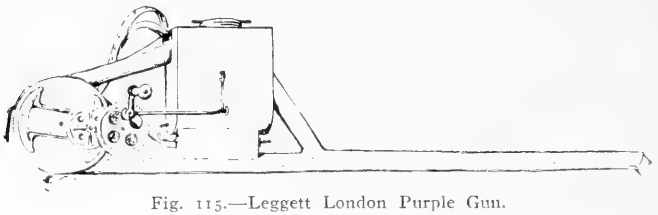


Fig. 115.—Leggett London Purple Gun.

INSECTICIDES AND FUNGICIDES.

A very complete list of spraying compounds for both sucking and biting insects, and for the more common fungicides used against fungous diseases which attack fruit trees, vines, etc., was given in the Annual Report of the State Entomologist for 1903, and need not be repeated here. The report referred to can be had for the asking.

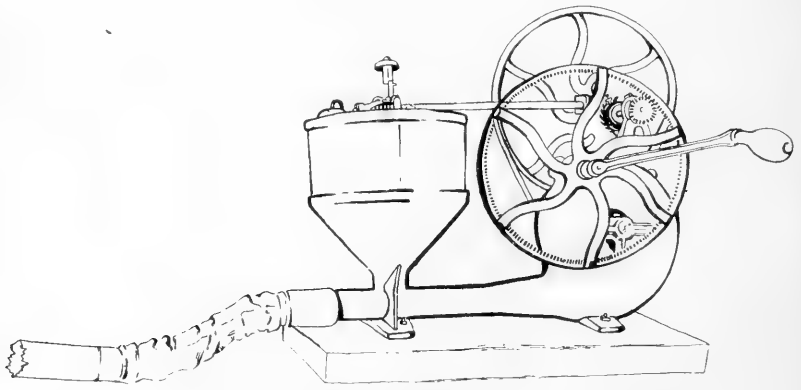


Fig. 116.—Cyclone Dust Sprayer for use on wagon. Approximate cost, $22.00.

Fig. 117.—McGowen Injector. For putting bi-sulphide of carbon about roots of trees or plants. Slingerland.

THE PLUM CURCULIO AN ENEMY TO APPLES.

(Paper read before the State Horticultural Society at its 1904 meeting.)

That this pest, which we associate so commonly with plums, does attack apples, is not a new fact, since this departure from the orthodox food habits has been known for some time; but since apple-raising in Minnesota is, practically speaking, in its infancy, this naughty feature in the life of this weevil, illustrated by the loss, in at least one instance, of 100 per cent of the apple-crop in a Southern Minnesota orchard last season, is unceremoniously brought to our door in a very emphatic and unpleasant manner. Fourteen other orchards have suffered, to my certain knowledge, and there are probably many other instances of its work in apples in this state not known to me. I might add that I placed some of these injured apples in a breeding jar and in September had a fine lot of Plum Curculios from the same.

There is no doubt but that this Curculio is to be regarded quite as much of a pest to the apple in Minnesota as the Codling Moth, or even more so.

This Curculio belongs to the family of beetles known as "Snout Beetles" or weevils, of which there are about 10,000 known species, which family causes a loss of over $30,000,000 annually in the United States. It is unnecessary to state that our little friend with the humps on his back, the Plum Curculio, does all he can with other members of his family to keep up his reputation as an evil-doer.

As a result of this weevil's attack on the apple we find the fruit dwarfed, misshapen, covered with ugly scars, looking like Fig. 120, and actually worthless except for hog food, as it falls to the ground.

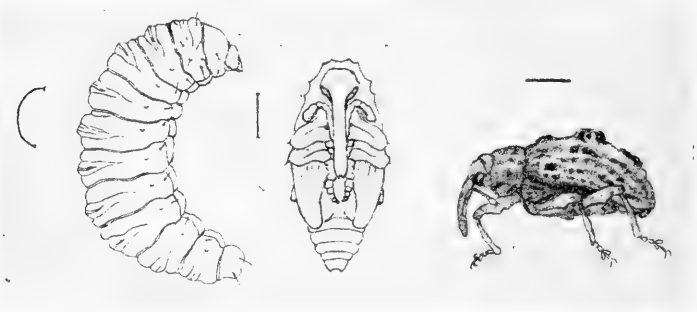


Fig. 119.—Plum Curculio, larva or grub, pupa and imago. After Lugger.

If one cuts into one of these apples during midsummer, in July say, the small whitish grub is disclosed, actively engaged in boring through the fruit, and waxing strong and fat, preparatory to the time when, the apple fallen, he or she, as the case may be, will enter the ground to pass through a resting stage or pupal stage of two or three weeks, before turning into the imago, or perfect insect. This takes place before fall, generally in August, but the beetle does not mate upon emergence from the pupal stage. Its first instinct is to eat, and after lunching upon fruit for a while, by puncturing the apples, it winters under rubbish and leaves, deferring its courtship until the following spring. The first warm days of spring, after the fruit is formed, find the lady Curculio laying her eggs. Although the insect is single brooded, she continues egg-laying for some little time, probably

through the latter part of May and June, and later, as though she were conscious that she had to do all she could before dying in the late summer or autumn. Now, insects must eat, as we all know to our cost, and while she is egg-laying she, as well as the male, feeds upon tender leaf buds and leaves, and upon the fruit also. Before the fruit is large enough to tempt her to lay, in fact before it has formed, and probably before she has mated, she varies her diet of leaf buds by consuming the petals of the flowers as well. For obvious reasons we cannot spray when the tree is in bloom. This eating of leaves and leaf buds is a significant fact and a habit on the part of the insect which should be taken advantage of by fruit raisers. The method of egg-laying by the Plum Curculio, shared to a certain extent by other

Fig. 120.—Minnesota Apples destroyed by the Plum Curculio. Original.

members of the weevil family, is curious enough. She first punctures and eats a small hole into the pulp of the fruit. She then turns about and lays one oval, whitish egg in this hole. Her next move is to make a crescentic cut on one side of the egg puncture, eating the tissue until she gets partly around and below the egg. This is the usual method followed, though it may vary in minute detail. Evidently this crescent, which practically undermines the egg, is made so that the tender egg may not be crushed by the growing pulp of the apple or plum.

Of course, if these "stings" are made when the fruit is well along in its growth, and the egg does not hatch, or if the puncture made at that time is just for feeding purposes, it does not spoil the apple, though the fruit, which would show the scar, could not then be classed as first grade, and if, for any reason, when the apple is small, the female does not lay an egg in the puncture, or if the egg fails to hatch, the young apple will probably outgrow the injury. These "stings," however, and a glance at the accompanying picture shows that there may be many, form starting places for decay and allow fungoid diseases, which would not otherwise, perhaps, gain an entrance to the interior, to enter the fruit and play such havoc that the apple is made comparatively valueless. It is said that it takes from five to seven days for the egg to hatch, and that the larva or grub lives in the apple from eighteen to twenty-one days. It is further claimed that *if the apple does not fall to the ground when the contained larva is half grown, the development of said larva stops and it dies* (Stedman).

The adult beetles have wings by means of which they fly, sometimes for long distances, in search of suitable places in which to pass the winter. It may be said, however, that they hibernate, for the most part, under the fruit trees, particularly if there is rubbish there, or if the ground is in sod which is not disturbed.

Now, in the orchard to which I referred at the beginning of this article, where practically all of the fruit was destroyed, ideal conditions appear to exist for the encouragement of this evil; an old orchard, sprayed only one year, 1902, sod growing undisturbed for several years beneath the trees, no stock of any kind allowed to run in the orchard, and numerous plum trees in close proximity. This is one of the oldest orchards in Southern Minnesota.

I have given the habits and life history of this pest in some detail, for you all know the necessity of knowledge upon these points in order to combat any pest successfully.

From the foregoing facts certain measures of relief appeal to us as practical, for instance, spraying frequently in the early spring and summer, jarring the trees in the cool of the early morning and catching the beetles on sheets below. One enterprising apple grower, however, makes the statement that he gets more Curculios by jarring between six and seven o'clock in the evening than at any other time. He uses a cheap spread, about 15 feet square, attached to poles along

two opposite sides, so that it may be easily rolled up, and having a slit to the center into which the trunk slips. Jarring the apple trees is continued by him from the time the fruit is the size of marbles until he can catch no more beetles. This seems a good rule to follow.

It should be noted in this connection that jarring means a sudden forcible blow (padding the stick or mallet used, so as not to injure the bark), not a shaking of the limb, the latter simulating the action of the wind so closely that the beetles would not be sufficiently alarmed to drop, and would cling to the twigs until the shaking ceased.

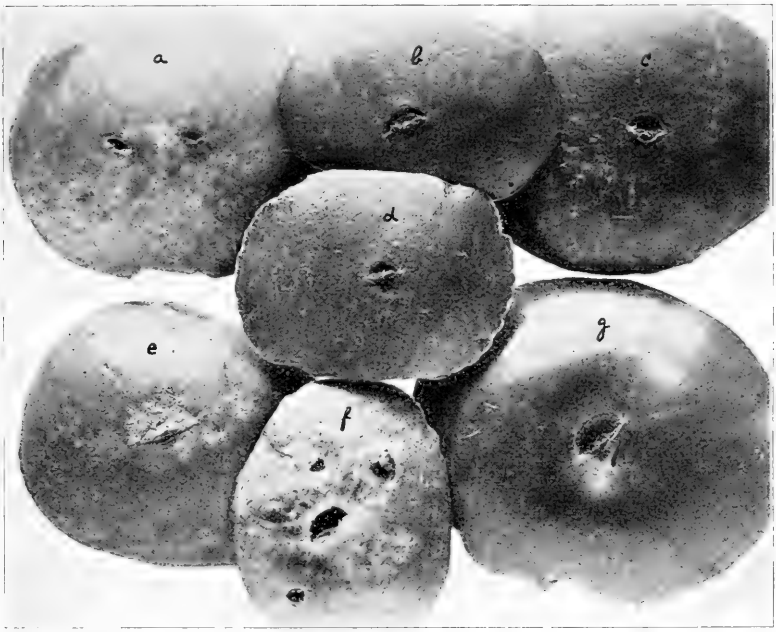


Fig. 121.—Details of injury to Apples: *a*, egg punctures with larvæ living in the pulp and the punctures beginning to decay; *b*, *c*, *d*, egg punctures beginning to heal, as eggs never hatched; *f*, badly stung portions of an apple; *e*, egg puncture nearly healed; *g*, scar in a depression. Stedman.

The ground in an infested orchard should be plowed every fall for a while, or both fall and spring, and stock, such as hogs and chickens, should have full access in order either that the fallen fruit be eaten before the grub emerges, which would be the best and safest plan, or the grub after emergence be scratched up and devoured by hungry fowls. Plum trees should not be planted in the immediate

vicinity of an apple orchard, nor should apple or other orchards be planted near a forest or wooded area, since not only does the Plum Curculio like to winter in wooded tracts, but many of our other orchard pests were originally insects of the forest. Above all it must be remembered that an ounce of prevention is worth a pound of cure, and these remedial measures must be applied in a timely way. For instance, spraying, to be of any use, must be begun before the eggs are laid, or, rather, frequent applications should be made during the entire period of egg-laying, from the middle or last of May, and before, to possibly as late as the middle of July. The writer would suggest one or two sprayings first before the blossoms open, and every ten days after the blossoms fall, until the end of the laying season, and jarring should be persevered in during this period. For spraying we would suggest using one pound of Paris green to every 160 gallons of water and the addition of a little quick lime to prevent any burning. As you are well aware, spraying in this way would also kill any other insect pest feeding upon fruit, leaf or twig. Plum trees infested with Plum Curculio should receive the same treatment. The writer would suggest using quite a little more lime when treating plums, as the plum foliage is more tender than that of the apple. A better and safer spray than Paris green, and one rapidly coming into favor, is arsenate of lead,* sometimes called disparene. This can be used of almost any strength (three to six pounds in every 100 gallons of water) without injury to trees, and remains on leaf and fruit much longer than Paris green. If a long continued and copious rain immediately follows a spraying, it is safe to conclude that much of the poison has been washed off, and spray again. I note that Stedman suggests in recent publications regarding this same evil in Missouri, the working of the soil in the apple orchard in July and August, a shallow plowing and thorough harrowing about the middle of July, followed by two more harrowings between that date and the middle of August. This would seem to be a valuable adjunct to the other work, inasmuch as it would disturb the ground at a time when the beetles were pupating just below the surface.

If not one but all the measures of relief above outlined be followed for a few years, the injury to the apple by this pest is bound to be

very much reduced, if not made to disappear altogether. Even one of the above remedial measures, if followed faithfully and intelligently, will cause a marked improvement.

*NOTE.—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 another wooden pail. The sugar of lead can be dissolved more quickly by using warm water. Pour these solutions into 150 gallons of water. Arsenate of lead can be purchased already prepared.

It is important to note in this connection that if one is using Bordeaux for early spraying for scab or other fungus diseases, adding an arsenical poison (Paris green, for example) to the Bordeaux will serve good purpose against the Plum Curculio, and other leaf and fruit eaters.

THE MOTTLED WILLOW BORER, AN INTRODUCED ENEMY TO CAROLINA POPLAR AND WILLOWS.

While this tree is not, from an æsthetic standpoint, as desirable as many others, it is becoming very popular as an addition to our list of trees for windbreaks on account of its extremely rapid and vigorous growth.

Fig. 122.—The Mottled Willow Borer, *Cryptorhynchus lapathi*, Linn., somewhat enlarged. Original.

It will interest the citizens of this state, therefore, to know that not only is this tree, but practically all the willows and probably most of the poplars, alders and birches threatened with a borer, which came from Europe several years ago, and though confined to the East for a long period, has worked its way, evidently through shipments of nursery stock, into Ohio, probably into Canada, and this

year specimens were sent to the Minnesota Entomologist from Carolina poplars received into Minnesota from New York State, and shipped from here to North Dakota, where twenty-five trees were reported killed.

This is the European alder and willow borer, *Cryptorhyncus lapathi*, Linn., shown in our illustrations. It is a snout beetle belonging to the family *Curculionidæ*, dark brown, or blackish, nearly one-half inch long, with a conspicuous whitish or yellowish (scaly) patch on the rear part of its back; these yellowish scales are seen also on its sides near its head.

It makes a hole in the poplar tree, frequently attacking a tree near the base, and in this hole deposits from one to four eggs. The white legless larva with brown head which hatches from the egg bores under the bark in the immediate vicinity of the place where it

Fig. 123.—Work of the Mottled Willow Borer in Carolina Poplar. Original.

has hatched during the first season, wintering in this position, and tunneling into the wood the second season. This boring beneath the bark, and the subsequent entering the wood will greatly injure any tree, and in the case of small trees, if the insect is in the trunk, undoubtedly cause their death. The larva, becoming full grown, transforms to a pupa at the end of the second summer, passing the second winter in this condition, and emerging as an adult beetle in the spring, the third year from the egg. In other words, two years are required for one generation. Mating and egg-laying take place after the beetle has issued from the wood.

The spread of this foreign insect westward in the United States is of interest. It was described by Linneæus in 1763; in 1824 in the vicinity of Liegnitz, a whole alder plantation was destroyed by it, willows also suffering. In some way, possibly in cuttings from

Europe, it was brought into America. In 1882 it was taken on willows in New York City; in 1884 one specimen was taken in New York State and one in Staten Island. In 1887 it was found on willows near West Bergen, New York. In 1891 Smith reports it as kill-

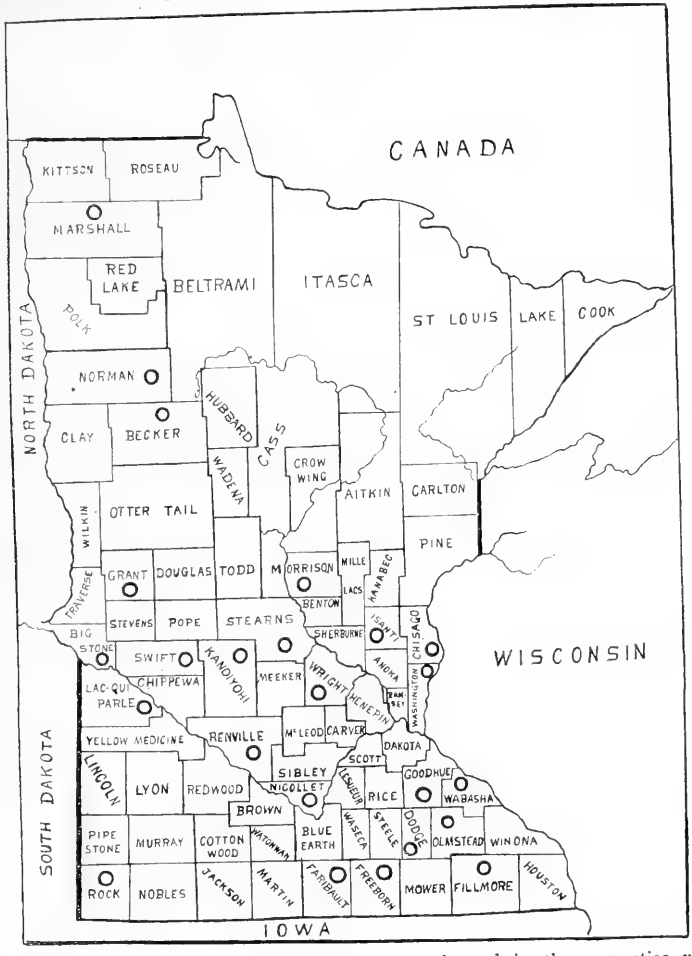


Fig. 123½.—Map of Minnesota. Correspondents are located in those counties which are marked with a O. See page 121.

ing willows and other trees in New Jersey; in 1895 it was found by Fernald at Melrose, Massachusetts, feeding in large numbers on willows. In "Garden and Forest," Vol. X, 1897, there is a statement to the effect that it was affecting all species of willows in the

Arnold Arboretum, and that it had been known about Boston and Cambridge for many years, and Vol. VIII of Psyche, 1899, states that it was very abundant about Boston in 1896. In 1898 and 1899 it became so injurious to Balm of Gilead Poplar and Willows in Massachusetts as to seriously threaten the business of nurserymen in these particulars. A report reaches us of the finding of one specimen in Montana in 1899, but this report lacks confirmation. A few years ago Burgess found it in Ohio. Dr. Howard reports receiving half-grown larvæ this summer from Detroit, Michigan. The above, with the specimens which we received from Bowbells in the northwestern part of North Dakota, indicate the westward march of this unwelcome foreigner.

Unfortunately, from the nature of the work of this insect, which is not very evident until the resulting injury is seen, most remedies or means of prevention are of but little avail; nevertheless something can be done in alleviation, and in view of its recent introduction into this part of the Northwest, radical measures should be resorted to in order to prevent such a destructive insect getting a foothold in this state.

Eleanor Ormerod, in her report of 1899, advised her constituents in England, where, by the way, the beetle has been known for a long time as "The Mottled Willow Beetle," to apply repellant washes to the trunks and branches of young trees, also to jar the trees, and the destruction of infested branches in the spring.

The writer has recommended the examination of nursery stock and young door-yard trees in June, if the presence of this pest is suspected, and the cutting off of the affected branches (or affected trunk if it is a small tree) and burning the same with the culprit inside. A possibly good preventive to young stock in the nursery or elsewhere would be a whitewash on trunks and larger branches, containing a liberal allowance of Paris green, applied two or three times during May and early June, and again, since egg-laying has been observed in the fall, in September. Jarring the trees during these two months, May and June, in the morning, causing the beetles to drop on a sheet below, is also suggested. The Agricultural Department recommends putting newspapers about the bases of trees, and above these, deterrent washes. Two parasites have been bred from this pest; an Ichneumon Fly, *Ephialtes irritator*, Fab., and *Ermogastra hartii*, Ashm.

The case has assumed such a serious aspect that this Department has notified all nurserymen who apply for State Certificates that hereafter no certificate will be granted to any nursery upon whose trees this beetle is found.

In addition to the works mentioned above, interesting accounts of this beetle can be found in "Loudon's Arboretum et Fructicetum," Vol. III, 1838; in Selby's "Forest Trees," 1842; in "Zeitschrift fur das Forst und Jagd-wesen," Vol. XXIII, 1891; in Westwood's "Introduction to Classification of Insects," Vol. 1; in "Lehrbuch der Mitteleuropäischen Forstinsekten Kunde," Vol. 1, by Judeith & Nitsche, 1895; in "Entomologica Americana," Vol. III, p. 123, 1897; in "Forest Protection," by W. R. Fisher; in "Forst-Zoologie," by Altum, Vol. III, Insekten, pt. 1; in Henschel's "Die Schadlichenfurst und Obstbaum Insekten;" in Journal of Columbus Horticultural Society, Vol. XVI; in 32nd Annual Report, Entomological Society of Ontario, 1902; in Bulletin No. 46, Bureau of Forestry, U. S. Dept. of Agriculture, 1904, entitled "The Basket Willow," and elsewhere. Many of the writers on this insect mention a habit it has of emitting a squeaking noise when handled or annoyed, evidently made by rubbing parts of the thorax together.

NURSERY INSPECTION.

The nurseries of the state which have applied for inspection have been found free from dangerous insects and contagious plant diseases, and, as a rule, appear to be in excellent condition in every respect. The nurserymen have, without exception, shown every disposition to assist the Entomologist in his work, and have been uniformly kind and courteous.

Since the discovery of the imported Mottled Willow and Poplar Borer, notice has been sent all nurserymen that hereafter no certificate will be granted if this dangerous pest is found in their stock.

Appended is a list showing the source of money ($130.18) obtained from inspection in accordance with the law, and also the fact that the same has been handed to the State Treasurer to be added to the fund for combating injurious insects in Minnesota.

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

Debit by Cash Received.

1904.	Name and Town.	No. of Cert.	Cash.
July 5.	Minnesota Seed Co., Faribault	27	$1.25
July 5.	Brand Nursery, Faribault	28	1.25
July 5.	Andrews Nursery, Faribault	29	1.25
July 6.	Clinton Falls Nursery Co., Owatonna	30	
July 6.	Mitchell Nursery Co., Owatonna	31	
July 6.	Minnesota State Nursery Co., Albert Lea	32	
July 7.	Albert Lea Nursery Co., Albert Lea	33	
July 8.	Wedge Nursery Co., Albert Lea	34	
July 9.	Winnebago Nursery, Winnebago City	35	47.59
July 9.	Fairmont Nursery, Fairmont	36	
July 10.	Amber Lake Nursery, Amber Lake	37	
July 12.	Kanaranzi Nursery, Kanaranzi	38	
July 12.	Luverne Nursery, Luverne	39	
July 21.	John Osborn, Dassel	40	2.00
July 22.	J. W. Beckman, Cokato	41	1.72
July 22.	John Eklof, Cokato	42	1.72
July 22.	W. H. Eddy, Howard Lake	43	1.72
July 22.	W. L. Taylor, Howard Lake	44	1.72
July 22.	D. M. Bowers, Howard Lake	45	1.72
July 28.	Jewell Nursery Co., Lake City	48	3.00
July 29.	County Line Fruit Farm, Lake City	49	3.75
July 29.	Pleasant Valley Fruit Farm, Pleasant Valley	50	4.50
July 29.	Vinegar Hill, Houston	51	6.50
July 29.	Preston Nursery, Preston	52	5.31
July 30.	Spring Valley Nursery	53	4.98
July 30.	A. O. Hawkins, Excelsior	46	1.55
July 30.	Chas. Hawkinson, Excelsior	47	1.55
Aug. 15.	John Hawkins, Minneapolis	54	1.50
Aug. 17.	Fred Cowles, West Concord	55	3.50
Aug. 17.	W. E. Fryer, Mantorville	56	3.50
Aug. 18.	G. W. Strand, Taylor's Falls	57	5.00
Aug. 24.	F. E. Cutting, Byron	58	5.00
Aug. 29.	John Zeller (New Ulm Nursery), New Ulm	59	4.25
Aug. 29.	Wm. Pfaender, Jr. (Pioneer Nursery), New Ulm	60	4.25
Sept. 3.	Mayfield Nursery, Lakeland	61	5.40
Sept. 3.	L. L. May & Co., St. Paul	62	
Sept. 12.	Hoyt Plant & Seed Co., St. Paul	63	1.00
Sept. 14.	Hennepin County Nursery, Eden Prairie	64	3.70
Total			$130.18

Credit by Cash Paid State Treasurer.

November	$130.18

REPORTS OF CORRESPONDENTS.

(See map on page 117.)

NAME AND LOCATION.	MAY.	JUNE.	JULY.	AUGUST.
Abrahamson, O. E., Buffalo Lake, Renville Co.	No insects.	Cut worms scarce; striped cucumber beetles abundant; currant worms plentiful; potato bugs abundant.	Minimum temperature 57; squash bugs (?) plentiful.	No chinch bugs observed; crickets numerous; plant lice on corn stalks; grub worms and cut worms noticed occasionally; rust took half crop.
Cook, S. Ray, Fort Ripley, Morrison Co.	No report.	Cut worms damaged corn considerably; currant worms damaged one-third of crop; plum leaf aphis and plum pocket found; potato beetles troublesome; plant lice on rose bushes.	Hessian fly reported but scarce.	No insect damage.
Emerson, Rudolph, West Concord, Dodge Co.	No chinch bugs; no potato bugs as yet.	Currant worm bad; potato bugs scarce; cucumber beetle quite numerous.	Potato bug and cabbageworm bad; latter just started.	Rust worse than all insects, 30 per cent loss; Minn. 169 not injured at all; fife next and bluestem injured worst of all; chinch bugs and Hessian fly not seen at all during season; cabbage worm bad; also potato bug.
Foss, Oluf N., Wendell, Grant Co.	No injurious insects, not even cut worms.	A few potato bugs.	Few potato bugs.	Wheat louse present; rust very bad; almost entire crop destroyed.
Graham, R. M., Rochester, Olmsted Co.	A very few chinch bugs; potato bugs few; tent caterpillars few.	Potato bugs numerous; smut on barley bad; rust on wheat not very bad; no chinch bugs.	No damage by chinch bug; potato bugs bad; elm-leaf louse plentiful.	Plum gouger damaged 25 per cent of plums; potato bugs very numerous; fire blight bad on young trees.
Hjelle, Ole, West Valley, Marshall Co.	No insect damage.	Potato bugs bad.	Hessian fly bad in wheat; potato bugs quite bad.	Hessian fly some damage; frit fly (?) bad; rust damaged 50 per cent of crop.
Holmberg, Ruth, Renville, Renville Co.	.....	.....	Potato bug worst pest; Hessian fly begun.	Hessian fly did little damage; potato bugs bad: cut worms numerous during first of summer.
Horton, T. J., North Branch, Chisago Co.	Chinch bugs; a carabid beetle, *Glopinus incrassatus*, Lec, found eating planted corn.	Potato beetle and cut worms numerous.	No insects.	No sign of chinch bugs.
Jensen, Andrew, Kanaranzi, Rock Co.	Wire worms bad on corn.	White grub bad; elm aphis abundant on shade trees.	.....	Hessian fly did some damage, but not much.

REPORTS OF CORRESPONDENTS—Continued.

NAME AND LOCATION.	MAY.	JUNE.	JULY.	AUGUST.
Larson, Albert, Goodhue, Goodhue Co.....	Few chinch bugs seen.	No damage by insects; only a few potato bugs.	Currant worms numerous; a few chinch bugs noticed; potato bugs numerous.	Cabbage worms present.
Ley, Lizzie L., Kellogg, Wabasha Co.....	No damage by insects.	Cucumber beetles and white striped (?) beetles numerous.	Potato bugs bad.	Potato bugs bad; grub worm damaged strawberry roots.
McKenzie, Wm., Willmar, Kandiyohi Co.....	Gophers numerous.	No insect damage.	Potato bugs destructive; smut and rust not damaging grain much.	Rust damaged wheat and oats badly; smut bad in barley, oats and wheat.
Moore, Chas. E., Detroit, Becker Co.....	Cabbage butterflies numerous; cut worms present and bad.	No sign of Hessian fly and chinch bug; sphinx caterpillar worked on clematis, etc.; potato bugs very numerous; plum gouger bad; plum pocket very bad; strawberry weevil (?) abundant.	Rust bad on wheat and oats; leaf rollers present; borer on boxelders; willow slug on golden willow.	Rust very bad.
Moore, O. W., Spring Valley, Fillmore Co.....	No trace of chinch bugs.	Chinch bugs present in limited numbers; potato beetles present; currant worms numerous; curculio bad; plum pocket serious.	No damage from chinch bugs; potato bugs worse than ever; pum curculio on apple serious; leaf hopper bad; codling moth at work; aphis scarce.	Cabbage worm active; insects same as mentioned for July; rot of potatoes bad.
Nelson, Chas. F., Braham, Isanti Co.....	Cut worms, quite a few.	Currant worms bad; potato bugs numerous.	No Hessian fly nor chinch bug; potato bugs very numerous; oak leaf badly affected with leaf miner (?).	Red-humped apple tree caterpillars quite numerous.
Newland, John G., Hendrum, Norman Co.....	Pocket gophers bad; no insects.	Potato bugs bad; worms eating into wheat kernels; cut worms numerous.	Lice on plum trees; rust bad on wheat; 20 per cent loss.	Some grain plant lice; no damage.
Olson, Chester, Adelaide, Big Stone Co.....	Cut worms present; tent caterpillars found; boxelders bothered with white worms (?) rolling leaves.	Small white (?) worm (sawfly) on ash leaves; Hessian fly is not noticeable; potato bugs not as troublesome as in 1903.	Effects of Hessian fly noticed on 24th; less than 5 per cent of wheat and rye damaged; potato bugs bad; slight damage from cabbage worm.	Hessian fly scarcely noticeable; rust damaged 50 per cent of wheat; crickets and grasshoppers extremely scarce; no boxelder bugs; potato bugs as bad as ever; cut worms did little damage.
Orton, Geo. E., Marietta, Lac qui Parle Co.....	Cut worms plentiful; tent caterpillars numerous; plum leaf galls (?) bad; boxelder galls.	Plum pocket plentiful; boxelder not badly damaged.	Hessian fly not very bad; rust bad; fire blight present.	.....

REPORTS OF CORRESPONDENTS—Concluded.

NAME AND LOCATION.	MAY.	JUNE.	JULY.	AUGUST.
Pederson, P. A., Town of Lorning, Swift Co..... Beardsley, Big Stone Co.....	Tent caterpillars present.	Ash tree leaves eaten; also oak leaves (Big Stone Co.).	Rust present; no ash tree insects (Swift Co.).	Rust worst enemy; Hessian fly only once found; crickets not numerous as in former years; potato bugs bad (Swift Co.).
Roach, S. Z., New Paynesville, Stearns Co.....	Grubs thick in fields; cut worms doing some damage.	Potato bugs very thick; currant worms very troublesome; chinch bugs in wheat.	Chinch bugs did no damage.	Rust bad; chinch bugs did some damage in one field; potato rot present.
Swenson, Edw., Scandia, Washington Co.....	Worms on fruit trees.	Plum pocket found; cockscomb gall on elm leaves; fall web worm (?) attacking leaves of bush. Joint worm or cut worm on timothy; lice on poplar (July 12); canker worm on cherry trees; greenish white worm enclosed at ends of branches of cherry and apple trees (leaf roller); currant worm; yellow checked caterpillar noticed; plant lice on elm and boxelder; potato bug present, not much damage done.	Army worm on timothy; cabbage worm; leaf hopper on apple tree; lice on apple trees; potato bugs bad.	.....
Washburn, Edson, Monticello, Wright Co.....	Chinch bugs few; few eggs of tent caterpillar.	No work of Hessian fly nor chinch bug; fire blight bad; few grasshoppers; no tent caterpillars; potato bugs plentiful.	Potato beetles; chinch bug present; tiny white worm one-eighth inch (frit fly ?) in wheat.	Chinch bugs scarce; no tent caterpillars.
Wedge, Robert C., Albert Lea, Freeborn Co.....	Lice on plum trees; strawberry leaf insect; galls on boxelder.	Leaf-hopper and lice on apple and plum trees in nursery; also same on ash in nursery.	.....	.....
Woolery, Roy, Blue Earth, Faribault Co.....	No insect damage.	Cut worms at work in corn; 2 to 5 per cent damage.	Potato bugs doing no damage; no worms on the trees.	.....

IDENTIFICATION OF INSECTS.

Some of the principal inquiries regarding insects received through the mail during the past year are here listed. Plant lice began to be heard from early in May, and wire worms, the larvæ of "Click Beetles," evidently caused trouble in May and June. Cut worms, beginning their depredations about the middle of June, were heard from through the summer as late as August 6th. The cabbage root maggot was the cause of numerous letters from June 10th; and from August 12th to September 7th we had our usual quota of green cabbage worms. About the middle of August some complaints of grain plant lice in wheat reached us, but this insect caused no special injury. Complaints of Cottony Maple Scale, which has been very abundant this summer, reached us through the mail from Hennepin, Ramsey and Cottonwood counties, besides being observed by the writer in Rock county. The Chinch Bug and Hessian Fly, the reader will observe, are this year conspicuous for their absence though mentioned in one or two instances. We append a map of the state showing the counties. From one to several inquiries came from each county marked by an X.

DATE.	COUNTY.	INSECTS IDENTIFIED.	HOST PLANTS, ETC.
Mar. 7	Ramsey	Buffalo Moth, *A. scrophulariæ*—Linn	Woolens.
Mar. ..	Hennepin	Mites, *Tyroglyphus longior*—Gervais	Flour mill.
Mar. 17	Hennepin	Staphylinid	Supposed by correspondent to injure radishes.
Mar. 18	Hennepin	Apple Bark Louse, *M. pomorum*—Bouche	Lilac.
Mar. 30	Rice	Oyster-shell Bark Louse, *M. pomorum*—Bouche	Transcendent Crab.
Apr. 6	Brown	Scurfy Bark Louse, *Chionaspis furfurus*—Sign	Apple tree.
Apr. 21	Wilkin	Cecropia Moth, *Attacus cecropia*—Linn	Cocoon.
May 3	Hennepin	Plant Lice	No specimens.
May 6	Stearns	Lachnosterna	Corn fields. No specimen.
May 6	Goodhue	Scurfy Bark Louse, *Chionaspis furfurus*—Sign	.....
May 10	Rice	Lecanium	Oleander.
		Aleurodes	Potted Plants.
May 16	Douglas	Lice, *Aphis mali*—Fab.	Apple.
May 16	Ramsey	Wire Worms	Asparagus.
May 17	Renville	Scolytid borers, also Atænius	.....
May 20	Dodge	Cattle Louse, *T. scalaris*—Nitzsch	Live Stock.
May 21	Becker	White Scale, *Aspidiotus nerii*	Oleander.
May 21	Ramsey	Wire Worm	Asparagus.

DATE.	COUNTY.	INSECTS IDENTIFIED.	HOST PLANTS, ETC.
May 23	Becker	Wire Worm	Wheat.
May 26	Ramsey	Scales	Box elder. No specimen.
May 27	Wadena	Wire Worms	Wheat.
May 27	Big Stone	Canker Worm	Box elder.
May 31	Hennepin	Cut Worms	Tomatoes.
May 31	Dakota	"Squash Bugs"	No specimen.
May 31	Redwood	Striped Cottonwood Beetle, *Melasoma scripta*—Fabr	Poplar.
June ..	Isanti	*Glopinus incrassatus*	Kernels of planted corn.
June 4	Renville	Wire Worms	Corn.
		March Flies, *Bibio albi pennis*	
		Apple Aphis, *A. mali*.—Fabr	
		Buffalo Tree Hopper, *C. bubalus*—Fabr	
June 9	Hennepin	Cut Worms	
June 9	Hennepin	Flies	Cattle. No specimen.
June 9	Lac qui Parle	Flies	Cattle. No specimen.
June 9	Lac qui Parle	Gall-making Plant Louse	Plum.
June 9	Dakota	Gall-making Plant Louse	Plum.
June 10	Hennepin	Lecanium	Elm.
June 10	Hennepin	Cabbage Maggot, *P. brassicæ*	
June 10	Dakota	Gall-making Plant Lice	
June 10	Polk	Cut Worms	No specimens.
June 13	Dakota	Squash Bugs, *A. tristis*—De Geer	
June 14	Hennepin	Cabbage Maggot, *P. brassicæ*	
June 15	Otter Tail	Elm Aphis, *Sch. americana* Riley	Elm.
June 16	Rice	Galls	Plum Leaf.
June 17	Renville	Galls	Plums.
June 17	Hubbard	Wire Worm	
June 18	Hennepin	Cut Worms	Tomatoes.
June 18	Hennepin	Ants	Remedies for, on lawn.
June 19	Martin	Rose Pests	
June 20	Douglas	Ants	Lawn.
June 21	Hennepin	Lice	Honey suckle.
		Rose Slug	Roses. No specimen.
June 21	Hennepin	White Grubs, *Lachnosterna*	Ginseng.
June 21	Ramsey	Cabbage Maggot, *P. brassicæ*	Cabbage.
June 21	Freeborn	Climbing Cut Worm	Apple.
June 24	Hennepin	Cabbage Maggot, *P. brassicæ*	Cauliflower.
June 24	Ramsey	Grubs, *Lachnosterna rugosa*—Welsh	Lawn.
		Cut Worms	Peas.
June 27	Rice	Ants	Lawn.
June 27	Pine	Apple-tree Borer	No specimen.
June 29		Plum Pocket	Plum leaves.
July 1	Hennepin	Mites, *Tyroglyphus longior* and *Aleurodes farinata*	
July ..	Hennepin	Fleas	Wheat in mill.
July ..	Freeborn	Plum Curculio, *C. nenuphar*	Apple, 100 per cent of fruit destroyed.
July 10	Chicago, Ill	Leaf-cutting Bee, *M. brevis*—Say	Roses.
July 12	Washington	Plum Pocket	Plums.
		Cockscomb Gall, *C. ulmicola*—Fitch	Elm.
		Lice	Poplar. No specimens.
July 13	Blue Earth	Luna Moth, *A. luna*—Linn	
July 13	St. Louis	Ephemerids	
July 14	Lyon	Gall-making Plant Lice	
July 15	Hennepin	Bumble-flower Beetle, *Euphoria inda*—Linn	Apple.
July 15	Hennepin	Unicorn prominent, *S. unicornis*—S. & A.	
July 15	Ramsey	Stalk Borer, *Gortyna nitela*—Gu.	Tomatoes.
July 18	Rice	Lice (eggs)	Old eggs in fur.
July 18	Waseca	Stalk Borer, *Gortyna nitela*—Gu.	
July 21	Hennepin	Stalk Borer, *G. nitela*—Gu	Aster.

DATE.	COUNTY.	INSECTS IDENTIFIED.	HOST PLANTS, ETC.
July 21	Blue Earth	Stalk Borer, *Hydræcia (gortyna) nitela*	Dahlia.
July 22	Ramsey	Maple Scale, *P. innumerabilis*—Rathv.	.....
July 22	Goodhue	Grain Plant Lice	Wheat.
July 22	Traverse	Grain Plant Lice	Wheat.
July 25	Mower	Grain Plant Lice	Grain.
July 28	Winona	Pear and Cherry Slug, *S. cerasi*—Peck	Cherry.
July 28	Hennepin	Horned Corydalis, *Corydalis cornuta*	.....
Aug. 1	Fillmore	Med. Flour Moth, *E. kuehinella*—Zell	Flour Mill.
Aug. 1	Blue Earth	Melon Louse, *A. cucumeris*—Forbes	Melons.
Aug. 2	Montreal, Canada	"Death Watch," *S. panicea*—Linn	Flour on shipboard.
Aug. 2	Ramsey	Apple Aphis, *A. mali*—Fabr.	Apple.
Aug. 2	Hennepin	Apple Aphis, *A. mali*—Fabr.	Apple.
Aug. 2	Hennepin	Maple Scale, *P. innumerabilis*—Rathv.	Elm.
Aug. 3	Hennepin	Lice	Wheat.
Aug. 3	Grant	*Chrysochus auratus*	"Shoe String Plant."
Aug. 5	Washington	Grain Plant Lice	Wheat.
Aug. 6	Otter Tail	Grain Plant Lice	Wheat.
Aug. 6	Hennepin	Lecanium	Elm.
Aug. 6	Polk	Cut Worms	Pasture.
Aug. 10	St. Louis	Scab	Apple Leaves.
Aug. 11	Nobles	Exotic Ant	Bundle of Bananas.
Aug. 12	Mille Lacs	Plant Lice	.....
Aug. 12	Lac qui Parle	Grain Plant Lice	Wheat.
Aug. 12	Beltrami	Cabbage Worms, *P. rapæ*—Linn.	.....
Aug. 15	Dodge	Apple Aphis, *A. mali*—Fabr.	Apple.
Aug. 16	Red Lake	Grain Plant Lice	Wheat.
Aug. 18	Polk	Grain Plant Lice	Wheat.
Aug. 19	Lyon	Cabbage Worm, *P. rapæ*—Linn.	Rape.
Aug. 20	Kandiyohi	Grain Weevil, *Calandra granaria*	Wheat in bins.
Aug. 26	Cass	Grain Plant Lice	Wheat.
Aug. 27	Otter Tail	Galls	Willow.
Aug. 27	.....	Galls	White willow leaf.
Aug. 30	Steele	*Coptocyla clavata*—Fabr.	Supposed by correspondents to be injuring wheat.
Sept. 1	North Dakota	Willow and Poplar Borer, *Cryptorhyncus lapathi*—Linn.	Carolina poplar.
Sept. 1	Isanti	Red-humped Apple Tree Caterpillar, *Oedemasia concinna*—Sm. & Abb.	.....
Sept. 7	Hennepin	Cabbage Worm, *Pieri rapæ*	Horse radish.
Sept. 7	Kandiyohi	Flies	Stock. No specimens.
Sept. 15	Hennepin	Bumble Flower Beetle, *Euphoria inda*	Apple Orchard.
Sept. 15	Hennepin	Unicorn prominent, *C. unicornis*	.....
Sept. 1	Ramsey	*Diplosis violicola*—Sm. & Abb.	Violet.
Sept. 26	Kandiyohi	Currant Lice, *Aphis ribis*—Linn.	Currants.
		Plum Aphis, *Aphis prunifolii*—Fitch	Plum.
		Apple Aphis, *Aphis mali*—Fabr.	Apple.
		"Lady Bird"	.....
Sept. 29	Ramsey	"Walking Stick"	.....
Oct. 3	Nicollet	Cercropia Moth, *Attacus cecropia*	Cocoon.
Oct. 6	Hennepin	Garden Spider, *Epeira*	.....
.....	Marshall	Oleander Scale	Oleander.
.....	Ramsey	Melon Lice, *Aphis cucumeris*	Cucumber.
Oct. 12	Rock	Zebra Caterpillar, *M. picta*	Tamarack.
Oct. 12	Becker	Bumble-flower Beetle, *Euphoria inda*	Carnations in greenhouse.
Oct. 17	Cottonwood	Maple Scale, *Pulvinaria innumerabilis*	Soft maple.

DATE.	COUNTY.	INSECTS IDENTIFIED.	HOST PLANTS, ETC.
.....	Morrison.....	Mites, *Aleurobius farinæ*—De Geer	In screenings.
Oct. 22	Ramsey.....	"Water Boatmen," *Corisa*.....	"Swarming by thousands in St. Paul on sunshiny afternoon, Oct. 12, between 2 and 3."
Oct. 28	Nicollet.....	Plant Bugs, *Trapezonotus*.....	Supposed by correspondent to be Chinch Bugs.
Nov. 4	St. Louis.....	Slugs, *Limacidæ*.....	Plants in garden.
Nov. 14	Hennepin.....	Ants, *Monomorium pharaonis*—Linn	In house.
Nov. 16	Dodge.....	Scurfy Scale, *Chionospis furfurus*	Apple.
Nov. 25	McLeod.....	Rabbit Bot, *Cuterebra*.....	Rabbit.

Fig. 123¼.—Map of Minnesota. Inquiries, one or more, regarding injurious insects, season of 1904, received from counties marked with a +.

A PLEA FOR SOME OF OUR COMMON BIRDS BASED UPON THEIR FOOD HABITS.

There appears to be a call for information regarding the food habits of some of our common birds, which are often condemned because of ignorance upon this point. In an endeavor to furnish this information and describe briefly some of our feathered friends in such a way that they may be recognized, Press Bulletin No. 19 has been issued. Largely at the instigation of the Audubon Society of Minnesota, a strong effort is being made to inculcate in our citizens, particularly in the school children, a love for the birds, which will check the cruel practice of shooting and maiming, with sling-shot or air gun, animals which are as capable of suffering acute pain as ourselves. However injurious a bird may be—and there are some which at times do work injury upon the farmer or fruit grower—this is nevertheless no excuse for its being caused to suffer at the hands of a thoughtless boy, who, in years after, will regret his cruelty. With this educational object in view the efforts of the Audubon Society are being ably seconded by the State Horticultural Society and the State Educational Association. These societies have appointed from among their members a committee to forward this work. Particulars regarding the work can be obtained from any one of the following members of the committee: Prof. Lange, Central High School, St. Paul; Pro. O. T. Denny, Central High School, St. Paul; Mrs. J. B. Hudson, Lake City; Mrs. La Penotiere, 1928 Portland Avenue, Minneapolis; Mrs. Ida Thompson, Duluth; Mr. S. A. Stockwell, Penn. Ins. Co., Andrus Building, Minneapolis; Miss Sarah L. Putnam, 229 Eighth avenue S. E., Minneapolis; Prof. A. W. Rankin, Minneapolis; F. L. Washburn, State Experiment Station, St. Anthony Park.

The State Experiment Station is only too glad to assist in this good work by publishing at this time the following economic data on the food habits of some of our common birds. These data are largely the result of the work done by the United States Department of Agriculture and by independent workers, credit for which is given in the text. The writer desires to urge upon the teachers the need of encouraging their pupils in humanitarian principles in connection with our birds, and discouraging the stoning of the same,

the robbing or destruction of nests, or the maiming of such helpless animals. These acts are, for the most part, punishable by law, but if a child can be led into the observance of these laws through intelligent interest in the birds themselves, the result is better than if fear is the instigating cause. Upon adults we would urge the desirability of discriminating in judging birds, the careful study of the food habits before condemning, in the building of boxes for wrens, bluebirds and martins, and in encouraging by their example generally a wise and humane policy toward our feathered associates.

Dudley Dorn rightly says: "No one should own or handle a gun unless first proved to be possessed of common sense."

BLUEBIRD.

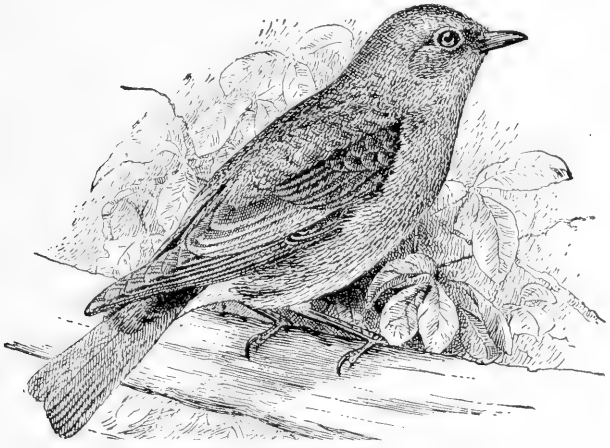


Fig. 124.—Bluebird. From Biological Survey U. S. Dep. of Agriculture.

Upper parts, including wings and tail, bright blue; breast, throat and sides, reddish. Length, seven inches. A description of this common bird is hardly necessary. It is of wide distribution, from the Atlantic to the Rockies, and from Canada to the Gulf of Mexico. Its note is among the first to be heard in the spring, and one of the last in the fall, at which latter time we associate it with the falling leaves of Indian summer. To the writer its note in the fall has always appeared to take on additional sadness, as though lamenting the dying of the year. It nests in hollow trees and boxes erected in suitable places, and should be encouraged by providing it with plenty of such

opportunities for housekeeping. An examination of two hundred and five stomachs showed that seventy-six per cent of the food consisted of insects and their allies, while twenty-four per cent is made up of vegetable substances. Beetles constitute twenty-eight per cent of the whole food, grasshoppers twenty-two, caterpillars eleven, and various insects, including spiders, comprise the remainder of diet. All these insects are more or less harmful, except a few predaceous beetles, which amount to eight per cent. Prof. S. A. Forbes of Illinois examined 108 specimens secured in every month except November and January, and results of these examinations prove that although the bluebird eats some insects which are beneficial, and occasionally takes a raspberry or gooseberry, it consumes such an immense number of injurious insects, cutworms and other insects, such as army worms, moths, grasshoppers and crickets, that it is undoubtedly a beneficial bird. Nestlings of the bluebird, like the young of almost all of our common birds, are fed an enormous quantity of insects.

PHOEBE.

Fig. 125.—Phoebe. From Biological Survey U. S. Dept. of Agriculture.

Length about seven inches, upper parts grayish brown shaded with olive, top of head darker; outer edge of outer tail feathers white or yellowish, except at tip. Under parts white, more or less tinged with yellow; breast and sides brownish gray; bill black.

This familiar bird is one of the earliest arrivals in the spring, and generally first observed before the leaves appear on our trees, at which time its plaintive note, sounding like "pe-wee," with the accent on the last syllable, announces the arrival of spring. It is commonly found near buildings on the farm, and frequently builds its bulky nest of moss and mud on a beam in a shed or under a bridge. It is of wide distribution, being found throughout the United States east of the Plains, and is deservedly a great favorite. While it occasionally takes a raspberry or blackberry, or more commonly seeds of various kinds, and elderberries, wild cherries, etc., its principal food is insects; it is, in fact, a true fly catcher. Ninety-three per cent of the contents of eighty stomachs examined consisted of insects and spiders. Generally two broods are reared in a season.

HOUSE WREN.

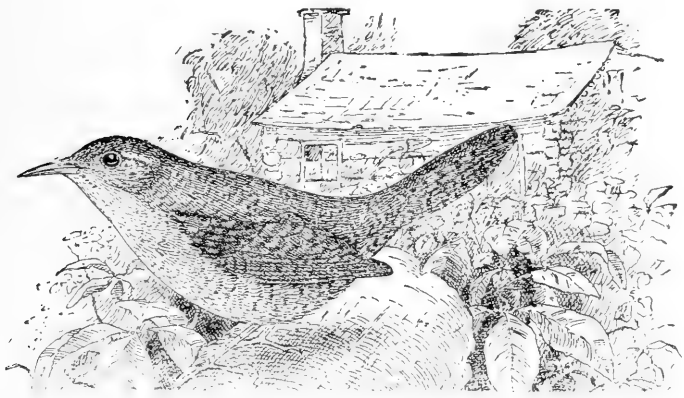


Fig. 126.—House Wren. From Biological Survey U. S. Dep. of Agriculture.

Cinnamon brown on back, marked indistinctly with black and white, becoming more reddish on rump and tail; tail rather long and marked with fine bars, black bars also showing on sides. Length five inches. This saucy bird is found over the entire United States,

nesting about buildings or in boxes or houses prepared for it by the thoughtful farmer. As in the case of the bluebird, it is well to give it every opportunity for nesting, since its food consists almost entirely of insects, and it will repay you for your friendship by searching out and devouring caterpillars in your shrubs and trees. It is said to raise several broods in a season. An examination of fifty-two stomachs by the United States Department of Agriculture showed that ninety-eight per cent of their contents were made up of insects and their near relatives, the remaining two per cent being vegetable matter, small bits of grass, etc., evidently taken with the insects by accident. One-half of the food consisted of grasshoppers and beetles; the remainder, caterpillars, bugs and spiders.

BARN SWALLOW.

Fig. 127.—Barn Swallow. From Biological Survey U. S. Dep. of Agriculture.

Throat, forehead and breast reddish chestnut, paler below. Metallic blue on back and head. Tail forked; some white on each feather in tail except those in the middle. Nest of mud and grass lined with feathers, in barns and other buildings. In the writer's opinion no farm scene is complete without these birds flitting in and out of the barn. A rapid and graceful flyer, it captures, while on the wing, moths, flies, beetles and frequently grasshoppers and flying ants. Of three specimens shot in June in Nebraska, in a "locust year," according to Professor Aughey, the stomachs of two contained sixty-eight locusts and the stomach of the third thirty-seven locusts. As might be inferred, these birds are strictly insect eaters.

MEADOW LARK.

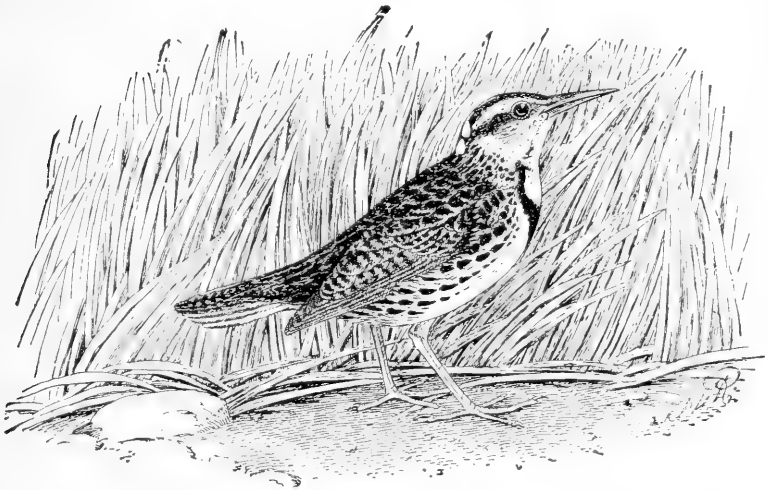


Fig. 128.—Meadow Lark. From Biological Survey U. S. Dep. of Agriculture.

The Meadow Lark is common from the Atlantic to the Great Plains, and a variety extends west of the Plains to the Pacific Coast. It is an inhabitant of both prairie land and fields in districts more or less wooded, and while not a fine songster, in the opinion of many, adds much to our enjoyment of the country. The color of the upper parts is a mingling of black, whitish and chestnut, darker on the head, where we find a light streak running back from the bill; side of head light, showing a yellow streak over and in front of eye; chin, throat

and breast bright yellow, with a jet black collar or cravat on breast in form of a crescent; all but the central tail feathers showing considerable white. Length, ten to eleven inches. It nests upon the ground, and seldom perches on trees. Analyses of stomach contents give interesting results: Two hundred and thirty-eight stomachs examined contained seventy-three per cent animal matter, and twenty-seven per cent vegetable, the latter being found in the winter. The animal food consisted of insects of the ground species—beetles, bugs, grasshoppers, caterpillars, and a few flies, wasps and spiders. A number of the stomachs were taken from birds killed when the ground was covered with snow, but still contained a large percentage of insects. Crickets and grasshoppers constitute twenty-nine per cent of the entire year's food, and sixty-nine per cent of the food in August. Twenty-one per cent of beetles was found, of which about one-third are predaceous ground beetles; the others all harmful species. In May caterpillars constitute over twenty-eight per cent of the whole food, with a large number of cutworms. Grain makes up fourteen per cent, and weed and other seeds twelve per cent.

VESPER SPARROW, VESPER BIRD, GRASS FINCH, BAY-WINGED BUNTING.

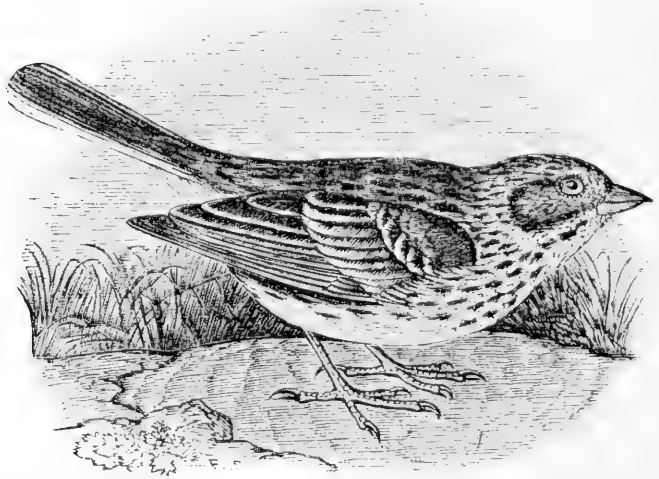


Fig. 129.—Vesper Sparrow. From Coues, "Key to North American Birds."

Like the Meadow Lark, a bird of the pasture, field and prairie. Frequently seen in the road, when it will run in front of you a distance before taking flight. At the latter time it always shows the white of its outer tail feathers, a most characteristic marking. The upper parts are brownish gray with more or less black and brownish black and brown streaks on sides and breast. Length, about six inches. Nests on the ground. This modest colored bird is quite a singer at times, its song reminding one somewhat of that of the Song Sparrow. About two-thirds of the year's food consists of seeds and other vegetable matter, the remainder consisting largely of cutworms, grasshoppers, army worms and spiders. Of thirty-seven Wisconsin adults studied by King, thirty-one had eaten various small weed seeds; five, four grasshoppers; one, eight grasshoppers' eggs; four, ten larvæ; fourteen, twenty-seven small beetles; three, eight moths; one, three flies; one, three land-snails; one, two kernels of wheat; one, a kernel of rye.

CHICADEE, BLACK-CAPPED TITMOUSE.

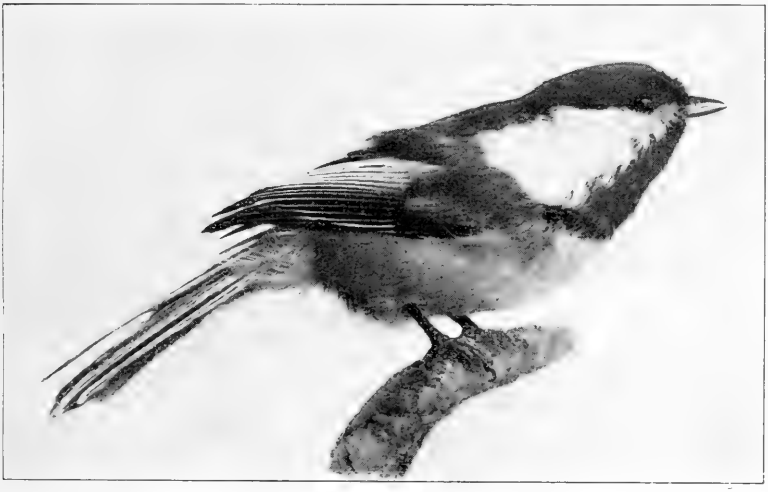


Fig. 130.—Chickadee. Original.

Dear to us because of its cheerful activity in the cold of winter when almost all other bird friends have left us. From an economic standpoint a great benefactor, for not only does it consume large

numbers of insects in summer, but more than one-half the winter food consists of insects and their eggs. The eggs of plant lice make up one-fifth of the entire food, in fact the destruction of these eggs on fruit and shade trees is the chief beneficial work of this bird in the winter, and the good it does in this way must not be under-estimated. Examinations of stomachs or crops of these birds has shown that sometimes more than four hundred and fifty eggs of plant lice are consumed by one bird in one day. Eggs of canker worms and tent caterpillars are also eaten. Four stomachs or crops examined showed, as the result of a single day's feed, one thousand and twenty-eight eggs of canker worms. Four others contained about six hundred eggs of canker worms and a hundred and five mature female canker worms. Surely if any bird deserves protection, it is this one. Such a familiar bird hardly calls for a description. Head, back of neck and throat black; sides of head and neck whitish; breast white; sides washed with brownish yellow. Length about five and one-half inches. Nests in old stumps and decayed trees, preferably birch; holes not far from ground generally. In addition to its cheerful "chic-a-dee-dee" it has a number of other notes, some of them extremely musical.

DOWNY WOODPECKER.

A true benefactor in that its food consists almost entirely of injurious insects, and it is with us both winter and summer. It is the smallest of our Woodpeckers, being only six and four-fifths inches long. Black above; a scarlet band on back of neck; white on middle of back; under part white; central feathers of tail black; the outer ones white with black markings; wings black spotted with white. The female lacks the scarlet patch on back of neck. It nests in holes in trees. Often seen in winter in company with Nuthatches, Chickadees and Brown Creepers. What little vegetable food it eats consists of seeds of poison ivy, sumac, etc. Seventeen Wisconsin specimens had eaten forty insect larvæ, twenty wood-boring grubs, three caterpillars, seven ants, four beetles, a chrysalid, one hundred

and ten small bugs, a spider, with a few acorns, small seeds and a little woody fibre apparently taken by accident with the grubs. Three-fourths of the food of one hundred and forty specimens examined by the Department of Agriculture consisted of insects. Nearly one-fourth consisted of ants, chiefly from those which were caring for plant lice, or burrowing in wood.

Fig. 131.—Downy Woodpecker. Original.

FLICKER, GOLDEN-WINGED WOODPECKER, PIGEON WOODPECKER, YELLOWHAMMER, HIGH HOLE.

Top of head ashy; band across back of head scarlet; back olive brown conspicuously barred with black; rump white; tail feathers above black, with white markings tinged slightly with yellow, and

with yellow shafts; black spot on side of throat under eye; side of head and throat dove color, black crescent on breast; lower breast and under parts white, more or less washed with light brown, and marked with large, round, black dots; tail beneath yellow; long feathers of wing yellow below, and with yellow shafts. The female lacks the streak or spot on the side of the throat. Length, twelve inches. Nests in holes in trees. This familiar bird, whose call we associate with the warm promising days of early spring, before the

Fig. 132.—Flicker. From Biological Survey U. S. Dep. of Agriculture.

leaves appear on the trees, differs from the other Woodpeckers in being something of a ground feeder. It eats wood-boring grubs, to be sure, but is very fond of ants, and is quite apt to be discovered dining on the ground before a large ant hill. Two stomachs examined contained over 3,000 ants each. The Flicker occasionally takes a little fruit.

THE NIGHTHAWK.

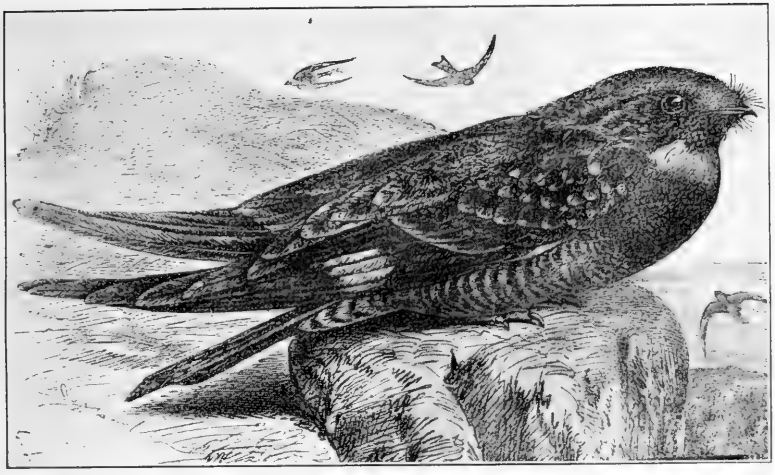


Fig. 133.—Nighthawk. After Brehm.

Back blackish, marked with whitish or cream; white bar on wings; tail blackish, forked; broad white band on throat and white band on tail of male; under parts barred with black and white. Nests on ground. But few who have walked in field and woods have not flushed this bird resting inconspicuously on ground or limb of a tree, and we are all familiar with its graceful evolutions in the air during afternoon and evening, where its rather harsh cry at once draws our attention. Frequently a bird closes its wings and drops swiftly, again soaring upward just before reaching the ground. At such times one hears a booming sound, something similar to the noise made by blowing across the large mouth of a bottle. Just how this is produced appears to be a matter of question among ornithologists. Some claim it is made by the air rushing through the stiff wing feathers, called primaries. The food of the Nighthawk appears to be May flies, dragon flies, beetles, certain water insects which fly in the evening, many bugs and grasshoppers. From seven specimens secured in Nebraska Professor Aughey took three hundred and forty-eight Rocky Mountain Locusts (one of our most injurious insects). In an Arkansas specimen F. L. Harvey found more than six hun-

dred insects—gnats, beetles, flies, ants and grasshoppers. Naturally a bird with habits like the Nighthawk would never injure fruit or berries. Some people confound the Nighthawk with the Whippoorwill, quite a different bird.

MARSH HAWK.

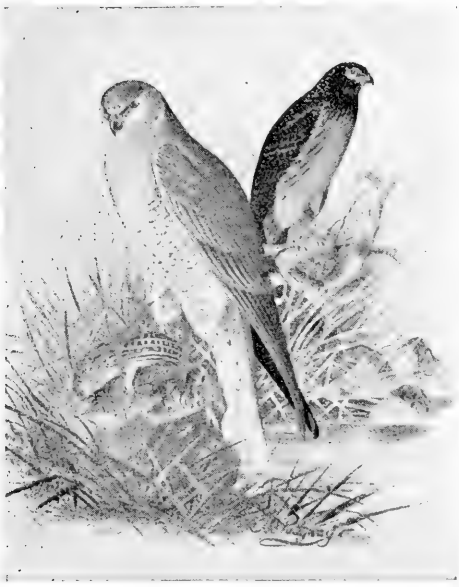


Fig. 134.—Marsh Hawks. After Ridgway, Bulletin No. 3, Division of Ornithology and Mammalogy U. S. Dep. of Agriculture.

Male and female quite different, both in size and color. Adult male nineteen inches long, grayish above, the tail being barred with blackish; feathers above at base of tail (upper tail coverts) conspicuously white; breast gray, fading into white on belly, where brownish markings are found. The adult female is twenty-two inches long, dark brown above, marked on head and neck with reddish brown; upper tail coverts as in male, conspicuously white; tail darker brown barred with reddish brown; breast buff, the color fading on belly. Nests on the ground in marshes. This is pre-eminently a bird of the meadows and prairies, and is often seen skimming over the top of the marsh grass hunting its food, at which time white of the upper tail coverts is conspicuous. It eats field mice, squirrels, rabbits, grasshoppers, frogs, reptiles, and occasionally small birds or poultry but not often. The writer regards it as a useful bird to the agriculturist. Out of one hundred and twenty-four stomachs examined by the United States Department of Agriculture, seven contained poultry or game birds; thirty-four contained other birds; fifty-seven contained mice; twenty-two contained other mammals; seven contained reptiles; two contained frogs; fourteen contained insects; the contents of one were undetermined, and eight were empty. Dr. B. H. Warren examined

fourteen stomachs with the following results: Seven had only field mice in their stomachs; three, frogs; two, small birds (warblers); one, a few feathers, apparently of a sparrow, and fragments of insects; one a large number of grasshoppers, with a small quantity of hair, evidently of a young rabbit.

SCREECH OWL.

Varies greatly in color from reddish or rufous to gray. In rufous specimens rufous above generally showing fine black lines. Below, whitish with feathers barred with reddish or rufous. Or, in grayish specimens, above brownish gray with faint black markings mingling with brown. Length about ten inches. This is a quite familiar bird about our orchards and barnyards, and, as its food habits show, its presence should be encouraged. Of two hundred and fifty-five stomachs examined under the direction of the United States Department of Agriculture, one contained poultry, thirty-eight contained other birds; ninety-one contained mice; eleven contained other mammals; one hundred contained insects; two contained lizards; four contained batrachians; one contained fish; five contained spiders; nine contained crawfish; seven contained miscellaneous matter; two contained scorpions; two contained earthworms; and forty-three were empty.

Fig. 135.—Screech Owls. After Plate 23, Bulletin No. 3, Division of Ornithology and Mammalogy U. S. Dep. of Agriculture.

From consideration of the food habits of the two above birds, representatives of the order of Hawks and Owls, it would seem that we make a mistake in wholly condemning this much maligned group, for among the hawks and owls we certainly find some in whom the good qualities seem to outweigh the bad.

THE ENGLISH SPARROW.

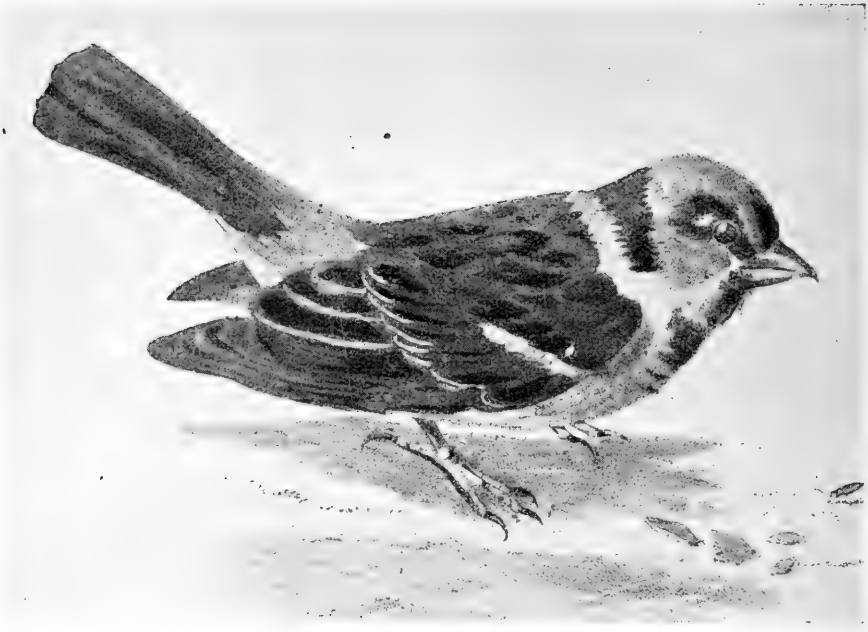


Fig. 136.

Our illustration is hardly needed, since this hardy and pugnacious bird has fought his way into every town and village of any size in Minnesota. He is welcomed by some, possibly, on account of his cheerful chirpings in winter when other birds have left us, but disliked by the majority not only because he defiles buildings and walks, and by his persistence in nest building wears out the patience of the house owner, who objects to the unsightly domicile of straw under the eves of his home, but also because he drives away other native birds whose presence is more desirable and more advantageous than that of the English visitor. We will say here that those seeking to encourage the wrens to build in bird houses on their grounds should make the entrance exactly the size of a silver quarter. This will admit the wrens, but keep out the undesirable tenant.

While it is apparently impossible to exterminate this bird, which in many ways is a pest, many of us desire to know some merciful way of lessening its numbers. Poisoned wheat, using arsenic in place of strychnine, in order that the birds may not die by the food and thus frighten away others, is used by some. This is open to the objection of danger to poultry, and cats also may eat birds so poisoned. A better way, practiced on some farms, is to feed wheat for a number of days, in the barnyard, say, placing it in a straight line, and one fine morning when the birds are feeding, rake the line with a shot gun. This may sound very cruel to some of our humanitarians, and the Entomologist may be censured for giving such advice, but death is not cruelty, and as this office is intended to relieve farmers of the presence of troublesome pests, he makes the suggestion without hesitation. We know of at least two instances of the successful use of the following: Wheat was soaked twenty-four hours in whisky, and while still moist was placed where the sparrows could get at it, presumably mixed with a small amount of other wheat not treated, and placed where fowls could not well reach it. The result of this was intoxication, maudlin, I am told, in which condition the birds could be readily picked up and disposed of. One case has been called to my attention where this failed, but it was on the farm of a prohibitionist where doubtless the sparrows instinctively refused to touch the grain soaked in spirit. There is some ground to believe, too, that the wheat in this case was not treated with whisky, as the young man told me that he thought it was whisky "but was not sure."

A 22 caliber rifle is sometimes handy, and its skillful use will keep them from forming the habit of roosting on cornices, etc. The tearing down of their nests repeatedly will, after a time, discourage the would-be housekeepers, though they persevere through several buildings before they finally cease.

We have seen English sparrows catching grasshoppers, and know of other good work they do, but it is of such slight import compared with the mischief caused by them, that a slight lessening of their number will do no harm.

GOPHERS, FIELD MICE, MOLES, WOODCHUCKS, RABBITS, ETC.

Everyone has heard the old story about the naturalist who was traveling with some pets, and the railway people had only made provision in their rules for charging for dogs. The ticket seller was therefore in doubt as to whether charges should be made for monkeys, cats and a large tortoise, which accompanied the naturalist. His judgment at last was given forth that the cats and monkeys would have to be paid for because under his instructions, he said, "Cats is dogs, monkeys is dogs, but that 'ere turtle is an insect, so we let them go free." The story does not state whether he would classify gophers and rabbits as insects also. Possibly not. Nevertheless there is no one in the state, outside of this department, so situated as to be able to publish an economic treatise on gophers, field mice, rabbits, etc., all of which are pests to the agriculturist, and as publications from this office are designed for the benefit of Minnesota farmers, the Entomologist does not hesitate to present here his own experience and that of others in combating gophers, rabbits, field mice and allied forms which are hostile to the interests of agriculture.

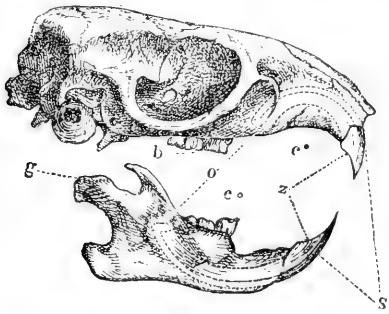


Fig. 137.—Skull of Rat, showing the dentition peculiar to rodents: *S*, hard enamel; *z*, softer dentine; *o*, roots of incisors; *b*, molars; *c c*, centers of semicircles formed by incisors. After Landois.

In the first place, a word as to the classification of these animals as having an important bearing upon their food habits: They all suckle their young and are more or less covered with hair, hence belong to that class of vertebrates known as *Mammalia*. Further, with the exception of the mole, they are all gnawers, and have teeth adapted to that constant habit, the incisors or front teeth above and below being chisel-shaped and remarkably well developed, and the canine teeth being absent. These, therefore, belong to the order *Rodentia* or Gnawers, which order includes all the squirrels, chipmunks, gophers, pouched gophers, rats, mice, rabbits, hares, woodchucks, beavers, muskrats and por-

cupines. The nature of their teeth and the general appearance of their skulls can be appreciated by a glance at the accompanying illustration, Fig. 137. The mole, on the other hand, *does not have the incisor teeth developed for gnawing*, and does have canine teeth in upper and lower jaws. Its eyes are very small, sometimes quite concealed, but with a little care one can find them, hence the popular idea that moles have no eyes is erroneous. They are insect eaters, feeding upon grubs, insects and earth worms, and probably do not often take vegetable matter as food. They belong to the order *Insectivora*, which order includes not only the moles, but also the little mouse-like shrews, in which, unlike the moles, we find no canine teeth. Our illustration, Fig. 138, shows the skeleton of a mole, the sharp pointed teeth, adapted to tearing insects and worms, and *not at all suited for gnawing*, as are the teeth of the gopher. One will at once note in the picture the enormous ridges in the bones of the fore limbs, to which in life powerful muscles for digging are attached, particularly suited to an animal which passes practically its entire life beneath the surface of the ground.

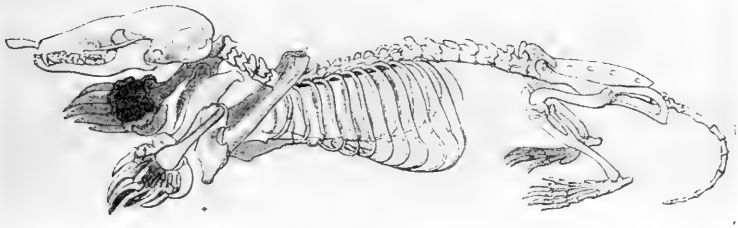


Fig. 138.—Skeleton of Mole. From Brehm.

Turning once more to the order Rodentia, we find it divided into families, and in order to properly place the Minnesota pests which occur in this order, we will arrange the families under the order in such way as to show just where our gophers and squirrels belong and why.

Family *Sciuridæ:* The Squirrels, including all the squirrels, ground squirrels, or chipmunks, the woodchuck or ground-hog, the *thirteen-lined gopher*, the *gray gopher*. All of these have five molar teeth above on each side and four below on each side.

Fig. 139.—Outline of head of Pocket Gopher showing extent and openings of cheek pouch of left side. Original.

Family *Geomyidæ:* Pouched Gophers. This family includes all of our Pocket Gophers. They possess well defined cheek pouches opening *outside* of their mouths on the side of the face, a peculiarity not possessed by the preceding family; furthermore, they have four molar teeth above and below on both sides. Their skulls are heavy and somewhat depressed, their fore feet and claws are large, adapted for digging, and the body is thick and clumsy, quite unlike that of the so-called gophers, found in the preceding family, and so common in Minnesota.

We have in this state two pocket gophers, both of which are injurious. The one, *Geomys bursarius*, is common almost everywhere, especially in our prairie counties. It is reddish brown. The second is *Thomomys talpoides*, a northwestern form, which penetrates the northwestern part of the state. This species is lead color, with breast, feet and tail more or less whitish.

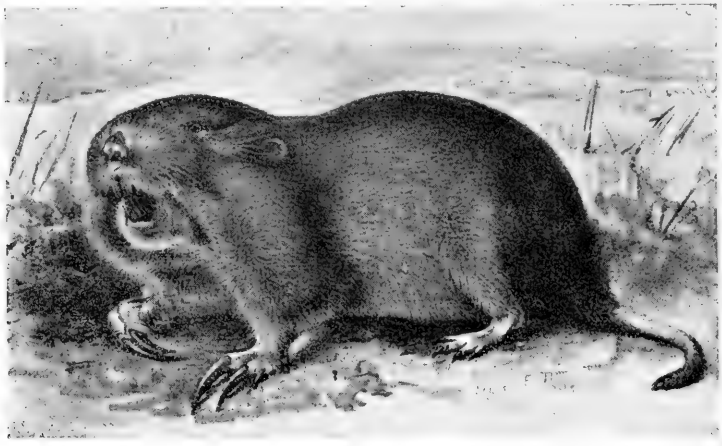


Fig. 140.—Pocket Gopher, *Geomys bursarius*, Shaw. After Merriam.

The injury caused by pocket gophers in a farming community is enormous; not only do they consume large quantities of alfalfa, clover and wheat in the neighborhood of their burrows, eat root

crops such as potatoes, carrots, etc., and kill young fruit trees and vines by gnawing the roots of the same, but their numerous mounds in a meadow destroy, by covering, large patches of grass or clover, and are especially annoying to the farmer in dulling and injuring the knives of the mower.

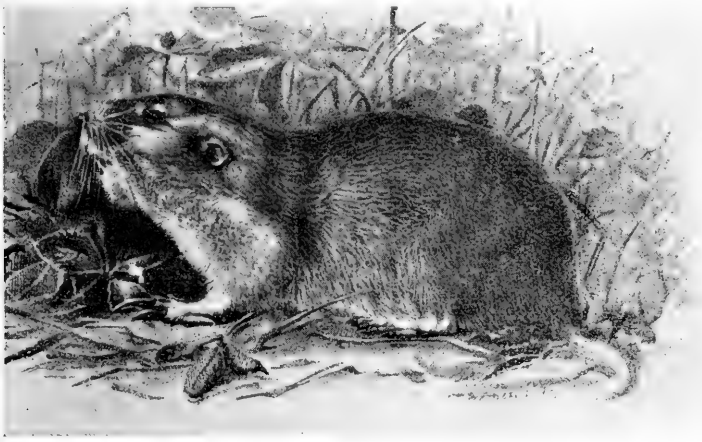


Fig. 141.—Pocket Gopher, *Thomomys talpoides,* Rich. After Merriam.

Professor Bailey suggests one good thing, probably the only one, accomplished by the pocket gopher. He estimates from observations in Minnesota, that about 500 square feet of soil is covered with subsoil in a season of seven months, and says that by this unique plowing and draining they may do much good, covering a burnt over prairie with a soil which will encourage the growth of vegetation. He has referred, however, to a time when the prairies of this state were frequently fire-swept and not thickly settled as they are now, and, further, it must be remembered that the subsoil brought to the surface may be of very poor quality.

Referring once more to the pockets which characterize this family, an erroneous opinion prevails that these animals use the same for carrying earth from their burrows. Many observations on our own part, indorsed by those of others, lead us to state that this is not the case, but that they carry food in these pockets to be stored in their burrows when not wanted for immediate use.

The family *Muridæ* includes all the rats, muskrats and mice, exclusive of the so-called jumping mice. Here occur the Field Mice, which are so injurious to the would-be fruit raiser and nurseryman, by gnawing the bark from the trunks of young fruit trees in the winter time when the snow conceals their depredations.

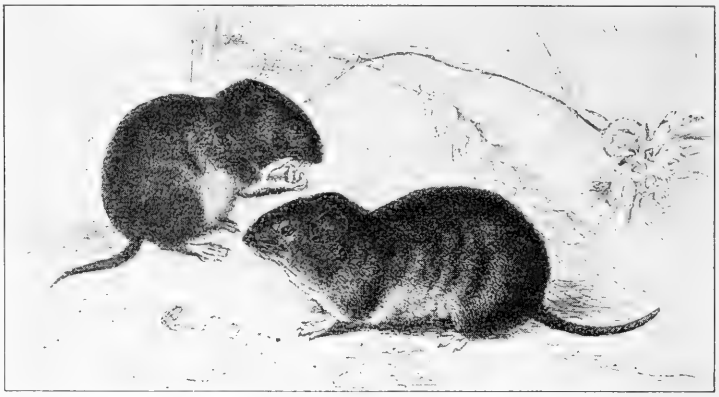


Fig. 142.—Field Mice (*Arvicola*). From Brehm.

The family *Leporidæ* includes the hares and so-called rabbits, differing from each other so little structurally that they all, whether "rabbits" or hares, belong to the single genus *Lepus*. In a general way it may be said that the rabbit burrows and the hare does not; that the young of rabbits are born naked and blind, while the young of the hare is born with fur and with eyes open. The meat of the rabbit is lighter colored than that of the hare. In Minnesota we have the Prairie Hare, or white-tailed hare, *Lepus campestris*, which is commonly called "Jack rabbit," found mostly in open prairie country, but rapidly becoming unpleasantly common in farming districts, even though more or less timbered. The Jack rabbit, while slate colored in summer, in winter, as is well known, changes to an almost pure white, the ears only retaining their black tips. This is a fine protection for Jack when there is snow on the ground, but in a snowless winter, their white color against the dull brown of the earth or grass works their ruin. Injury to windbreaks and to gardens from this species is becoming more common every year.

In the timber we get the Northern or varying hare, *Lepus americanus*, sometimes called "Timber Rabbit," which is not especially injurious, since it finds plenty of food close at hand, though fruit trees near the woods sometimes suffer. The bark of the cottonwood appears to be especially palatable to this hare. Brownish in summer time, it turns white in winter, though the hairs are lead colored at base, and a band of brown is maintained down the middle of the back.

Fig. 143.—"Cotton-tail," *L. sylvaticus*, Bachman. A. G. Ruggles.

Finally we get our little Cotton-tail or Gray Hare, *Lepus nutalli sylvestris*, which is common everywhere in the localities favored with a little brush or timber. It is the most destructive of all the hares, in winter time not hesitating to girdle fruit trees, oftentimes gnawing off the tops of nursery trees which project above the drifted snow. Deep snows or drifted snows make the so-called "rabbit-proof" fence useless. In the summer time it occasionally troubles gardens. This species does not turn white in winter.

The family of hares, *Leporidæ*, differs particularly from the other families of the order *Rodentia* by the possession of two small extra

incisor teeth in the upper jaw just behind the large pair; our illustration shows this peculiarity.

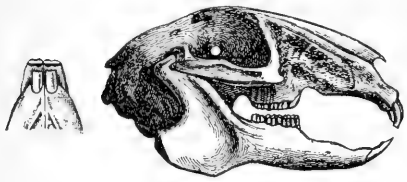


Fig. 143½.—Skull of Hare Showing Extra Incisors.

Turning once more to the squirrel family, *Sciuridæ*, we find therein two or three forms which gave us the name of "Gopher State," but which are squirrel-like in their structure. These all belong to one genus, *Spermophilus*, which means seed loving, and, sure enough, we find that they are fond of almost all kinds of seeds—wheat, oats, rye, barley, corn, pigeon grass, millet, sunflower, pig weed, ragweed, black locust, solanum, strawberries, and a host of others. They also eat green leaves, roots of trees and plants, and grasshoppers, crickets, beetles, ants, cutworms, lizards, mice and other forms of animal matter. The members of this genus have pouches but, unlike those of pouched gophers, they are inside the cheeks and not distinct from the cavity of the mouth. Their bodies are slender. They eat like other squirrels, sitting erect and bringing their food to their mouths with their front feet.

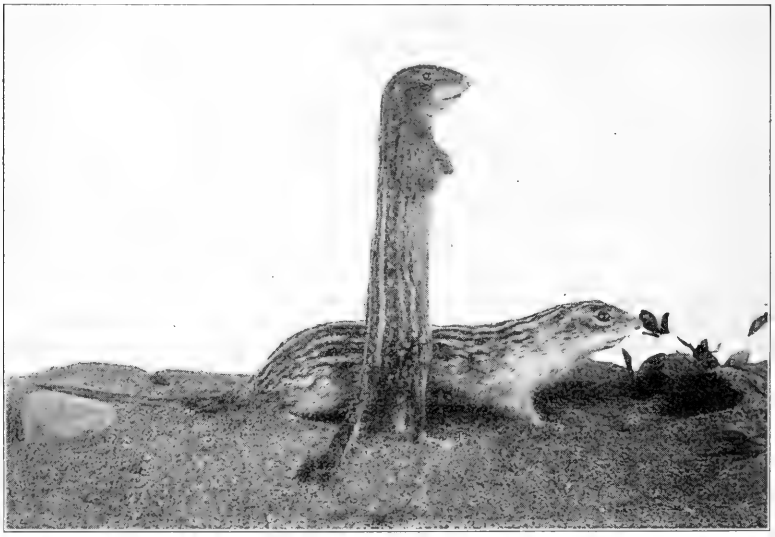


Fig. 144.—Thirteen Lined Spermophilus, *Spermophilus tridecim-lineatus*, Mitch. A. G. Ruggles.

First of all, and most abundant of the "Spermophiles" here, is the Striped Spermophile, or striped gopher, sometimes called the Thirteen-lined Gopher, or "Stars and Stripes." See Fig. 144. This animal is common almost everywhere in Minnesota, and is a familiar figure to almost everyone not living in the city. It is reddish brown in color, yellowish below. Counting the rows of yellowish "stars" and stripes, we find thirteen lines in all, which fact gives it its scientific name. Minnesota specimens show the lower stripes on sides indistinct or broken.

We have also the so-called gray gopher, or ground squirrel, or scrub-gopher (see illustration), found on prairies in this state and elsewhere in localities not too much timbered or covered with brush.

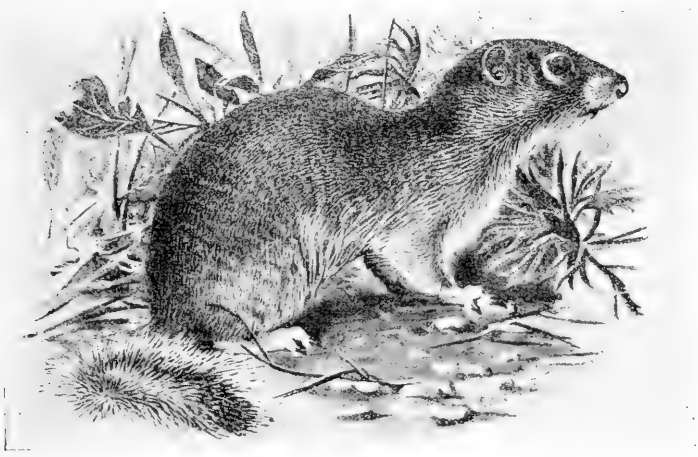


Fig. 145.—Gray Gopher, *Spermophilus franklinii*, Fab. After Merriam.

Finally in the prairie country of North Dakota is a serious pest which has pushed east into the Red River Valley but not in sufficient numbers to be destructive. This species is known as the "Flicker-tail Gopher," resembling closely the previous form, albeit it has a short tail and is grayish, while *S. franklinii* is brownish with faint lines of black.

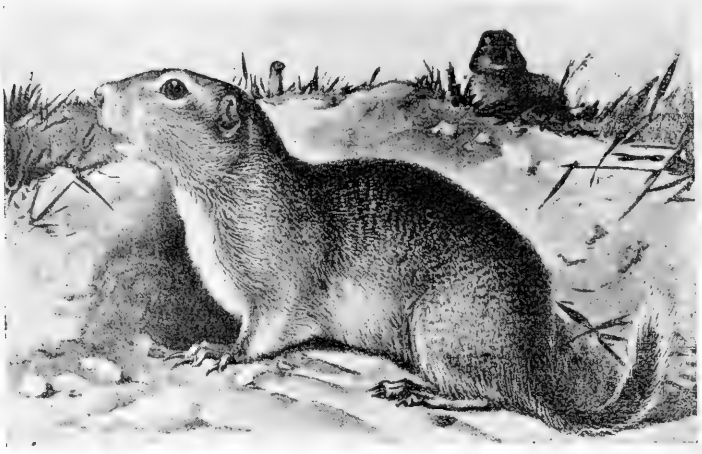


Fig. 146.—*Spermophilus richardsonii,* Fab. After Merriam.

Excluding the moles, the following list of depredations have been laid at the door of the principal pests listed above, by various correspondents:

Jack Rabbits: "Occasionally cut down small patches of grain; gnaw bark from apple trees, causing same to die; cut off tops of young trees; eat a few small melons; eat corn when up three or four inches high."

Cotton-tail Rabbits: "Injure carnation plants in field; plants gnawed die during early months of winter. Eat off small apple trees; bark old ones; one-tenth of nursery stock injured in '98 and '99; five per cent of apple trees killed. Do not eat plum or cherry trees. Eat bark off of evergreen and fruit trees. Cut off yearling apple trees; injure evergreens and girdle plum trees; work in winter, spring and early summer. Ruined hundreds of trees of all ages last winter. No injury except in severe winters, when young apple trees may be gnawed. Ate bark off of apple trees in 1902-3. Girdle young apple trees not protected by wood veneer; when snow goes over this protection they attack lower branches. Destructive to apple trees; will eat off limbs two feet from ground; strip bark from large trees; prefer wild crabs. Eat cabbage plants in summer; fruit trees in winter."

Field Mice: "Lost thousands of evergreens last winter by girdling; have lost apple and other trees. Shell grain out of shock when left standing long, also gnaw bark on apple trees when mulching is left too close. Girdle apple and plum trees, also box elder and ash, shrubs and gooseberry bushes in nursery. Girdled a few dozen nursery trees last year. Eat grain in shocks. Gnaw trees more than rabbits when snow is deep. Considerable damage to nursery stock during winter by working under deep snow drifts; girdle apple or even forest trees which have been mulched with straw. Damage corn and grain shocks when left standing long. Young trees girdled. Damage grain in granary. Damage fruit trees and shrubbery of all kinds. Cut twine on grain in shock. Girdle apple trees occasionally. Damage arbor vitæ where rows are close. Destroy large quantities of corn in field. Very bad on apple and evergreen trees. Eat grain and bands on bundles, also girdle trees."

Thirteen-lined Gopher (Striped Gopher): "Dig up corn and eat other grain. Damage corn in spring when first planted. Dig up newly planted corn, doing considerable damage. Eat seed planted in garden. Damage corn. Injure corn fields by digging down and eating corn just planted, or when a few inches tall, damage five per cent. Dig up corn hills. Dig seed out of ground and eat heads of wheat in shock. Destroy corn just as it is coming out of the ground. Some damage to seed corn. Some damage to grain shocks. Eat newly seeded grain. Much damage in corn fields by digging up corn. Bother a great deal by digging up corn just as it shoots above ground. Much damage done by seed eaten in ground. Considerable damage to corn just planted, also corn in shock."

Pocket Gophers: "Make large mounds in clover fields. Eat roots of young orchard trees and elms. Cut up grain in shock and carry earth up into shocks. Gnaw roots of trees. Cut up hay meadows badly. Gnaw roots off trees and shrubbery. Injurious to fruit trees, five per cent damage. Destroyed nearly half of potato crop last year. Very injurious to roots of orchard trees. A nuisance in clover and potato fields. Go under grain shocks near sloughs, burrow into shock and eat grain, cutting the bands around bundles; about two per cent damage. Damage apple trees

and clover meadows. About two per cent of all crops destroyed. Throw up hills in clover meadows, which are injurious to machinery; often eat off all roots of large apple trees and destroy trees. Destroy carrots and potatoes. Considerable damage in hay land. Damage to apple and evergreen trees. Damage grain and meadows and trees by throwing up mounds of dirt and gnawing roots of trees. Damage grain shocks by carrying dirt into them and eating heads of grain. Considerable damage to shocks of grain. Troublesome in gardens and potato patches. Destroy young trees."

Ground Squirrel or Gray Gopher: "Quite troublesome. Scarce; no damage. Scarce. Not numerous; eat grain. Damage very slight. Eat corn. Very few; no damage. Not numerous. Some damage in corn fields. Scarce; no noticeable damage. Seldom seen. Not injurious. No damage. Sometimes work in grain shocks, cutting the bands. More injurious than striped gopher. Very few of them; dig up and eat seeds just planted."

The scarcity of these animals in most of this state prevents its being classified as such a pest as it is west of Minnesota.

A few farmers who write me labor under a misapprehension as regards the mole. While I have seen this animal in captivity eat peas, and while it may occasionally eat bulbs, *its teeth are adapted to an insectivorous diet, and are not constructed for gnawing as are the teeth of mice and gophers.* Its reprehensible habit of making mounds and ridges in flower beds and lawns will be referred to later. Bearing these facts in mind, it will be seen that some of our correspondents, who write as follows, must be mistaken: "Eat bark of apple, plum, cherry and other trees. Also damage hay stacks by chewing up hay in little pieces." This party is undoubtedly ascribing the work of mice to moles. Another says "Injurious to fruit trees." Another hits the nail on the head in saying "Do no damage, may be beneficial by destroying grub worms.

REMEDIES.

Jack Rabbits: These are kept in check somewhat by gunners and other natural enemies. Poisoning apple or pieces of melon with strychnine, powdering the same and introducing it into slits in the fruit has been tried with some success. One must bear in

mind that strychnine is a deadly poison, and that any stock eating baits poisoned in this way would most certainly die. Corn poisoned in a solution of strychnine—see under Gophers—will kill those which are eating the corn. If fruit trees are injured, in addition to the poisoned bait, they may be wrapped with woven wire, or paper or poultry netting; the latter should be wound around the tree several times. Two correspondents, taking a humane view, say, if they or the cotton-tail are fed with corn, oats or wheat screenings in orchard they are not likely to eat bark. This may be so, but if our apple trees were exposed we would not dare to trust them.

Fig. 147.—A Young "Jack," from Life.

Cotton-tail Rabbits: Sweet apples, poisoned, as described under Jack Rabbits. We would suggest putting out of their reach, while poisoning, all other apples except the poisoned ones, which should be fresh. Watermelon rind or carrots may be used in the same way, though they are particularly fond of sweet apples. One correspondent suggests putting out pieces of apple on little sticks when the snow is deep, so that the bait is raised conspicuously above the surface. He choses moonlight nights for this. Building paper, newspapers, burlap, straw, corn stalks or wire screen placed around trunks of trees are often effective. Some boil strychnine until dissolved and then soak corn in same. A handy gun, if supplemented by a good dog so much the better, is useful at times. The inadequateness of the so-called rabbit proof fence when the snow is deep and drifted is well shown in our illustration (Fig.

160), which represents the case of a nurseryman who, in spite of such a fence, lost a large number of trees through the agency of rabbits.

Mr. Yahnke, the veteran nurseryman at Winona, tells me that for two years he has kept rabbits (and mice) from gnawing his nursery trees by the use of a whitewash made about the consistency of cream, to which has been added enough blue vitriol solution to give the mixture a "robin's egg blue" color. Mr. Yahnke goes between the rows, and with a brush rapidly covers the trunks on the sides next to him with the mixture. The opposite side is coated in the same way. Axle grease smeared on the trunks of young trees is claimed to be effective by some. It would also be unfair to our small boys not to mention the figure four box trap.

Rabbits are much affected with parasites; almost invariably tape worms can be seen in their alimentary canal, and frequently in summer a bot is found hanging on their necks, which later develops into a two-winged fly. There may be several species of bot flies which affect rabbits in this way.

From the December issue of the Minnesota Horticulturist we take the following remedy for rabbits and mice. It looks feasible: "An experienced orchardist recommends the following sure method of getting rid of these orchard pests: 'Make a poisonous solution of one part sulphate of strychnine, one-third of one part of borax, one part of white syrup, ten parts water. This is put into a roomy bottle and well shaken. Now cut fresh twigs from apple trees (water sprouts are excellent); have a small brush, and brush lightly over the twigs, especially the terminal buds. The great value of this over poisoned grain is that it will kill rabbits and mice and will not injure the birds or chickens, while the poisoned grain will kill all. Scatter the poisoned twigs in runways, and places infested with mice or rabbits, and the results will be satisfactory.'"

Field Mice: Perhaps there is no more annoying four-footed pest to the nurserymen than these animals. Heavily mulched nursery rows, or nurseries where oats are planted as a winter protection, are, we believe, more liable to injury than others when snow lies on the ground, or when there is anything which attracts the mice to the trunk, either in the nature of food, or in the nature of a shelter, such as mulch or weeds, or partaking of both these

qualities. The snow melting in the spring discloses their work to the nurserymen, trees oftentimes being completely girdled. Even a girdled tree will live the first season, the sap finding its way to the top through ducts in the wood, but later it is sure to die unless prompt measures are taken to save it. The only way to do this, and it is well worth the time when the tree is a valuable one, is bridge-grafting. Fig. 159 shows what this means, and illustrates the process so clearly that there is hardly need of words. Girdled trees, too small to bridge-graft, may be grafted in the ordinary way below the injury. In bridge-grafting make three grafts rather than two. If large trees are only partially girdled, bridge across the injured place. The tree's own branches may be used for bridge-grafting. In course of time the injury is obliterated by the growth of the bridge grafts. Pressing down the snow and what is below it around the tree with the feet is a help in that it makes it harder for the animals to get at the trunk; there is a solid barrier, as it were, protecting it.

Other remedial or preventive measures are as follows: Keep ground clean of grass and weeds, so there is no place to harbor mice; dig straw away from trees for a short distance; protect trees with wire mosquito netting wrapped once around trunk, about fourteen inches high, or with wood veneer, or with building paper; bank with dirt before freezing weather six or eight inches above surface. Mice may be poisoned with strychnine, using corn meal mush or wheat or corn, scattered about bases of trees. Poisoned wheat already prepared can be purchased in some places. Cats are instrumental in keeping down field mice; some dogs delight in hunting them, and hawks and owls reduce their numbers. Strychnine, as mentioned eleswhere, must be used with caution, that live stock or poultry may not suffer. *It should, of course, be kept out of the reach of children.* Cats eating mice or gophers which have died from strychnine poisoning would probably suffer the same fate as the animals they fed upon. Skunks are said to do us a good turn by eating field mice.

Thirteen-lined Gopher or Striped Gopher: Corn soaked or dusted with strychnine, placing a spoonful in each hole, is a good remedy. Wheat, if used, or corn, should be soaked for twenty-four hours in a solution containing strychnine, and where the

strychnine is dusted on the grain, the latter should be moistened so that the grains of poison will adhere to the kernels. The solubility of strychnine is slight. A teaspoonful of the crystals boiled in 2 quarts of water would make a solution sufficiently poisonous and is probably all that amount of water will take up. This solution may well be sweetened with sugar or syrup.

Steel traps are useful against these animals, and the writer remembers that, as a boy in Minnesota, he used to place a slip-noose occasionally over a hole, and when Mr, Gopher showed his head, as he was quite sure to do very shortly, he was easily snared by the boy at the other end of the string. A shot gun or a 22 rifle would be useful in this connection.

Gray Gophers or Ground Squirrels: The same poisoned baits are used successfully against these as against the thirteen-lined gopher just discussed, and field mice, but they are not generally numerous enough in this state to call for special measures beyond those offered by shooting or trapping. In a far western state, where they are much more numerous than here, the writer used to place poisoned wheat in long covered boxes (about two feet long and ten inches square), the ends being closed except for a space of about three inches wide at the bottom; this allowed gophers to run through but kept out poultry and anything else which might eat the poisoned wheat not intended for them. These boxes were placed on the ground in fence corners in infested fields.

Pocket Gophers: In order to understand fully the application of various remedies and traps against these pests, it is well to have

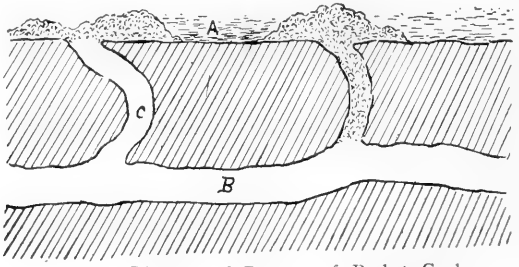


Fig. 148.—Diagram of Burrow of Pocket Gopher.

an idea of their burrows. Fig. 148 illustrates somewhat crudely the main burrow, about two feet below the surface of the ground, and

two of the branch burrows leading from it to the surface, and affording means of removing the earth dug from the main burrow. The mounds of earth one sees mark the places where these branch burrows were open and later closed. The last one made that marks the end of the main burrow, is frequently found open, as that is nearer the location of the animal's work, as he tunnels in some desired direction, possibly toward a patch of potatoes, or along a row of potatoes, or toward some promising clover field. By pouring about ½ pint of bisulphide of carbon on a piece of old burlap or oakum, thrusting it quickly down this open branch burrow, preferably when the soil is moist, and then stopping the aperture with earth, the writer has killed many. Nevertheless the main burrow is sometimes so extensive in its length that treatment with this poisonous gas is not always successful, and recourse must be had to poison. I have been extremely successful with strychnine poisoning, proceeding in this way: The crystals of strychnine were powdered in the bottle in which they were purchased, by means of a large headed nail. Having previously provided myself with an old spoon tied to a long stick, I made slits in a piece of potato with a pen knife, and with the same blade introduced a little powdered strychnine, the poisoned piece of potato was then placed in the spoon, which was thrust away down the hole, turned over and withdrawn, thus leaving the bait in the burrow without having had to put my hand in, the scent of which might alarm the gopher. Another and perhaps simpler way, when the ground allows, is to take an old spade handle or shovel handle of the short kind, sharpen it and thrust it through the soil in the course of the main burrow, and when quite sure that has been reached, dropping in the poisoned potato, and gently pushing it with the spade handle until you are sure it is in the main burrow. Or, if all the branch burrows are filled, one can carefully remove the earth from one of them and introduce the spoon containing the poisoned potato therein. Some claim that they have had better success with parsnips than with potatoes when using poisoned bait.

I have also had success with an ordinary steel trap, digging down to the main burrow with a spade, excavating a place for the trap on the floor of the burrow, covering the set trap lightly with soil, and then placing a piece of board on the surface of the

ground, covering the hole I had made, and heaping earth on the board. I have also used with equal success against pocket gophers and against moles in lawns a cheap trap gun shown in Fig. 149. I believe this is one of the few so-called gopher traps

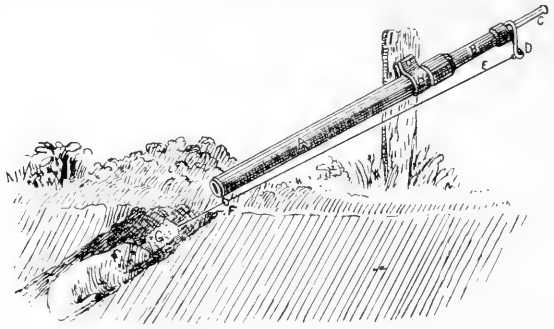


Fig. 149.—Gopher Gun.

worthy of notice. It is made of a piece of gas pipe, and shoots a central fire Winchester shell of small size. Only a small load is required to kill either a gopher or a mole. This gun is fastened to a peg which is driven down in front of the gopher's hole; a piece of potato, or cork or corn cob is put on the end of the wire (see illustration) which extends in front of the nozzle and down the hole, being connected with the trigger at the other end. The gopher, in seeking to cover up the hole and thus exclude the light,

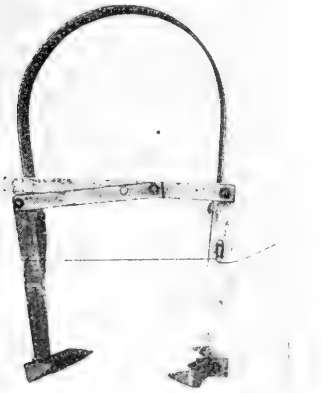


Fig. 150.—A New Gopher Trap, Set.

Fig. 151.—The Same Trap, Sprung.

pushes earth before him, it presses on the cork or potato, fires the gun and never fails to kill the animal in the burrow. A trap said to be excellent, of comparatively recent invention, is shown in Figs. 150 and 151. This is placed in the gopher's burrow, and is kept set by a string, as shown in Fig. 150. The animal seeing this string, and realizing that it is foreign to his dwelling, proceeds to gnaw it. The result of his biting the string is shown in Fig. 152. The trap sells for 35 cents, three for $1.00, and is manufactured in Chicago.

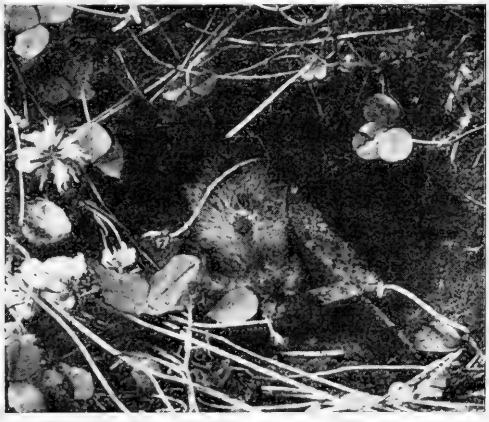


Fig. 152.—Pocket Gopher caught in Trap.

The prominent front or incisor teeth or rodents, upon which so much depends in the way of subsistence, are peculiar in that while the front of each tooth is hard enamel, back of this is comparatively soft dentine, the enamel in front being much thicker than anywhere else on the tooth, and the chisel-like sharpness of these teeth is brought about and maintained in each case by working against the opposing tooth in the opposite jaw. As we can readily see, the working of the enamel edge in the lower teeth against the inner or dentine surface of the upper teeth, and vice versa, would result in a sharp enamel edge in both upper and lower teeth. If, as sometimes happens, through disease or by accident one incisor is lost, or both, the opposing tooth or teeth in the upper or lower jaw, as the case may be, keeps growing, not being worn away at the free end, as would be the case normally, and completes an arc

of a circle outside of the jaw, resulting in a deformity, if it is the upper teeth, something like the illustration shown in Fig. 153.

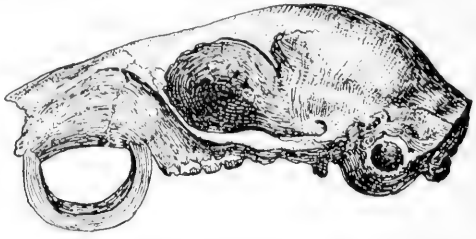


Fig. 153.—Skull of Squirrel showing abnormal growth of upper incisor teeth. Standard Natural History.

Woodchucks: The accompanying excellent illustration shows an animal familiar to us all, and generally not so abundant or injurious but that the farmer's boy and a steel trap are quite equal to the occasion. Bisulphide of carbon is also used successfully, and at least one party known to the writer has had recourse to the somewhat dangerous use of blasting powder.

Fig. 154.—Woodchuck, *Arctomys monax.*

The gas generated by bisulphide of carbon is inflammable; keep all lights, pipes, cigars or matches away from it.

Moles: I regard moles as more beneficial than injurious, and dislike to offer any means of killing them. At the same time they

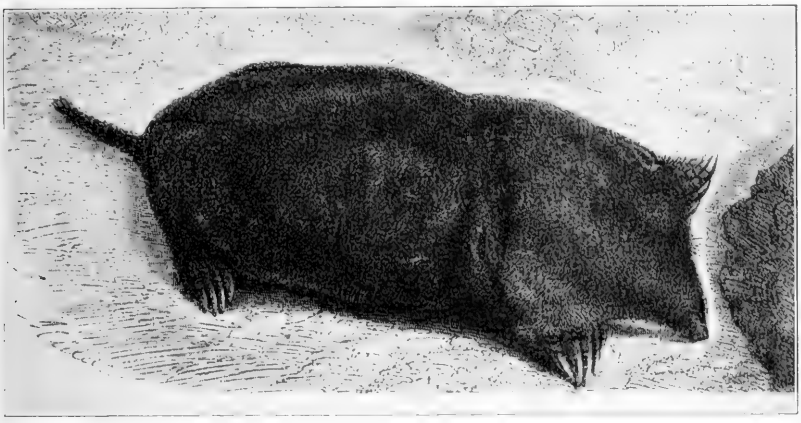
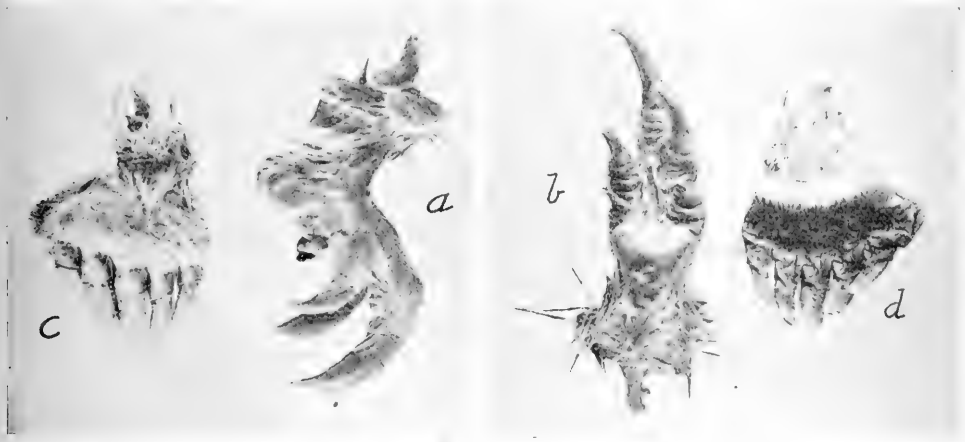


Fig. 155.—A Mole. From Müller.

are sometimes so aggravating in mining lawns that some remedy is called for. In some parts of the country moles have certain times of the day when they work. Knowing this and seeing their mounds move at such times, we may, as has the writer, stand with a many-tined fork over a mound, and when the movement is repeated plunge the fork as accurately as possible into the middle



Figs. 156 and 157.—*a* and *b*, Feet of Gopher; *c* and *d*, Feet of Mole, from above and below. Lugger.

of the moving area. The chances are that the mole will be impaled on the fork. A light charge of shot fired into the mound at such a time at close range, using but very little powder, would undoubtedly accomplish the same result, and would perhaps be more sure.

Fig. 158.—Ear of Corn gnawed by some rodent. Supposed by a Correspondent to be the work of Insects.

I have killed many moles in lawns by the use of the gopher gun shown in Fig. 149, opening the surface burrow, leaving it open, and having the gun point into it. Moles have burrows much like gophers, that is, a main burrow and branch burrows coming

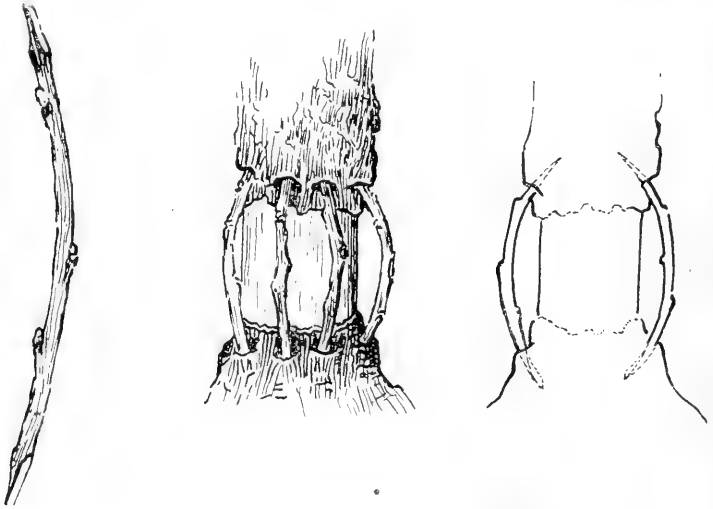


Fig. 159.—Bridge-grafting. After Thomas.

therefrom. The surface burrow, which raises the sod in ridges, is quite distinct from the main burrow, which lies deeper. The surface burrow is made, I believe, by the mole in pursuit of grubs or worms among the grass roots or just below.

I have no faith in attempts to poison moles, and believe poisoned wheat or corn or meal is absolutely of no avail in this connection. Moles appear to be almost entirely carnivorous or meat eaters, and the meat must be living apparently. Wheat, corn or meal is not attractive to them. The ordinary steel trap is sometimes used with success. One writer claims, upon what ground I do not know, that moles are very fond of sugar, and that

Fig. 160.—A "Rabbit-proof" Fence which is not always true to name.

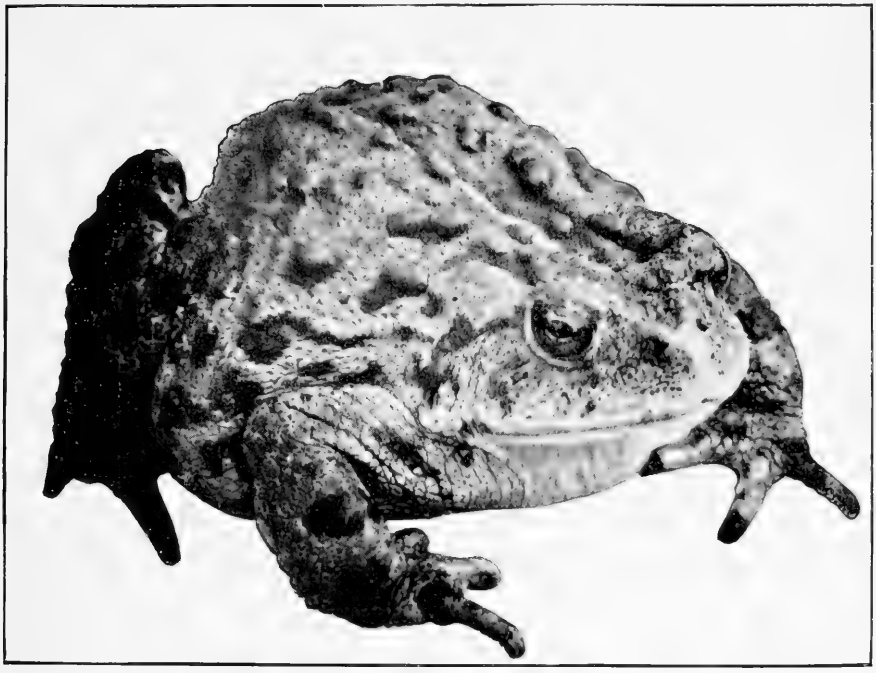
if it is slightly poisoned with powdered strychnine and placed in their burrows, beneficial results follow. The Entomologist wishes again to caution those who use strychnine. It is a deadly *poison* and should be handled with the greatest care.

THE COMMON TOAD A FRIEND TO GARDENERS.

Most of the old superstitions regarding the toad, such as the possession of a jewel in its head, and that warts are produced on one's hands from handling, etc., have been pretty much done away with. We hear astonishing stories regarding the finding of live toads encased in solid rock, in wood, etc., evidence going to prove that they have been thus buried for many years. These stories are not authenticated, however, and may be looked upon as myths. The ancients believed, too, that toads had medicinal value; that broth made of toad's entrails was poisonous, that any part of the toad if eaten would cause death, that killing toads on the farm would make the cows give bloody milk, etc. These and similar superstitions have given away before modern education. Nevertheless, that toads are long lived, and may endure what would seem to be unfavorable conditions for a long time, is well known. We hear of a toad in Europe said to have reached the age of thirty-six years before it was killed by accident. We are told by Mr. Mosher, a most careful observer, that he has "positive knowledge of a toad which had occupied a door yard for at least eight years." Other testimony regarding the longevity, not so satisfactory, claims twelve years for one and twenty-three years for another. These statements may be correct, but we lack absolute proof. Of particular interest, and having a bearing upon the reports that toads have been found encased in rocks, etc., is the fact that Mr. Herrisant in 1877 placed three toads in sealed boxes of plaster, and found two of them alive when the boxes were opened eighteen months after. Later experiments along the same line, however, indicate that they are not capable of standing such imprisonment without food for an unlimited time.

Very few realize the immense good done by the common toad in consuming insects which are, for the most part, injurious to the flower and vegetable garden. He is a true insect hunter and therefore deserves a place in the Entomologist's Report.

A few words as to the life history of the toad may not be out of place. In the spring of the year both sexes repair to pools and



THE COMMON TOAD.

A Practical "Bug Catcher" and therefore a Useful Friend. Encourage His Presence in Your Gardens.

Courtesy of R. A. Cooley.

ponds for breeding, and the air is filled at that time with that shrill purring which is so characteristic of the early spring, when the poplars and cottonwood are in bloom and the first moccasin flowers are found in the woods.

Fig. 160½.—Head of Toad, showing the peculiar attachment of the tongue. After Kirkland.

The eggs, to the number of 1,000 or more, unlike those of the frog, are laid in strings of gelatinous matter wound about aquatic or submerged grass. These eggs hatch after a while into tadpoles or polliwogs, much resembling the tadpoles of the frogs, which breathe for a part of their lives by means of gills, and are familiar to every farmer's boy and any one at all observant in the fields and woods. These so-called polliwogs after a while lose their tails, acquiring first hind legs and then fore legs, while their tails are disappearing. Losing their gills, they finally breathe entirely by means of lungs. Then they emerge from the water in large numbers. They avoid the sun, and both old and young are

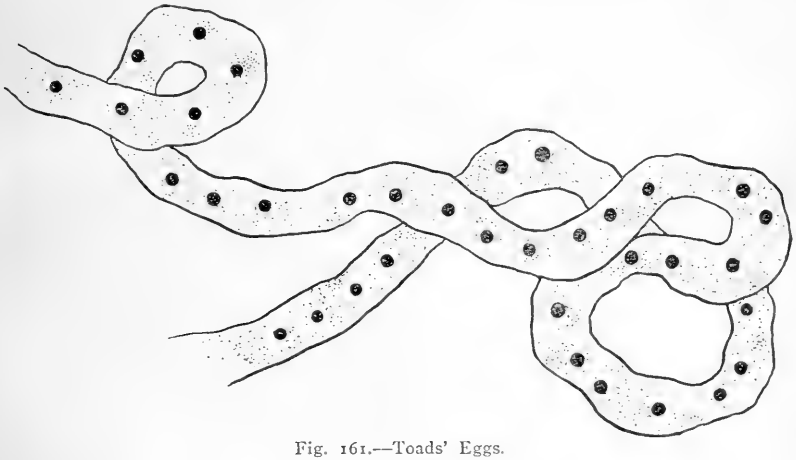


Fig. 161.—Toads' Eggs.

seen at night-fall, or sometimes in large numbers after a rain, at which latter time their extreme abundance gives rise to the popular belief that "it is raining toads."

Those of these young creatures that escape their enemies (and their foes are extremely numerous) begin before very long their

useful work of feeding almost entirely upon insects and allied forms, and the number of insects which they consume, as adults, is almost incredible. Some excellent work done by A. H. Kirkland, of the United States Department of Agriculture, and published in Farmer's Bulletin No. 196 (which is practically a reprint of his work published as Bulletin No. 46 of the Hatch Experiment Station), brings to light the startling fact that in twenty-four hours the insect food consumed equals in quantity four times the capacity of the toad's stomach. In other words, the stomach is practically filled and emptied four times in each twenty-four hours. Mr. Kirkland states further that 149 stomachs examined by the Department during the months of April, May, June, July, August and September showed 19 per cent of ants, 16 per cent of cut worms, 10 per cent of thousand-legged worms, 9 per cent of tent caterpillars, 8 per cent of ground beetles and other close allies, 6 per cent of May beetles and allies, 5 per cent of wire worm beetles and allies, 5 per cent of destructive weevils, 3 per cent of miscellaneous caterpillars, 3 per cent of grasshoppers and crickets, 2 per cent of spiders, 2 per cent of sow bugs, 1 per cent of potato beetles, 1 per cent of carrion or burying beetles, 1 per cent of miscellaneous beetles, 1 per cent of snails, 1 per cent of angle worms, 1 per cent each of vegetable matter and gravel probably taken in with the insects, and 5 per cent of unidentified animal matter.

In considering the value of the toad as shown by this work, we must remember that ants, while not directly injurious to the agriculturist, are a pest to the housekeeper, sometimes injure lawns, and always encourage by their assiduous devotion and attention destructive plant lice. The toad makes a fine showing in the above percentages on cut worms. The thousand-legged worms eat into fruit when off the tree; the injurious qualities of the tent caterpillar we are well aware of, and we also know that but one or two birds will touch them on account of their disagreeable covering of hairs. Ground beetles are, for the most part, beneficial, but May beetles or June bugs, as they are sometimes called, of which the above toads ate six per cent as compared with the rest of their food, we all know are most destructive upon lawns, strawberry

patches and elsewhere. The wire worm beetles, as we know, are the source of one of our most destructive pests, both in the garden and on the farm. All weevils are exceedingly injurious, and the rest of the list needs no comment, except possibly spiders and sow bugs. Spiders may be beneficial in killing injurious insects, but their webs also catch beneficial insects, forms which live as parasites or prey upon the injurious forms. Sow bugs, which belong to the class Crustacea and are not insects, sometimes do great damage in green houses by eating tender roots and plants, and are always obnoxious things to have in the vicinity of the house. The carrion beetles or burying beetles are useful to man. Snails are a pest of the flower bed. Angle worms, of which the above toads consumed a small amount, are beneficial in draining soil and turning it over, but sometimes are unpleasantly injurious in flower beds and on lawns and about walks.

Our friend, the toad, eats grape and celery caterpillars, tomato worms, the destructive cabbage worm, cucumber beetles and canker worms. Some bee-keepers, alas, say they occasionally eat bees. Upon this point Mr. Russell, President of the Minnesota Bee-keeper's Association, tells me that he has fed a toad by throwing drones at him, the toad never missing a drone, but catching each one most adroitly, and with but the slightest evident effort. On account of this one apparent weakness, and even the best of us have our weaknesses, as well as for other reasons, bee-keepers should keep their hives off the ground. It is well to remember, however, that toads do most of their feeding at night when bees are not active. We have never witnessed any such reprehensible act on the part of the toad.

Mr. Kirkland, in summarizing his work, says, excluding the five per cent of unidentified animal matter, that the food of the above toads represented 11 per cent of beneficial forms, 22 per cent neutral forms, or forms which affect the gardener or the farmer neither one way nor the other, and 62 per cent of very injurious forms. Let us give all credit, then, to the toad for his good work, and let us encourage his presence in our gardens as well as in our greenhouses in every way possible. **Perhaps the worst enemy the**

toad has is the thoughtless boy, who sometimes brags of the number of toads he has killed in the spring, not realizing that he is not only killing a perfectly harmless creature, but that every toad he kills would, if allowed to live, have consumed thousands of insects which prey upon plants of the garden and the farm.

The toad's food must be alive in order to attract him, and it is astonishing with what lightning-like rapidity his tongue is darted out and drawn back with an insect. Awkward as he appears, he is frequently quick enough in this process to catch an insect while on the wing. This tongue, with which he accomplishes this marvelous work, unlike the tongue of most other animals, is attached at the anterior end and free behind, admirably fitted, it will be seen, for its purpose.

We are indebted to Prof. R. A. Cooley of Montana for the use of the photograph which precedes this article.

Fig. 162.—"They Work While You Sleep." (*Bufo vulgaris, B. variabilis* and *B. calamita.*) From Brehm.

REMEDIES FOR SOME COMMON PESTS OF THE VEGETABLE GARDEN.

Some insect pests, like the poor, we have always with us, and to forestall many inquiries which will reach this office in the future, as they have in the past, we include here remedies for these common insects, even though they may have been treated of before. These pests are everywhere more or less abundant, and possibly with one exception, so well known to our farmers that we omit descriptions, confining ourselves simply to remedial measures.

Cut Worms: Late fall plowing, thus bringing up the pupæ where they are subject to extremes of temperature, and the attacks of blackbirds, crows, poultry, etc. Cleaning up and burning all rubbish. Poison bundles of clover with a strong solution of Paris green and strew the same among the plants which are being cut. We have been successful with these poison baits. Plant an excessive number of seeds or plants. Cylinders of tin, fruit cans with ends melted out are good, or cardboard, or even paper placed around young plants, melons, squashes, cucumbers, etc., and extending into the earth two or three inches will protect plants until they get beyond danger. We have trapped them by placing flat on the ground cabbage leaves or any large leaves or boards among plants needing protection, finding the worms underneath these traps in the morning. We have frequently found the guilty worm concealed an inch or two in the soil in the morning, not far from the plant injured in the night. We have poisoned them by making a bran mash, sweetening it with molasses or sugar (it should not be sloppy) and adding Paris green liberally. Place one or two teaspoonfuls of this near the base of each plant likely to be cut. It should not be placed too near tender plants—beans, melons, cucumbers, etc.—since a heavy rain would wash the Paris green against the plants and injure them. Arsenic may be used in place of Paris green, observing the same precautions. Land recently in sod is likely to be infested, and the crop following sod is pretty sure to suffer, if attractive to these pests. Nursery trees affected by climbing cut worms may be sprayed with Paris green, or cotton or tin barriers fastened about trunks, or a ring of one of the various sticky compounds on the market placed around the trunks.

In using any of the above remedies, or, in fact, remedies for any insect, each farmer or gardener must be guided in making his choice by the conditions existing with him. Some of the above, for instance, would not seem practicable to one farmer or gardener, while they would exactly suit the conditions existing with another. It is the policy of the Entomologist to give as many good remedies as possible in each case in order to allow of a choice.

Wire Worms: Frequently abundant in sod land, and troubling crops following sod. Fall plowing as for the cut worm, and repeated several years in succession, is desirable, since they live more than one year in the larval stage. The writer has trapped them in a patch of beans, by sticking pieces of potato on slender sticks eight inches long, and burying the potatoes three inches near the roots of the bean plants, examining the potatoes every few days

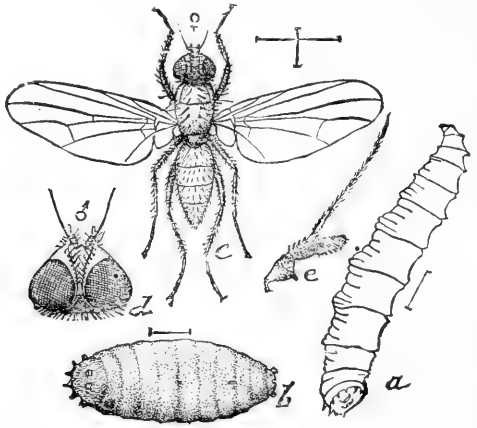


Fig. 163.—Cabbage Maggot, *Phorbia brassicæ*: *a*, Larva; *b*, Pupa; *c*, Adult; *d*, Its head; *e*, Antenna. From Riley.

and killing the wire worms found feeding thereon. This, of course, is not practicable for field crops. Rotation of crops as far as possible is desirable. The adult insects may be attracted to poison baits in the spring. Certain commercial fertilizers are recommended, but are not altogether satisfactory. The worms are the larvæ of Click Beetles, see Fig. 72.

Cabbage Maggot: The larva of a small fly, boring into roots of cabbage, cauliflower and radishes. Other closely allied flies affect onions, beans, etc. One market gardener reports having lost

15,000 cabbage plants and 10,000 cauliflower plants, practically his entire crop, through the agency of the cabbage maggot. He states further that the fly worked right through September, and was as bad on late cabbage as on early. The number of cabbage or cauliflower plants set to an acre is small compared with beans or onions on the same area; hence, remedies may be applied to cabbage or cauliflower which would not be practical for beans or onions. These flies lay their eggs upon the surface of the ground near the stem, and the maggots, hatching a day or two later, work through the ground to the stem. One means taken to prevent attack consists of round discs of the cheaper grades of tarred paper, about 4 to 4½ inches in diameter, with a slit cut from the edge to the center. These are slipped around the stems of the plants, and made to lie flat on the ground. To be effective they must be applied *before the eggs are laid.* The idea is to keep the fly which lays the eggs away from the stalks where they enter the ground, obliging her if she lays at all, to lay her eggs so far from the plants that the maggots cannot reach them. Onion plants infested by maggots, evidenced by the yellowing and wilting of the leaves, should, if weakened beyond all hope of recovery, be pulled and destroyed, that the maggots therein may not develop and spread the mischief. In bad cases weak kerosene emulsion might be employed along the rows, wetting the stalks and adjoining soil. This would, to some extent, if used frequently, repel the fly, and possibly kill some of the larvæ which might not be protected. One party claims to have obtained relief by making an application of about a thimbleful of common salt about the root stalk. We have never tried this, but would remind our readers that while a little salt is good for plants it should be used with caution in connection with flowers or most vegetables. Finely ground tobacco, or soot, or ashes, or air slaked lime, or sand wet with kerosene, a cupful of kerosene to a pail of sand, is sometimes applied around the plants, or along the rows. This must be done before the eggs are laid. When the maggots are working on the stem, kerosene emulsion or carbolic acid emulsion has been used with success. Carbolic acid emulsion is made as follows: Dissolve 1 lb. hard soap in 1 gal. boiling water, add 1 pint crude carbolic acid, and churn through force pump. When wanted for use against cabbage maggots dilute it

with thirty parts of water. Dilute with 35 parts of water when used against radish maggots. About one-half pint of this emulsion should be poured about the base of each cabbage plant. The recipe for kerosene emulsion is given in Report for 1903 (Bulletin 84). Against the radish maggot the writer has successfully used, in a small garden, tobacco water making several applications with a watering pot, beginning when the radishes were quite young. The tobacco solution not only acts as a repellant, but is also an excellent fertilizer. He has also used ashes and slaked lime.

We note that when radishes are raised on a large scale the following compound is recommended (J. B. S.): Nitrate of soda 700 lbs., ground rock 1,000 lbs., muriate of potash 300 lbs. This should be applied at the rate of 500 lbs. to the acre, sown after plants are up, "when the leaves are about an inch long" and should be used during or before a rain. Applied too late, after the insects have got into the roots, it would be a waste of time and money as far as a remedy against the maggots was concerned.

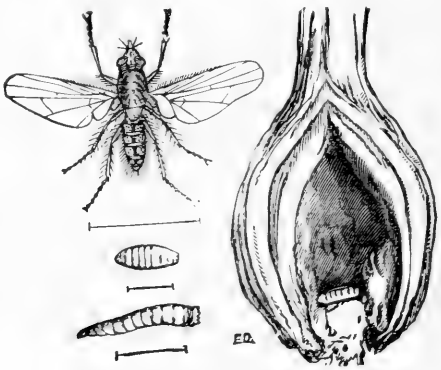


Fig. 163½.—Onion Maggot.

Cabbage Worm: This green worm, the larva of the white cabbage butterfly, not only attacks cabbage, cauliflower, kale, etc., but various kinds of cruciferous plants. We believe in paying children something to hand pick the worms and kill them, and also to make nets of mosquito bar in the early summer and catch every white butterfly they see hovering over the cabbages. A small sum

expended in this way will not only please the young people, but will work astonishing results. Three children in about 2½ hours collected in the writer's small garden 360 green cabbage worms.

Dusting or spraying with Paris green has been successful. Paris green may be mixed with cheap flour, 1 lb. of Paris green to every 25 or 50 lbs, of flour, and dusted in the morning upon the plants when the dew is on. Or the cabbage may be sprayed, using 1 lb. of Paris green to every 160 gals. of water, and adding some soft or hard soap to prevent the liquid "rolling" off the cabbage leaves. In using Paris green in water keep the solution constantly stirred. Hellebore dusted on in the early morning can also be used, if one objects to Paris green. We will say in this connection that there is absolutely no danger of poisoning when Paris green is used on cabbage, since not a trace of the poison will be found in the head itself. Hellebore is poisonous to insects, although harmless to man.

Squash Bug and Cucumber Beetle: See pages 80 and 81 respectively.

Stalk Borer in Tomato Vines: See page 178.

Naked Snails or Slugs on Lettuce: See page 180.

To Get Rid of Potato Blight and Potato "Bugs" at the Same Time: In traveling over the state the latter part of last summer I was struck by the prevalence of blight in potato vines in many sections. Since then many complaints have reached us regarding this trouble. The following treatment with Bordeaux mixture has, in New York State, given excellent results, and a knowledge of the method, it would seem, should be in the hands of every farmer in our state who raises potatoes.

Spray the vines with Bordeaux mixture first when plants are six or seven inches high. Two weeks later give them another spraying, following this with two, three or four later sprayings, even nine and ten sprayings are sometimes given, allowing two weeks to elapse between applications. The necessary strength of Bordeaux mixture for this purpose is made as follows:

Place six lbs. of copper sulphate (bluestone) in a burlap sack, and hang it in sufficient water to dissolve it in any vessel which is

not made of iron. Slake four lbs. of fresh lime gradually. When slaked add 25 gals. of water, and the water containing the dissolved bluestone. Stir thoroughly and add 25 gals. more water, 50 gals. in all. This mixture should be strained through burlap, or, better, a wire strainer, before being used, to remove particles which might clog the sprayer. To kill potato beetles or "bugs" at the same time, add one lb. Paris green to the amount of the mixture necessary to cover one acre. Each plant must be thoroughly covered. To be successful the spray should be used before the blight starts. This process (four sprayings) costs about $4.00 per acre, and each farmer must decide for himself whether the expense is justified.

It may well be said here that when one is treating potato vines for the beetle alone, arsenate of lead is safer and better than Paris green.

Farmers should read in this connection the article on potato diseases, page 66 of Farmers' Institute Annual No. 16. These Annuals are obtained by mailing a request to O. C. Gregg, New York Life Building, St. Paul, Minn., enclosing postage.

Potatoes this year are much troubled by rot, which subject, as well as that of potato blight, naturally belongs to another department, and does not call for detailed discussion here. We are led to say, however, that the old theory that potatoes should be dug early to avoid rot appears to have been disproved in the light of certain recent experiments, in which only 7 per cent rotted when they were allowed to remain in the ground ten days after the tops were all dead, while some which were dug much earlier lost 55 per cent by decay. It is claimed that the common dry rot of the tuber is caused by the same fungus that produces the late blight of the foliage, and potatoes in blighted fields are likely to be infested with rot; if not during the same season in which the blighted tops appar, then the following. It is believed by some that the spores are washed down by rain into the soil. Said spores would remain dormant for a while, until favorable conditions for germination occurred. Much remains to be learned on this question.

ENTOMOLOGICAL SUGGESTIONS FOR THE FLOWER GARDEN.

Without attempting to list remedies against the army of insects which attack the flower garden, simple remedies against some of the more common forms, which the Entomologist has found useful in his own experience, may be helpful.

Plant Lice: These are perhaps the most vexatious of all to those seeking to raise flowers. We find various kinds in the flower garden, on golden glow, sweet peas, roses, spirea, buckthorn, etc., all busily engaged in sucking sap from their various host plants, frequently blasting our hopes of flowers, or good growth of plant or bush unless we take prompt measures against them. We cannot well use the usual radical remedies which are sure death to lice, since they would either destroy the tender growth of the plants, or hide by their offensive odors the delicate fragrance of the flowers.

Occasionally on sweet peas or other delicate plants, a forcible spraying of water from the garden hose, frequently repeated, will wash them off. Fresh pyrethrum dusted on them with a bellows will, of course, kill them, and is an excellent thing if one can buy the fresh material. On shrubbery from which no flowers are to be gathered, whale oil soap, tobacco solution, or weak kerosene emulsion can well be used. More convenient, easily prepared, and adapted to all flowering plants is the following soap solution: A 5c. cake of Ivory soap dissolved in eight gallons of water Possibly other soap could be used as well as Ivory Soap, but the latter is found in almost every household, and has been successfully used

Cut Worms: Frequently cutting dahlias and other tender plants. See page 171 for remedies.

Stalk Borer: This disgusting "worm," found in the growing shoots of dahlia, hollyhock, golden glow, aster, catalpa, etc., is frequently as troublesome in the flower garden as in the vegetable garden, in which latter place it attacks tomatoes, potatoes and other plants, and some shrubs whose stems have a soft center. It is the larva of a brownish moth, and there appears to be more than one brood during the summer in Minnesota; at least, we have obtained pupæ from hollyhocks in August, and had the moths

emerge on September 7th. The young caterpillar, on emerging, is purplish, with eight stripes running along the body. Later it becomes duller colored, and about midway of its length the color is such as to make that part appear diseased. The presence of this borer in a stem is indicated by a drooping and wilting of the growing tip and examination will disclose a round hole on the surface of the stem, below the wilted portion, the opening of its burrow. The affected stem can be cut off just below this hole, and the "worm" in its burrow be killed; or, in rare cases a slitting of the stem on one side, above the hole, with a penknife will bring the culprit to view. If it is not found in the burrow above the hole, one must note whether any part of the burrow is in the stem below the hole; if so, the caterpillar must be sought for there. If these precautions are taken at the very first appearance of the drooping of the plant serious injury may be prevented, and further trouble by these worms turning into moths and laying more eggs, averted. In stems which are straight, offering no irregularity in growth, a flexible wire may be run up in the burrow, or down through the opening, and the caterpillar killed in this way. Most feasible af all, possibly, is the method hit upon by a Minneapolis party whose choice tomato vines were being injured. With a medicine dropper he injected into each hole about one teaspoonful of chloroform, immediately plugging the hole with a bit of cotton, that the fumes might be retained. This worked like a charm, did not appreciably injure the tomato plant, and would doubtless be effective upon flowering plants. We have suggested the use of bisulphide of carbon in place of chloroform on the ground of its being less expensive, and have been informed that it has been found quite as successful as the chloroform.

Cabbage Worm: This vegetable garden pest finds also food to its liking in the flower garden. The writer had a fine growth of nasturtiums last season, which, in late summer, were badly eaten by the larvæ of the white cabbage butterfly. We resorted to hand picking. See in this connection the remedial measures discussed on page 174.

Rose Beetle, Rose Chafer, "Rose Bug": This yellowish beetle, being a leaf eater, can be easily killed by an application of some internal poison, like hellebore. By jarring the bushes in the morn-

ing they can be readily shaken into sheets placed below to receive them. They sometimes appear in large numbers when roses begin to bloom. Frequently grapes, apples, plums, etc., also suffer.

Slugs, Slug Caterpillars: These worms, found in leaves of various bushes and shrubs, are larvæ of four-winged flies. They are not true caterpillars. Two forms are found on the willow; one black with orange spots on the side; another, larger and green. Some feed on leaves of cherry, plum and pear; others on roses. Some have a slimy covering, while others look more like a genuine caterpillar. They are all leaf eaters, and can be easily killed, therefore, by Paris green sprays, or white hellebore, 1 oz. in 1 gal. of water, or dry, or tobacco solution. The slimy form can be destroyed by dusting with air slaked lime, fine ashes or even road dust, and they will all yield to pyrethrum.

Mildew on Roses: This fungus which attacks the leaves of roses, as well as many other similar parasitic plant growths, has been controlled by the Entomogolist by the application of "potassium sulphide" (liver of sulphur) using 1 oz. dissolved in a gal. of warm water, and sprayed on bushes at the *very first appearance of attack*, repeating the treatment occasionally. If one delays application until the fungus has worked into the tissues below the surface, the above fungicide cannot reach it. Hence, the necessity of early and frequent applications. If roses calling for treatment are trained against porch or house, avoid getting the liquid on the paint; white paint particularly is badly discolored by it.

Small Ant Hills in Lawns and Walks: The writer has stopped the depositing of sand by ants on a lawn by the same agent used against the large unsightly mounds made by one species in our pastures and elsewhere, though it is somewhat more laborious and expensive. The process consists in pouring into the opening of each ant hill about ½ teaspoonful of bisulpide of carbon, and then closing the opening with earth. It would hardly pay one to treat occasional, very small and scattering hills in this way, but occasionally one will be annoyed by a cluster of hills, the owners so busily engaged in bringing up sub-soil that an unsightly patch on lawn or walk results. When several so located have been treated, throw a wet burlap sack or something of the kind over them for several hours to still further aid in retaining the gas. When a cluster of

hills, as above indicated, is found in the lawn, and the ground seems more or less honeycombed by their burrows, punch several holes from two to four inches deep at intervals through their villages, using something like a sharp croquet stake, and pour about a teaspoonful of the above liquid in each, then cover with earth and burlap, as suggested.

The minute ants, *Monomorium*, which sometimes get a foothold in the house, annoying careful housekeepers, can only be eradicated by finding the nest or nests, even though it is necessary to remove some carpentering to do so, and killing the queen or queens. Sometimes she can be reached by squirting kerosene, using a machine oil can, into cracks and crevices in the immediate neighborhood of the nest. There are various ways of temporarily alleviating the trouble, but no permanent relief can be expected until the queen, the source of all the eggs, is killed. Bisulphide of carbon, observing the usual precautions as regards the proximity of lights, is sometimes successfully used.

Naked Snails, "Slugs": These must not be confounded with the "rose slug" or "pear and cherry slug" or "willow slug" discussed above, which are insects. The subjects discussed in this paragraph are not insects at all, but belong to the group or phylum of animals known as *Mollusca*—soft bodied creatures, frequently covered with a shell, such as our pond snails, clams, oysters, etc., but sometimes without, like these slugs which crawl about flower beds, frequently eating violets and pansies, and in some sections notoriously troublesome on lettuce in the vegetable garden.

Moist ground is always more likely to be frequented than dry situations, hence, drainage, where practicable, tends to lessen their numbers. I have trapped them by placing cabbage leaves flat on the ground among plants infested, leaving them there over night, and finding Mr. Slug underneath in the morning, he having sought that protection against the heat of the day, after his night's feed. Shingles or pieces of boards answer fairly well for traps. When lettuce is troubled I have had the best success by using clear weak lime water, sprinkling the plants with the same, which in no way injures the lettuce, but is extremely distasteful to the slugs, evidently keeping them away, and they are destroyed if it comes in contact with their slimy bodies. It is claimed that cheap salt at

the rate of four or five bushels to the acre, or lime at the rate of ten or twelve bushels to the acre, applied twice in succession, will be instrumental in ridding soil of them. Salt is especially injurious to their mucous membrane. Fields should be dressed when slugs are active after heavy rain or in early morning before the sun is up; never during the hot part of the day or in very dry weather. Salt may be used sparingly in the flower garden. It should never be put close to plants for obvious reasons.

Moles in Lawn and Flower Beds: See page 163.

COTTONY MAPLE SCALE ON ELM AND MAPLE.

Fig. 164.—Cottony Maple Scale, *Pulvinaria inumerabilis*, on Soft Maple. Original.

Our illustration shows this insect, which has been extremely abundant this year, on soft maple. Maples and elms, as well as various vines and shrubs, in St. Paul, Minneapolis, St. Anthony Park and many towns throughout the state, as well as trees in localities in South Dakota and elsewhere, have been more or less affected. Its extreme abundance during the present season is not difficult to account for, since the wonderfully rapid rate at which

it increases, coupled with the fact that a number may have been present last year and yet not noticed, would account for its seemingly miraculous appearance last summer in enormous numbers.

The spreading from tree to tree could be affected, where trees interlace, by the active young crawling from limb to limb, and further by being carried on the feet of birds. In the opinion of the writer the English sparrow is, in a large measure, responsible for this, for he is pre-eminently now *the* bird of the city and village streets. We must not, however, overlook the agency of insects of various sorts, upon whose bodies the young lice could be easily transported. Prof. Riley, in the First Missouri Entomological Report, comments on this and says, "the copious secretion of honeydew attracts many honey loving insects, such as bees, wasps and flies, and these without doubt carry many of the restless young larvæ from tree to tree. "Spiders, too, are said to assist in this work, and even the beneficial "lady-bird" beetles which prey upon the scale. The wind too, in blowing infested leaves or twigs from one place to another, also plays a part in distributing this insect.

Ordinarily a strong, vigorous tree can withstand considerable sapping of this sort without being appreciably weakened, but when the pest is as abundant as it has been the past season, their pernicious work is bound to show, as indeed it did late in the summer, in the sickly appearance of some of the branches of the maples.

Remedies: If trees are trimmed in winter or early spring, and the cuttings burned, the adult scales on the cuttings, with many thousands of eggs, will be destroyed. The same result would be obtained by pruning and burning in the late summer and fall. Sprayings of kerosene emulsion in the spring and early summer will kill the young lice as they are crawling over branches and leaves, and strong caustic sprays, such as lye, or lime and sulphur, applied in the winter when the trees are dormant, will kill the adult scales and the contained eggs. Spraying a tall tree, however, is difficult and sometimes impossible. When but a few are present on a vine or shrub they may easily be got rid of with a bucket sprayer, or even killed by touching them with kerosene.

This scale has many natural enemies, both predaceous and parasitic, which unknowingly assist us in our work against it.

Life History: This scale belongs to the family *Coccidæ*, which contains all the scale insects, and its life history resembles in general that of other scales. Briefly, the young lice hatch in the spring and early summer, immediately migrate to the leaves, and temporarily become fixed. Sucking the sap from the leaves, they rapidly increase in size, moulting a number of times as they grow. The males undergo a metamorphosis, emerge from pupal case as minute two-winged insects, mate with the females and die; the impregnated females later migrate to the twigs and pass the winter fixed to the same. The following spring the developing eggs cause the body of the female to increase in size, and late in May and in June these eggs are laid in the cottony growth which the female has secreted at the posterior end of the body. In the above photograph the cottony (waxy) secretion is full of eggs. After laying from 1,000 to 2,000 eggs the female dies, probably in July.

The insect feeds not only on the trees above indicated, but upon various species of maple, upon wild grape, oak, basswood, hackberry, currant, locust, sumac, box elder, willow, woodbine (Ampelopsis), etc.

A LECANIUM ON CONIFERS AT THE STATION.

Fig. 163.—*Lecanium sp.* on Scotch Pine, showing whitish Coccinelled larvæ, *Hyperaspis*. Original.

For a number of years, so I am told by Prof. Green of the Horticultural Department, the above insect has been at work in the "forest" at the Experiment Station, and has caused the death of several Scotch Pines, *Pinus sylvestris*, though the horticulturist reports using 50 per cent kero-water with success. They were later found in large numbers on the Jack Pine, *Pinus divaricata*. At Prof. Green's request this department undertook to free the Scotch Pines from its attacks, and on July 11th these trees were sprayed with kerosene emulsion, one part emulsion to eight of water. On August 3rd they were sprayed again with the same strength, and the Jack Pines treated in the same way, this being the first treatment for the Jack Pines. Subsequent examination showed a marked decrease in the scales on the Scotch Pines, which received two treatments. In view of the presence of an immense number of larvæ and imagoes of the Coccinellid, *Hyperaspis*, which were feeding upon the scale, and which, naturally, suffered by the treatment meted the scale, we stopped further spraying. The white larvæ of the "lady bird," *Hyperaspis*, are shown in the accompanying cut among the scales.

THE STRIPED POPLAR BORER, MELASOMA SCRIPTA, FAB., AN ENEMY TO WINDBREAKS.

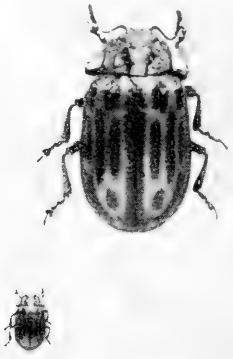


Fig. 166.—Poplar Borer, enlarged and natural size. A. G. Ruggles.

The above excellent illustration shows this beetle much enlarged and natural size. Complaint of its attacking poplars reached us

in May from Redwood County. It feeds upon the foliage of willow and poplar, and sometimes succeeds in almost defoliating these trees in windbreaks. Spraying with Paris green or any other arsenite will effectually stop their work. Fig. 167 illustrates the great variations in the markings of this species.

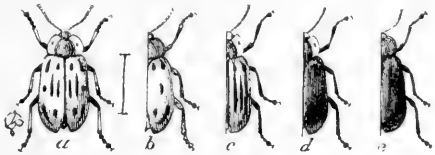


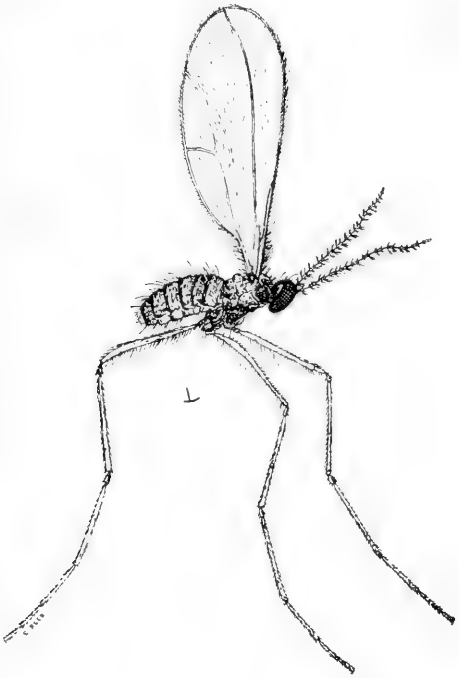
Fig. 167.—The Poplar Borer; variations from type. From Riley.

GALL MAKERS ON THE BOX ELDER, SOFT MAPLE AND BASSWOOD.

The accompanying illustration, Fig. 168, is from a photograph of box elder leaves, which exhibit a gall made by a tiny two-winged fly. For two years or more box elders, always attractive to many

Fig. 168.—Galls on leaves of Box Elder. A. G. Ruggles.

insects, have suffered from this pest. Our efforts to breed the fly from the gall have at last been successful, and the adult insect is shown in Fig. 169. The larva which comes from its egg lives within and helps form the gall, and is shown in Fig. 170. This fly, an expert in this group states, is probably *Cecidomyia negundinis*, Gill.



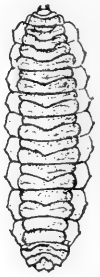


Fig. 170.

Fig. 169.—Fly bred from Box Elder Leaf Gall. Much enlarged. Original.
Fig. 170.—Maggot of Fly shown in Fig. 169. Much enlarged. Original.
The small line near the fly, as in other drawings in this report, shows the natural size of the insect.

Another tiny fly belonging to the same genus, *C. aceris*, Fig. 172, has this year affected soft maples, causing a rolling of the leaves, in which very imperfect gall lives the larva.

Two hymenopterous parasites, *Tetrastichus sp.* and *Meraporus sp.*, upon this fly were bred from the larvæ in our laboratory. Another parasite is shown in Fig. 173.

The work of this fly was first observed by us in July, and flies issued in our breeding jars the latter part of that month, between

Fig. 171.—Imperfect Galls on Leaves of Soft Maples. Original.

July 20th and 25th. On August 1st we found fresh galls containing larvæ on the maples, and assume from this and the date of emergence of flies in the breeding jars that this represents another brood of maggots, possibly the second. Maggots were found at

Fig. 172.—Fly Raised from Galls in Soft Maple Leaf. Much enlarged. Original.

work on the maples as late as August 25th. Later examinations, September 4th, failed to disclose any eggs, larvæ or pupæ, and the work of the fly had evidently stopped for the season. I believe we are safe in stating that there are at least two broods of this fly in this locality.

Both of these flies belong to the family of gall-making gnats known as *Cecidomyiidæ*. In it are found some of the most destructive insects, the Hessian fly, for example, the Wheat Midge, Willow Gall Flies, etc.

It is doubtful if any remedy is practical for the injury caused by these insects, beyond the picking off and destruction of affected leaves containing the larvæ, if the trees are small and few in number. Some repellant solution might possibly be sprayed on leaves frequently during the season of the insect's attacks, and be more or less effective. The gall-like growths caused by many flies in this and other gall-making families—said growths being seen in

Fig. 173.—Four-winged Parasite, reared from maggots of Fly shown in Fig. 172. Original.

willow, oak, golden rod, sumac, maple and countless other trees and plants—are caused by the tissue of the plant in the immediate vicinity of the egg or larva making an abnormal growth, due evidently either to the presence of an irritating agent placed there by the parent insect, or by a secretion from the newly hatched larva, or in some other way not at this time thoroughly understood. Two hundred years and more ago it was believed that these growths on plant, bush or tree were vegetable productions, and that the "worms" found therein had arisen spontaneously.

We have also reared this year *Cecidomyia robiniæ*, Hald., from galls on leaves of Locust, *Robinia*. From this latter gall fly we raised a four-winged parasite belonging to the group *Peromalinæ*. A Washington expert in this sub-family informs us that it represents apparently an undescribed genus.

The Basswood here are always more or less affected with galls on leaf and fruit as represented in Fig. 174. Fig. 175 represents one of the galls opened showing two larvæ inside, and Fig. 176 a

Fig. 174.—Basswood Leaf and Fruit, showing Galls. Original.

larva much enlarged. We have not yet reared the fly and hence hesitate to name it. It belongs to the same family, *Cecidomyiidæ*, as the gall flies in box elder, maple, and locust discussed above.

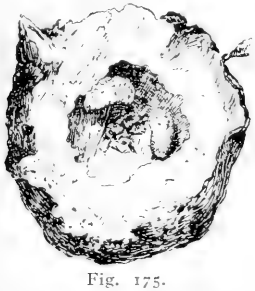


Fig. 175.

Fig. 176.

Fig. 175.—Gall of Basswood enlarged, showing maggots within. Original.
Fig. 176.—A Maggot shown in Fig. 175, much enlarged. Original.

FUMIGATION FOR THE VIOLET GALL FLY, *DIPLOSIS VIOLICOLA*, COQ., AND FOR THE BLACK OR BROWN APHIS OF VIOLETS, *RHOPALOSIPHUM VIOLÆ*, PERG.

During the Entomologist's absence from the office in September, his assistant, Mr. Ruggles, answered a call in St. Paul, from a

lady who was troubled with the above pests in her greenhouse. The Violet Gall is caused by the larva of a small two-winged fly, which rolls up a violet leaf and lives within. Rotting of the leaf is apt to follow this imperfect gall.

Mr. Ruggles first accurately determined the cubic contents of the greenhouse, and then fumigated with hydrocyanic acid gas at the rate of 0.15 grams (2,325 grains) to a cubic foot of space. The cyanide of potash, sulphuric acid and water were used in the proportion of 1-1½-2, and the exposure was 35 minutes. As results proved, 25 minutes, the prescribed time, would perhaps have been better, since some of the more tender growth was injured.

Some of the Aphids survived the above treatment, though many perished. The insects causing the galls were apparently killed, though the difficulty appeared after the above treatment, calling for a second application.

GRAIN PLANT LOUSE.

A few reports of the occurrence of this insect have been mailed the Experiment Station by parties who were somewhat alarmed at seeing them on heads of wheat. As usual, they have been taken care of by parasites, and their presence has resulted in no serious harm.

Fig. 177.—Grain Plant Lice from which parasites have issued.

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