FOURTEENTH REPORT

OF THE

STATE ENTOMOLOGIST

OF

MINNESOTA

TO THE GOVERNOR

FOR THE YEARS 1911 AND 1912

EIGHTH REPORT OF F. L. WASHBURN

GRASSHOPPERS AND OTHER INJURIOUS INSECTS OF 1911 AND 1912

AGRICULTURAL EXPERIMENT STATION
ST. ANTHONY PARK, MINN.
DECEMBER 1, 1912

FOURTEENTH REPORT

OF THE

STATE ENTOMOLOGIST

OF

MINNESOTA

TO THE GOVERNOR

FOR THE YEARS 1911 AND 1912

EIGHTH REPORT OF F. L. WASHBURN

GRASSHOPPERS AND OTHER INJURIOUS INSECTS OF 1911 AND 1912

AGRICULTURAL EXPERIMENT STATION
ST. ANTHONY PARK, MINN.
DECEMBER 1, 1912

HARRISON & SMITH CO.
PRINTERS
MINNEAPOLIS, MINN.

LETTER OF TRANSMITTAL

STATE EXPERIMENT STATION,
ST. ANTHONY PARK, MINN.,
DECEMBER 1, 1912.

To His Excellency, A. O. Eberhardt, St. Paul, Minn.

DEAR SIR:—I have the honour to submit herewith the Fourteenth Report of the State Entomologist of Minnesota, covering work of this office and insect conditions during 1911 and 1912.

During the year 1911 we experienced a culmination of grasshopper injuries begun in 1909 and 1910 and had it not been for opportune rains occuring in May and June, Minnesota would have lost, in 1912, thousands of dollars from the depredations of this insect. The present year has seen but little loss from this pest, but two or three dry summers in succession, similar to 1910 and 1911, will again furnish us with enormous hordes of these destructive pests to agriculture.

We have carried on field work during 1911 and 1912 against these insects and are glad to report successful results in that we have found a method (a modification of that practised in South Africa) by which the individual farmer can protect his crops from excessive grasshopper injuries. Several thousand posters describing this method have been mailed to farmers over the state. For full account of this work see page 1.

In this connection, since their abundance in destructive numbers depends largely upon the abundance of grasshoppers, upon the eggs of which they feed when young, we may well mention here the occurrence of one or more species of Blister Beetles. In 1911, beginning about June 1st, they became exceedingly abundant and destructive. They are general feeders, attacking potatoes, peas, clover, grain, shrubbery and particularly alfalfa. For detailed discussion of this pest, see page 44.

In 1911 Cut Worms of several species were extremely numerous and destructive. This we believe was due to two causes, primarily because the preceding season was dry and not conducive to

the spread of fungous diseases among these caterpillars, and secondarily to the slow growth of vegetation in the spring of 1911. It has been many years since cut worms have been as abundant as in 1911. Complaints in that year began to reach us about May 8th, rapidly increasing in number until about May 28th, at which time letters regarding this pest rapidly fell off, although some inquiries were received during the first half of June.

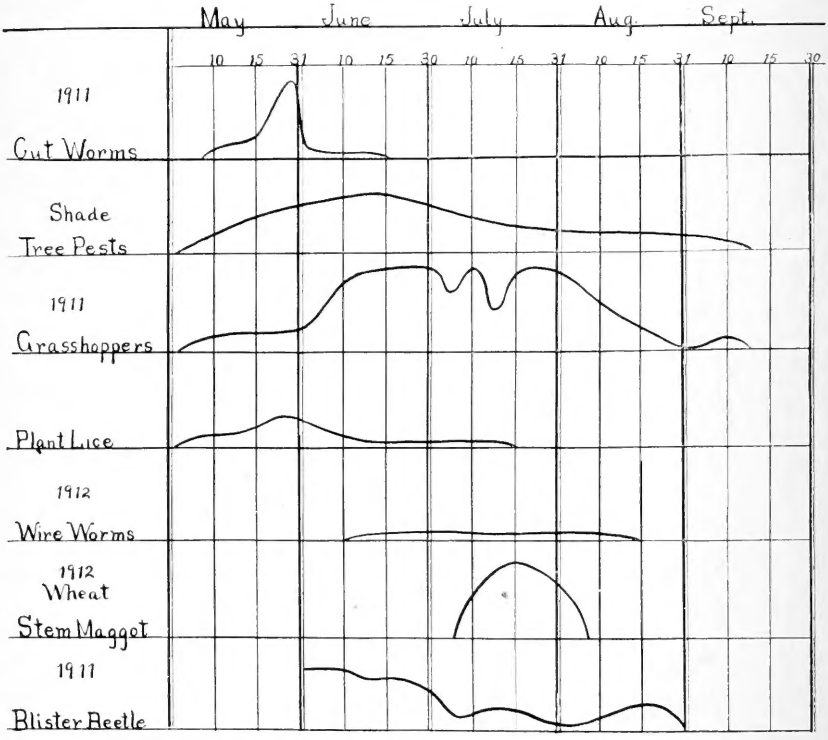


Diagram showing when certain insects were most troublesome as evidenced by complaints in 1911 and 1912. Pests not dated were present both years.

The Wheat-head, Army Worm, so abundant and destructive in 1910, was not reported in 1911 and 1912.

The Wheat Stem Maggot, causing "bald heads" in wheat, rye and barley, has been unusually common during the summer of 1912 and caused some alarm amongst our farmers. Except, however, in very few instances its injury was, as usual, only infinitestimal, but from about July 5th to August 5th our mail was crowded with inquiries relative to the maggot, the greater number of letters being received the middle of July. The insect is confused with two others,

a joint worm working in wheat, and also the Hessian fly; in very many instances the work of the wheat stem maggot was ascribed to joint worms. Farmers can easily distinguish the work of the former from the latter by the fact that while the wheat stem maggot is found in the stalk, the larva of the Hessian Fly, as is attested by the location of the so-called "flax seed" is always on the outside of the stalk, next to it, under a sheathing blade. See page 45 for further discussion of the wheat stem maggot.

The years 1911 and 1912 have witnessed great mortality amongst our shade trees, the pride of the State, and this passing of oaks, maples and elms is perhaps the most serious problem which confronts the Entomologist today. The Entomologist, however, is not alone in the battle, for various fungous diseases belonging to the province of the plant pathologist are playing a very important part, and in some instances possibly the leading part, in the death of our trees. Two circulars have been issued from this office treating on the leading insect pests of shade trees. These circulars can be obtained by any citizen of the state for the asking. Page 54.

On our apple trees both the Scurfy Scale and the Oyster-shell Scale are much in evidence and the latter apparently decidedly on the increase. It is to be noted in this connection that while a large amount of Oyster-shell Scale on a tree is naturally quite detrimental to its bearing qualities and should be eradicated, this species does not approach in its destructiveness the San Jose Scale. A comparatively small infestation of the latter scale will cause a young tree to droop and ultimately die, the same tree being able to resist a hundred times as many Oyster-shell Scales.

We have to report the occurrence of a Corn Bill Bug in Minnesota, a corn field of twenty-five acres at Shakopee being nearly destroyed by this pest. Page 71.

White Grubs, the larvae of the large May Beetles or "June Bugs" have been again abundant and destructive, but the injury in our state this season will not compare with the widespread destruction worked by this pest on corn and other plants in Wisconsin. However, in more than one locality in Minnesota, the White Grub has, during the biennium just completed, made destructive inroads upon agricultural products. In 1912 corn, hay, timothy and potatoes were severely injured.

The roots of corn were eaten and the stalks blown over. Timothy was killed before it could produce seed. Potatoes following sod suffered severely. Injury from White Grub was particularly

noticeable between July 1st and October 1st. Thorough cultivation along approved lines is a decided help in connection with this pest, coupled with a proper rotation. As is well known, many birds feed upon White Grubs, and when practicable it is a desirable thing to turn hogs into a field after the crop is harvested. They root out the grubs and devour them eagerly. Page 49.

A very large "Weevil" belonging to genus *Sphenophorus* has worked locally on our wheat this year. See page 45

The Green-striped Maple Worm has in at least one instance defoliated many Maple trees.

Not insects, but coming within our province, upon the ground of their being plant pests, we have to report naked snails or "slugs" as being unusually abundant and troublesome during 1912. See page 111.

During the winter of 1911, field mice were especially destructive, one large land owner losing several acres of young maples as a result of the activity of these creatures. See page 88.

There has been the usual quota of complaints of gophers and moles, the latter at times being quite troublesome.

SPECIAL WORK.

GRASSHOPPER EXPERIMENTS: During 1911 we had in the field four workers and in 1912 two experts and an assistant. We regard this as the most important work of the biennium and feature it as such in this report. See page 1 and colored plates, I, II, and III.

CLOVER-SEED CHALCIS: This insect is quite commonly called "weevil" by farmers and reduces the yield of clover seed in Minnesota to the extent of many thousands of dollars. Our Adams Fund worker, Mr. Williamson, has been investigating this insect both in the laboratory and insectary, as well as carrying on co-operative field experiments with farmers in different parts of the state. These investigations begun several years ago will, we hope, be shortly completed. See page 52.

LARCH SAW FLY: Mr. Ruggles, Assistant Entomologist, is continuing work with this pest which is destroying annually in Minnesota millions of dollars worth of tamaracks. See page 62. He is also studying the life history of a species of an Elm Twig Borer. See page 54 for discussion of certain shade tree pests.

SPRAYING FOR CODLING MOTH AND PLUM CURCULIO: Our constituents urge upon us the necessity for impressing upon fruit growers the fact not only that there is actual profit in spraying, but

that spraying is an absolute necessity if one would raise good fruit. To that end we have been continuing work in this line. Page 68.

WORK WITH THE CORN BILL BUG: Page 71.

PUBLICATION OF INSECT LIFE: Page 110.

FLY CAMPAIGN: A state-wide campaign against the House or Typhoid Fly. In the fight against this common and disease-bearing insect, we have co-operated with the State Board of Health. For particulars see page 62.

INSPECTION OF NURSERIES AND FOREIGN STOCK: In 1911 fifty-two nurseries were inspected and $236.25, collected as legal fees of inspection, the same being turned into the State Treasury in accordance with the law. This inspection was done by a specially employed expert, and the work faithfully carried out. In 1912 fifty-six nurseries were examined. The sum of $246.99 collected was handed to the State Treasurer and receipt received therefor. *San Jose Scale in limited amount was found in two instances.* The new quarantine law recently enacted by Congress and becoming operative October 1st, 1912, has a direct bearing upon all Minnesota nurseries as well as upon the entrance of foreign stock. See page 103. Inasmuch as the federal government can under this law quarantine a portion of Minnesota or the entire state if it deems it necessary, thereby preventing the nurserymen from shipping outside of the state, it is evident that the nursery inspector of Minnesota should be given more authority and be allowed to inspect any grounds, compelling the eradication of an insect or plant disease which might render us liable to quarantine. The amount of nursery and ornamental stock shipped into Minnesota is increasing yearly, and its inspection when it arives, places, with other duties, quite a burden upon the entomologist who is deputized by the Federal Board to do this work. From October 1st to December 15th approximately, and during April and May, we are called upon so frequently to inspect material of this sort from Europe that it imposes considerably upon the time and duties of our force. We believe that an expert should be employed as deputy inspector to take charge of all Minnesota inspection, both of domestic and foreign stock, and that some especial appropriation should be made for this work, thus relieving the nurserymen from paying the legal fee now required. *One case examined in* 1911 *was found to contain a nest of Brown Tail Moth Caterpillars.* See page 103.

LEGISLATION AFFECTING THE WORK OF THE ENTOMOLOGIST OF MINNESOTA: Mention has just been made of the direct bearing of the quarantine law upon Minnesota conditions. In this connection we may also speak of the insecticide laws, one enacted in Minnesota and the other a Federal insecticide law, covering practically the same ground as the State law, though more comprehensive. Complaint was made by the Entomologist to our State Dairy and Food Commissioner this year (1912) of a certain manufacturer who had placed upon the Minnesota market a consignment of paris green not conforming to our State law, nor to the Federal law.

EXHIBITS: The Entomologist has placed exhibits at the State Fair of 1911 and 1912, featuring grasshopper work in 1911 and campaign against the house fly in 1912. Through the generous cooperation of our staff, the exhibit of 1912, consisting not only of fly traps, etc., but many specimens and models of injurious insects, was extremely successful and our booth was crowded with visitors. We believe these exhibits should be made at all the County Fairs where possible in order to acquaint our citizens with the appearance of our injurious insects and the work of this department.

CORRESPONDENCE AND LECTURES: In 1911 the Entomologist dictated 2741 letters, largely answers of inquiries regarding insect pests. In addition a large number of circular letters were mailed and about 2571 circulars and press bulletins, exclusive of the Station mailing list. This does not include the Thirteenth Report which was sent to approximately 700 addresses in addition to copies sent to comply with individual requests. Experiment Station Bulletin No. 123, (Cutworms, Army Worms and Grasshoppers) representing a portion of the Fourteenth Report, was sent from the Experiment Station mailing office to something like 16,000 addresses. In 1912 we mailed 2253 letters, answering inquiries in addition to over 2507 circulars. The following lectures were given during the biennium:

In February, 1911, before the Y. M. C. A. at Duluth, a lecture on "Insect Pests of Garden, Lawn and Park and How to Destroy Them."

In March, 1911, before the Women's Club, Minneapolis, a lecture on "The House Fly."

In May, 1911, a lecture at Hendrum, Minn., on "Grasshoppers."

On December 27, 1911, Presidential Address before the American Association of Economic Entomologists, Washington, D. C., "The Relations of the Station Entomologist to His Environment."

PUBLICATIONS:

1911.

April	Vol. I, No. 4 Minnesota Insect Life
May	" I, " 5 " " "
June	" I, " 6 " " "
July	" I, " 7 " " "
August	" I, " 8 " " "
May	Bulletin No. 123. "Cutworms, Army Worms and Grasshoppers." (Station Publication.)
June	Circular No. 21. "'Fleas, Bedbugs, Cockroaches, Carpet Beetles or Buffalo Bugs."
July	Circular No. 22. "New Methods of Combating the House Fly."
November	Extension Bulletin No. 23. "Some Common Insects and Their Control." (Station Publication.)

1912.

March	Circular No. 23. "Mosquitoes, Ants, Silver Fish, and Crickets."
April	Vol. I, No. 9 Minnesota Insect Life.
May	" I, " 10 " " "
June	" I, " 11 " " "
July	" 1, " 12 " " "
August	" II, " 1 " " "
August	Circular No. 24. "The Minnesota Fly Trap."
October	Circular No. 25. "Shade Tree Borers."

Many requests for the Insect and Bird Charts first issued in 1910 are still reaching us, not only from points in Minnesota, but from many quarters in various portions of the United States.

INSECTARY AND EXPERIMENTAL GARDEN: The insectary and garden have again proven their usefulness. Life history experiments in connection with clover seed insects, grasshoppers, parasitic insects and various pests of farm and garden were carried on during 1911 and 1912. We have a record of 100 insectary experiments during 1911 and a hundred or more in 1912. During the latter year a large amount of accumulated material was sorted and recorded.

INSECT COLLECTION: This has been added to each season and in 1911, the following additional specimens were accessioned.

Hemiptera	1,400
Odonata	140
Lepidoptera	700
Coleoptera	1,400
Diptera	1,050
Hymenoptera	2,110
Total	6,800

These collections were made in various counties of the State and comprise many species new to our collection and in some instances new to the State. As evidenced above, the largest gain was in Hymenoptera and we hope to have before long an excellent representative collection. We are indebted to Mr. Spooner for his enthusiastic efforts in behalf of the collection not only in its increment, but also along the lines of preparation and classification. The season of 1912 has been so occupied with other work that this feature has not been emphasized, although the collections were added to materially thourgh work in the insectary.

ACKNOWLEDGMENTS: The work of the State Entomologist is so closely interwoven with that of the Experiment Station Entomologist that any acknowledgment must of necessity include station workers. We therefore take pleasure in testifying our appreciation of the help in the work afforded by the Director of the Station and other Station workers. The faithfulness and efficiency of the members of the divisional staff are largely responsible for the amount of work and practical results turned out during 1911 and 1912. The Press has been helpful in co-operating with us where it has been necessary to get timely notice to the public. Nurserymen and florists have met us half way in the discharge of our duties as inspector, and farmers and orchardists when called upon have shown a willingness to co-operate in field experiments. At Fergus Falls during both seasons, the High School authorities have been exceedingly courteous in allowing us laboratory rooms and other facilities.

Mr. H. B. Scammel, acting as deputy inspector during 1911, endeared himself not only to us on account of his gentlemanly bearing and application to his work, but also to the nurserymen of the State for the same reason. Mr. Scammel has left us to take up orchard work in Colorado, which state offers a bigger field in fruit growing interests. Mr. C. S. Spooner, also valued by us for his efficiency, has accepted a position in Georgia offering a much higher salary than he received here.

During 1911 Mr. M. P. Somes, and Messrs. Tanquary, Stoner and Zetek did excellent field work against grasshoppers, and in 1912 Mr. C. W. Howard and Mr. Somes also worked on these insects in the field. The results of this work the past two years are embodied in this report, page 1. Mr. Howard is eminently qualified to handle the grasshopper problem, since he was a government entomologist in Portugese East Africa, a position he

occupied shortly before coming to Minnesota, where this feature of entomological work is of paramount importance. Mr. O. G. Babcock, formerly of the Maryland Experiment Station, is now in charge of our insectary and is a tireless worker. A large part of the success of our exhibit at the State Fair in 1912 is due to his efforts. Mr. Warren Williamson is still engaged in research work on the Clover-seed Chalcis and has obtained some striking results. In Mr. George Peake we have a diligent and hard-working assistant. Mr. Ruggles, who has in charge orchard spraying and shade tree pests, is away at date of writing on a seven months' leave of absence, having been called to a postiion on the Chestnut Tree Blight Commission in Pennsylvania.

The colored drawings in the Report (Plates I, II and III) are faithful representations of specimens taken in Minnesota. The excellent work of the artist, Miss I. L. Wood, has been reproduced by the engravers with remarkable accuracy of detail.

The custom house officials in St. Paul, Minneapolis and Duluth have been very helpful in their courteous co-operation in connection with the inspection of foreign stock.

To the Governor of the State and other officials at the State Capitol, the undersigned wishes to express his appreciation of various courtesies.

Respectfully,

F. L. Washburn,

State Entomologist.

FINANCIAL STATEMENT,* FISCAL YEAR, AUGUST 1, 1910, TO AUGUST 1, 1911.

Assistant Entomologist's salary	$1,199.97	
Assistant Entomologist's traveling expenses	18.44	
Assistant in Federal inspection	41.65	
Building Machine Shed	385.00	
Clerk and accountant	905.00	
Cuts, etching, etc., for press bulletins and circulars	144.81	
Drawings for report, bulletins, circulars, etc	475.80	
Express and freight	63.80	
Field work	161.62	
Insectary assistant, (field expenses)	177.57	
Insectary chief (field expenses)	115.11	
Insecticides	10.64	
Kerosene for combating grasshoppers	125.89	
Labor	183.00	
Laboratory supplies	81.02	
Lumber	4.45	
Models of insects	15.00	
Nursery inspection	175.55	
Office assistant	69.58	
Office supplies	29.05	
Photos, negatives, prints, etc	40.15	
Printing (bulletins, circulars, reports, etc.)	712.54	
Publications, periodicals, press notices, etc	109.23	
Postage (correspondence, bulletins, report, etc.)	139.00	
Stationery	52.39	
Substitute stenographer	45.00	
Telegrams	15.36	
Telephones	50.00	
Traveling expenses	40.14	
	$5,586.76	
Balance on hand August 1, 1910		$ 324.12
Credit shown on State Auditor's books carried from end of year 1908		92.45
Credit nursery inspection		263.73
Fund		5,000.00
		$5,587.85
		5,586.76
Balance on hand		$ 1.09

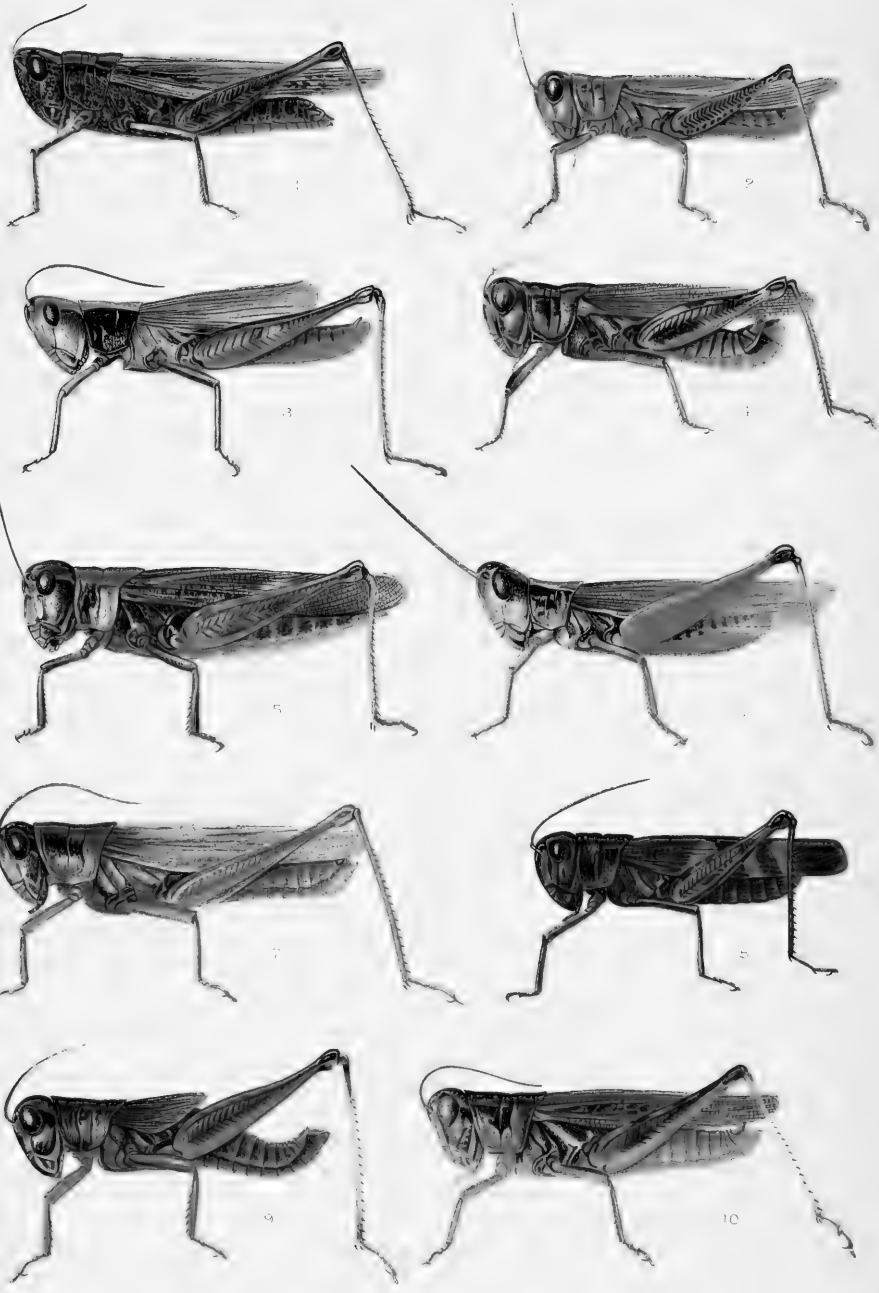
FINANCIAL STATEMENT,* FISCAL YEAR AUGUST 1, 1911, TO AUGUST 1, 1912.

Apiary	$ 14.00	
Assistant Entomologist's salary	1,466.63	
Assistant Entomologist's expenses	19.13	
Assistant in Federal inspection	36.72	
Clerk and accountant	985.00	
Cuts, etchings, etc., for press bulletins and circulars	38.94	
Drawings for report, bulletins, circulars, etc	325.00	
Express and freight	37.81	
Field work	50.36	
Insectary assistant, (field work)	35.46	
Insectary chief (field expenses)	5.40	
Insectary supplies	62.01	
Labor	219.13	
Laboratory supplies	38.04	
Nursery inspection	84.83	
Office assistant	53.12	
Office supplies	143.31	
Photos, negatives, prints, etc	234.60	
Printing (bulletins, circulars, etc.)	696.85	
Publications	149.72	
Postage	100.00	
Stationery	57.66	
Substitute stenographer	99.00	
Telegrams	47.65	
Telephones	60.00	
Traveling expenses	165.59	
	$5,235.96	
Fund		$5,000.00
Nursery inspection		236.25
		$5,236.25
		5,235.96
Balance on hand		$ .29

*Bills covering details of above on file in State Auditor's Office.
Statement of sums appropriated by the legislature, the aggregate amounts drawn from the State Treasury and balances unexpended, are correct as shown by the records of this department.

Samuel G. Iverson

State Auditor.



J. L. WOOD, del.

A. HOEN & CO. BALTIMORE

SOME MINNESOTA GRASSHOPPERS

GRASSHOPPERS, AND OTHER INJURIOUS INSECTS OF 1911 AND 1912.

BY F. L. WASHBURN.

GRASSHOPPERS.

In the past two years special work has been done against these pests of agriculture, four men being stationed in the field in 1911 and two in 1912. These men gave their entire attention to this subject. We were in part enabled to do this with a small special appropriation voted by the last legislature for this purpose, but the money so provided was inadequate and we were obliged to use a portion of our State fund to finish the work. The results of these investigations and of practical application of same have been highly gratifying and we feel fully warranted in making the following statements.

SUMMARY.

1. The only thing that saved Minnesota from a plague of Grasshoppers in 1912 was an abundance of rain in May and early June, which may have destroyed many insects directly after hatching, but which, more especially, gave all crops (as well as weeds) a decided stimulus.

2. Given two or more successive dry seasons, and we will again lose many thousands of dollars' worth of crops through the agency of these insects unless farmers in infested districts take prompt and co-operative action along the line of approved methods of control.

3. We have found a successful control method in the following poisonous spray: Sodium Arsenite 3 lbs., water 180 gallons, molasses 1½ gals.; or in smaller proportions, Sodium Arsenite 1 lb., water 60 gals., molasses 2 quarts. The Sodium Arsenite should be

EXPLANATION OF PLATE I.

1. *Orphulella speciosa;* 2. The Differential Locust, *Melanoplus differentialis;* 3. The Sprinkled Locust, *Chloealtis conspersa;* 4. *Chloealtis gladstoni;* 5. The Clear-winged Locust *Camnula pellucida;* 6. The Short-winged Locust, *Stenobothrus curtipennis;* 7. The Pale-green Locust, *Hesperotettix pratensis;* 8. The Clouded Locust, *Encoptolophus sordidus;* 9. *Phaetaliotes nebrascensis;* 10. *Melanoplus minor.*

thoroughly dissolved in the water, the molasses added, stirring it in thoroughly. Page 21.

4. Cost: About 30c per acre (50 gals. per acre) for material, figured at the rate of retail price of Arsenite of Soda, 22c per lb.

5. The use of this spray calls for early and concerted action on the part of farmers, and should be applied when hoppers are very young (shortly after hatching) and always before wings are developed. See illustration.

6. Spraying is best done early in the morning. Do not spray just before a rain. Do not delay spraying on account of pressure of other work; delay might mean a loss of from 25 per cent to 90 per cent of the year's crop.

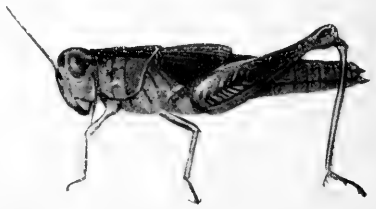


FIG. 1. A very young grasshopper, much enlarged. Spray at this stage or before.

7. Co-operation is the key to success. Grasshoppers might enter a crop of a careful farmer from land owned by a careless neighbor who had taken no action against the pest.

8. Between May 8th and 15th, look for young hoppers hatching in old stubble or in weedy tracts or unused land, in pastures, hayland, and along roadsides. With the above poisonous solution spray a strip from two to four rods wide about the area where they are hatching or over the entire field if not too large. If the infested tract is very extensive, spray a strip about the edges of field from two to four rods wide and several strips through the field. Or spray the poison on a broad strip of planted field, bordering the infested land. The solution at above strength and used as directed will not injure grain or poison stock.

Our observations show that it takes from twenty-four to forty-eight hours for this poison to kill grasshoppers, but the insect is practically paralyzed immediately after partaking of the poisonous dose and eats little or nothing thereafter.

9. Any sprayer which is used ordinarily to distribute paris green in water or any other liquid spray may be used for this work, although a regular field sprayer is best. A combined field and orchard sprayer may be obtained.

10. It should be remembered, in using this spray, that co-operation amongst farmers of a neighborhood is necessary; that early concerted action in spring is important: that while the above solution is not dangerous to plants or stock, if used as directed, it is nevertheless

a poison and if human beings accidentally partook of it, or if stock drank it or ate a large amount of forage thoroughly drenched with it, fatal results might follow. Used as above directed, it is safe. See page 22 for account of our experiment in endeavoring to poison stock with this mixture.

11. For suggestions regarding use of hopperdozers and burning fields, see pages 19, 24, 26.

12. For discussion of cultural methods, protection of gardens, ets., see pages 23, 26, 33.

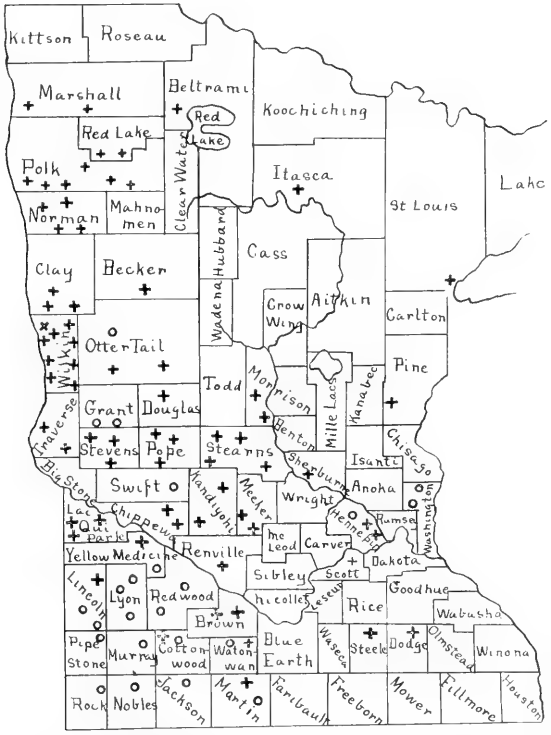


FIG. 2. Grasshopper conditions in 1910. Crosses indicate presence of grasshoppers; circles, the presence of army worms.

13. Plowing Against Young Grasshoppers: Young hoppers just hatching may be plowed under in a field by beginning on the outside of the field and working toward the center with the plow. Or a strip a few rods wide can be plowed between the valuable crop and a large tract of unplowed land when grasshoppers are hatching. This will form a barrier rather difficult for very young hoppers to cross, thus giving time to prepare other means to use against them. The above

would prove probably only partially effective, and is recommended for an emergency only, in order to gain time. See page 26 for merits of harrowing.

In 1908 complaints of increasing numbers of native grasshoppers began to reach us from Ottertail, Norman, Sherburne, Wadena, Anoka and Stearns counties. Clover crops near St. Cloud,

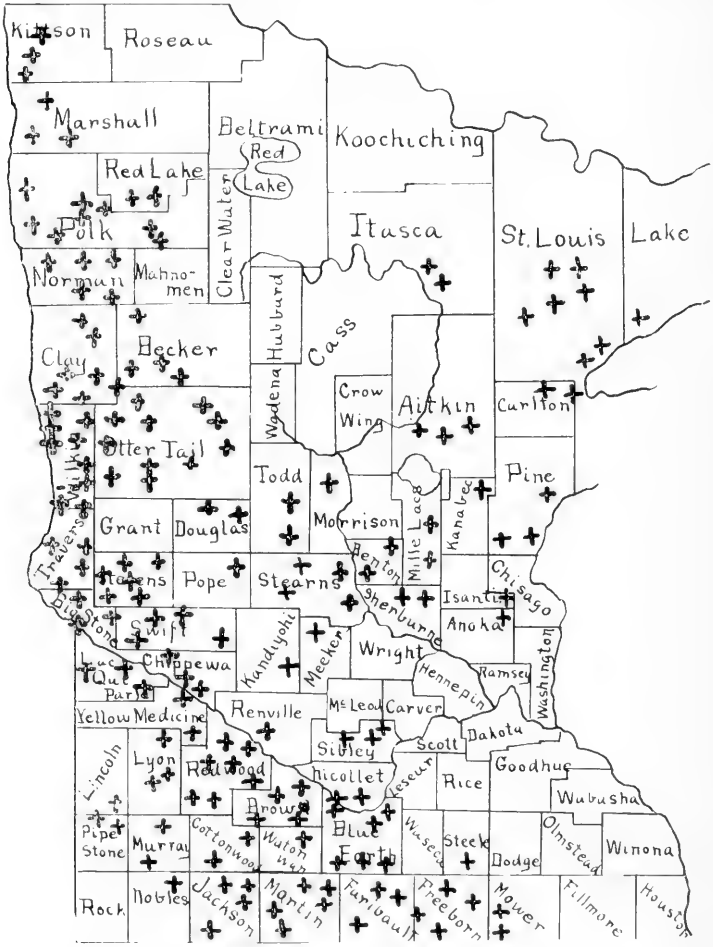


FIG. 3. Grasshopper conditions, 1911. Crosses indicate localities from which many complaints of grasshopper injury were received. Compare with Fig. 2 and note spread of these insects.

tially or entirely destroyed. In other localities it was either clover, alfalfa, pasture land or grain which suffered. In 1909 these pests were again troublesome and evidently on the increase. Conditions Clearwater, Sauk Rapids and South Haven were in that year par-

were so favorable for their multiplication that in 1910 they were much more numerous. In that year about two-thirds of our flax crop was sacrificed to locusts. In 1911 we experienced the culmination of their destructiveness,—the result of the increase of the three preceding years under conditions favorable to these insects.

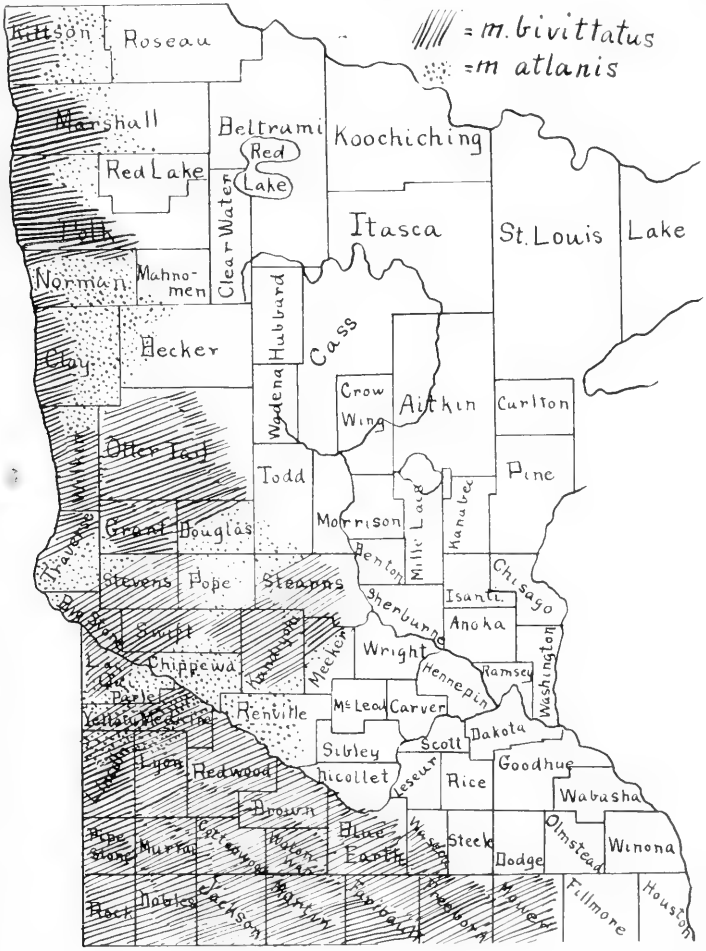
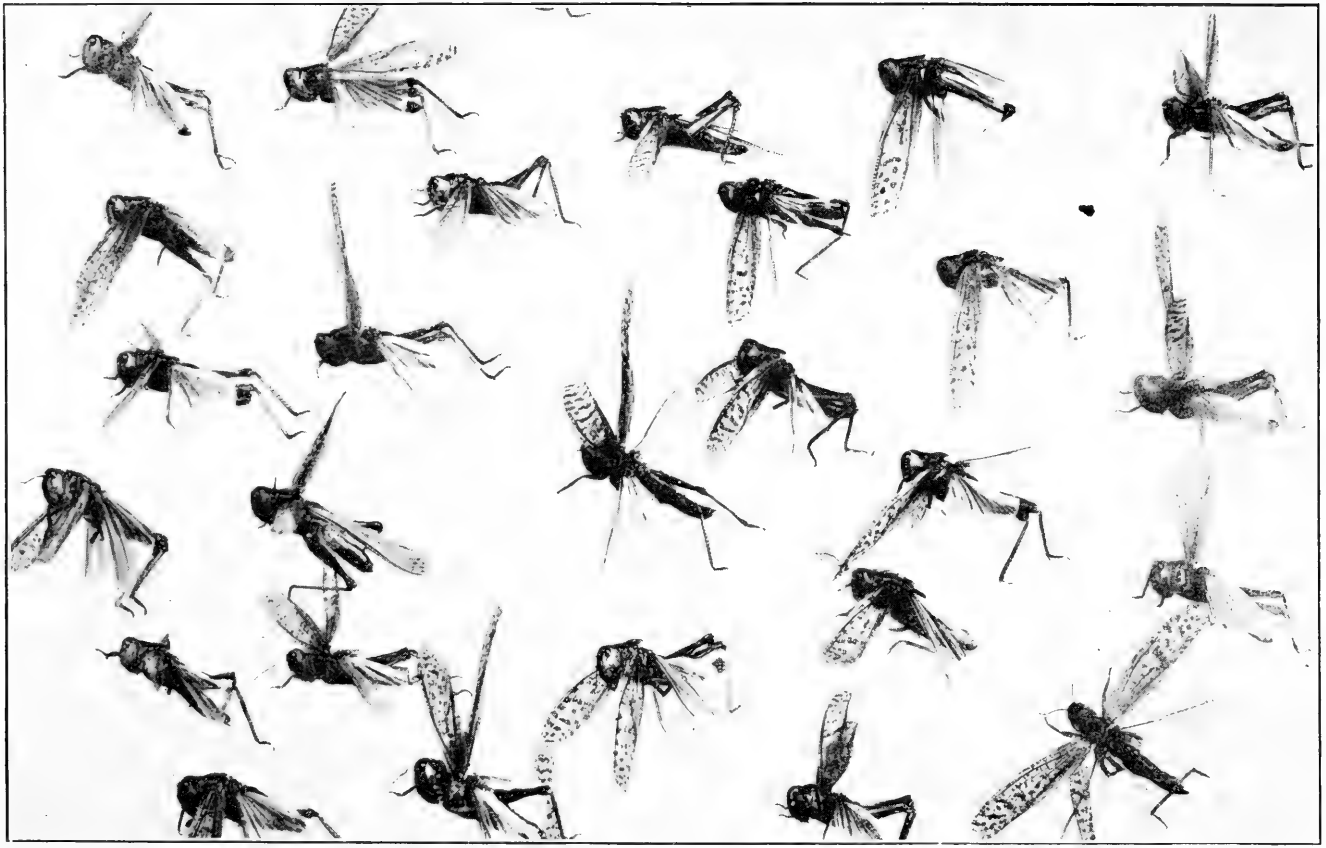


FIG. 4. Showing portions of State where *M. atlanis* and *M. bivittatus* were most abundant in 1911. Somes.

In that year grasshoppers were very bad in various localities in the western third of Minnesota from the Canadian border to the Iowa line. Many farmers lost from 25 per cent to 95 per cent of their crops. During the year 1911 they were also bad in Iowa, Wisconsin and other states, and in that year, too, many complaints were



A remarkable photograph of a small portion of a swa'm of South African Locusts. These swarms sometimes extend for ten or fifteen miles across the veldt. The photograph has every appearance of being genuine, the insects not actually in focus being taken out in the original. From a South African pictorial paper. Courtesy of C. W. Howard.

received from districts in the southern half of Minnesota. The outlook for 1912 in the summer of 1911 was serious and Mr. Somes, in charge of this work in the field, predicted an alarming increase if weather conditions favored. Fortunately for us, the spring and early summer of 1912 were very unfavorable to grasshopper ravages and but few reports of injury have reached us during last summer. It must be borne in mind, hovewer, that two or more dry seasons in succession, or even one excessively dry summer, a condition we are quite likely to meet in this state, will encourage the increase of grasshoppers to such an extent that much loss will be again occasioned if farmers are not ready to take concerted and timely action. It is to be hoped that our citizens will not, therefore, be apathetic, doubting and critical of this work until, when the destruction of crops is at its height in midsummer, they feel compelled to call upon the entomologist for help, too late for effective action. This has been too often the case in the past, and July and August have witnessed hundreds of letters in the mail of this office, asking for relief at a time when relief is not possible.

It is not to be understood that the entire grain output of the State has been materially lessened by the ravages of these pests, but individual farmers living in the regions above mentioned have lost from 20 to 90 per cent of their crops and in some cases all of their grain has been destroyed.

The greatest destruction has, in every case, been in proximity to large tracts of land which have been, perhaps, in tillage some years ago, and have been allowed to revert to natural conditions. Such tracts are really the direct cause of all the trouble which we have experienced. It is true we have in Minnesota a grasshopper law which, supposedly, effects the plowing of such dangerous land when infested with grasshopper eggs, but, as a matter of fact, the law is ineffective through faulty wording, and it is utterly impossible for counties to plow this land. For instance, in one township alone in a western county we know of at least 8,000 acres of land which calls for the plow and does not get it. Through the ineffectiveness of this law the owners cannot be forced to plow, and at the rate of $2.50 an acre it would cost this county over $16,000 to take care of reverted land in this single township alone.

Quoting from Mr. Somes' report for 1911:

"We may say that the grasshopper question has been growing more serious each year for several seasons and that during the past summer (1911) the damage was greater and far more widespread than at any time previously since the visitations of the Rocky Mountain Locust. The reports of damage from hoppers came to us from almost all parts of the state and although the

dry winds which prevailed in portions of the state during the summer make it almost impossible to say exactly what percentage of the damage was due to grasshoppers and what to these dry winds, yet to any one visiting as we did all parts of the state, it was very apparent that the grasshoppers' share of the damage was great. The oats, flax, wheat, barley and timothy were seriously damaged and the crop much reduced in both quantity and quality.

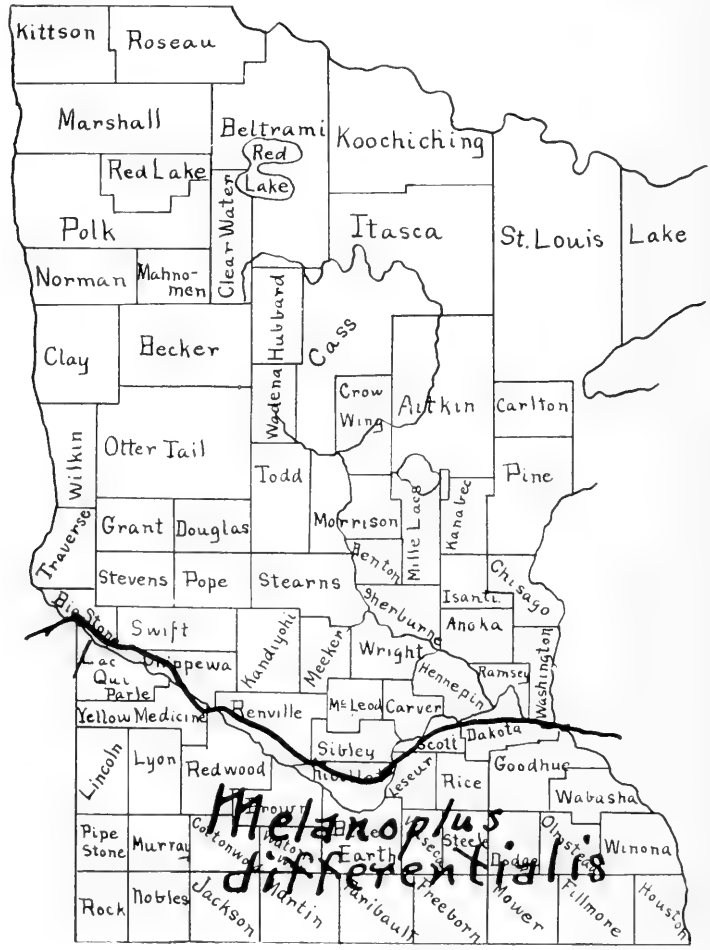


Fig. 5. Where *M. differentialis* was abundant and destructive in 1911. Practically confined to southern portion of the State. Somes.

In the southern portion of the state and in parts of the eastern portion the grasshoppers were noted in serious numbers this season (1911) for the first time, which can only mean that the grasshopper area is growing in at least these two directions. This was true not only within the state but in neighboring states, as in Iowa, the Dakotas, Nebraska and southern Wisconsin. According to reports from people living in those places, the grasshoppers also appeared there in numbers so great as to cause more or less alarm. While it is always dangerous to attempt prophecy, yet it seems evident that

this widespread occurrence of the grasshoppers in midsummer must result in equally widespread deposition of eggs. We prefer to thus simply present the facts and leave the interpretation of these to others. The facts to which we may call attention are, that we have had grasshoppers in harmful numbers in some parts of the state, and that we will doubtless have them to meet at least in some places during the coming summer. We have called attention to the need of early action against this pest to accomplish any real good. We have also called attention to the need of organized effort or co-operation against this common pest."

We have stated that in practically every instance of serious and widespread grasshopper injury, we have found the original source of the grasshoppers to be reverted or waste land. In this connection we quote again from Mr. Somes' report:

"A discussion of means of reclamation of these infested areas would hardly fall within the province of this report but it must be recalled that although the so-called 'plow law' or 'grasshopper law' is by reason of its wording. practically worthless, yet any law that may be drafted is equally worthless unless rigorously enforced.

A certain tract near Beltrami is very well adapted to illustrate the general conditions in any infested area and may be treated in some detail.

In the above sketch "A" represents a large tract of "reverted land" and the source of infestation from which the grasshoppers will sooner or later spread in all directions. Thus it may be seen that the farms surrounding this tract must suffer. In this case we note the grasshoppers spreading first in great numbers to the tract "B" where they were so thick as to totally cover spots of ground from ten to twenty feet square. Later they spread out to "D", "C", "E", "F", and "G". They were not found in numbers in "I" and "H" probably because these pieces were pasture and the hoppers were there more or less disturbed by the stock. This illustrates the general condition found elsewhere, save that the source is variable in size."

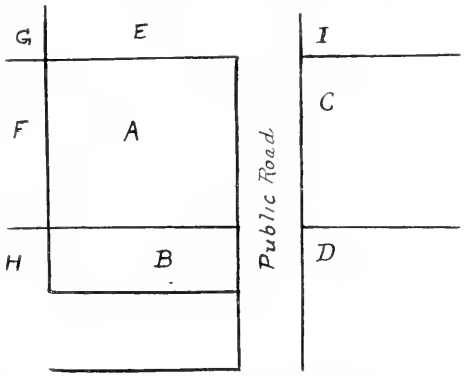


Fig. 6. Diagram showing where grasshoppers start and how they spread. Somes.

The four men in the field in 1911 carried on work along certain definite lines. Headquarters were established at Fergus Falls in the Red River Valley, and there, through the courtesy of city officials, were given a laboratory, and also secured near the city a piece of land for experimentation.

The laboratory work consisted largely of the study of life histories of injurious species, the rearing of parasites; and upon our experimental ground we planted grain crops to test thereon the efficacy and safety of the poison spray referred to at the beginning of this article. We also secured the co-operation of many farmers

of intelligence in the matter of this spraying. We desire to express our appreciation of the many favors shown us by the High School authorities at Fergus Falls, and by other citizens, notably C. R. Wright & Co.

An important feature of the work in 1911 and one which took almost the entire time of the leader, and also a large share of the time of one of the other workers consisted in answering calls of individual farmers who needed advice or encouragement, or both. This has taken much time and much money, as one will readily realize, and we determined in the fall of 1911 that this part of the work would have to be discontinued. We are willing to meet and discuss the question with groups of farmers, when such meetings are called for this purpose, but we find that frequently farmers who had no special occasion for our help, summoned us, although quite indifferent to what we had to say and to our advice. This was not, by any means, always the case, and we believe that, in spite of the large expense occasioned by this variety of work, much good was accomplished by our individual visits.

The attitude of the farmers and citizens generally was one of interest and showed a co-operative spirit; at the same time, many instances were met with which were discouraging. This, we believe, is particularly true among those renting farms, who took the attitude that it was not worth while to make any effort, or that, perhaps, the grasshoppers would not be so bad another year, or they were leaving to go to what seemed to them more promising fields, or they doubted the efficacy of the treatment advised, or they thought, some at least, that the State should bear all expense in treating individual farms. We found criticism and lack of sympathy on the part of real estate dealers, who felt that their business interests were being interfered with by what looked to them like undesirable advertising. In one case, where a hopperdozer with its victims(over a bushel) was displayed in a public street, to show the efficacy of this treatment, interested and misguided citizens who had land for sale in that vicinity ordered the machine and dead hoppers to be removed.

Quoting again from Mr. Somes' report for 1911:

"After about May 20th the calls by mail and by wire from farmers asking advice regarding methods of combating this pest became so numerous that practically all of my time for the greater part of the summer was taken up in replying to these. At times I had as high as thirty calls per day by mail alone. It is needless to remark that the visits entailed in responding to these calls meant almost continuous travel. Our plan, suggested by yourself, was to visit the interested parties and give advice as to methods and especially to urge the energetic and concerted action by the men of the community that is necessary to

meet so serious and widespread a pest. In this connection I may say that at times I was forced to take one or more of the men from the field work and place them also at answering these personal calls. We have visited during the past summer (1911) one hundred sixty-one localities and have in this way given advice to approximately one thousand farmers. Thus we have been able to spread a real knowledge of methods of fighting the grasshopper, together with some realization of the problem as a whole throughout a large part of western and southern Minnesota.

In general we may say that we found the farmers very much interested and willing to consider the methods of treatment which we were presenting. There is, however, a noticeable tendency among the farmers, while admitting the serious damage resulting from the grasshoppers, to put off until some future date the actual work against these insects. During the early part of the season many exaggerated reports were published in various newspapers concerning the wholesale destruction of grasshoppers by abnormally cold weather in late Spring and assuring the interested farmers that for "this season" there could be no danger of grasshoppers becoming abundant. It is needless now to call attention to the true conditions resulting during the summer, but it is interesting to note that one of the most seriously affected areas within the whole state—where the grasshoppers were noted in most abundance and the damage to crops was most apparent—was but fifteen miles from the office of one of these papers which had reported the pest as having been exterminated by late frost and snow. The effect of these false prophets was far more serious than might be thought, since farmers deluded by such reports bearing some tinge of authenticity from the fact of publication, neglected to take any action against the pest even in localites where the older methods of attack, such as the "hopperdozer" were well known.

A peculiar attitude of mind was discovered in some cases regarding the expense for labor and materials used in fighting the grasshoppers. It was urged by some, and notably by land owners of some means rather than by the poorer class of farmers who in losing relatively little had lost all, that the State should pay for the work and for materials used in freeing the fields of the farmer from this pest. Since the money available for such ends must come through added taxes a very little consideration usually served to change this attitude. Another peculiarity was noted in the fact that certain farmers after asking for advice would refuse to act upon this advice after your agents had made long trips to reach them. A still worse attitude was encountered in a few cases where mere curiousity had prompted the party to send in a call for a visit from the agent though there were relatively few grasshoppers. The usual justification offered was that "since the State paid the expenses" they felt entitled to the visit although they did not desire and could not utilize any advice which might be given. The loss of time and incurring of considerable expense uselessly was entirely overlooked."

About seventy-nine Orthopterous species were collected and named during 1911, which must not be regarded as representing our entire Orthopterous fauna. Of these species, only a comparatively few were strikingly injurious; namely, the Two-striped Locust, *Melanoplus bivittatus;* the Lesser Migratory Locust, *M. atlanis*, the Red-legged Locust, *M. femur-rubrum*, and the Differential Locust, *M. differentialis*, to which harmful species we may possibly add the Short-winged Locust, *Stenobothrus curtipennis*, and, to a lesser extent, the Clear-winged Locust, *Camnula pellucida*, and the Carolina Locust, *Dissosteira carolina*.

Quoting from Mr. Somes' report for 1911:

"While the Rocky Mountain Locust has been very commonly mentioned in the newspapers this summer, as usual it is merely a case of mistaken identity. ..... One of the most abundant of the species found, however, is *Melanoplus atlanis*, a species based on such slight difference of structure that none but a specialist could positively separate the two. Indeed, from the study of a very large series of this species taken this summer in widely separated localities, it appears that with the wide range or variation found in both there must be doubt as to the validity of specific separation. Thus the public may well be excused for mistaking two species which are in such close relationship as to render them a puzzle to the student of this group. .....

Regarding the seven species listed above we may say that while ordinarily the Tryxalinæ are of little importance, yet we found *Stenobothrus curtipennis* a very serious pest being very numerous and also extremely widespread, occurring at every point where we made collections.

Camnula pellucida was found locally plenty in several places but is not apparently very generally distributed. It is, however, a species which may at times become a very serious pest.

Dissosteira carolina, the familiar Carolina locust, is widely distributed but seldom to be considered actually a pest, being for the most part an insect of roadsides. Late in the season it has been found abundant, however, in cornfields and other dry places and did considerable actual damage.

Melanoplus bivittatus, here including also *M. femoratus*, which we can but consider as a form of this, has been the most seriously injured of the species, from point of numbers and from distribution. It has been the dominant species in most localities where we studied the conditions.

Melanoplus atlanis, "The Lesser Migratory Locust," has been a close second to the preceding species in importance, being nearly as numerous and but the two preceding.

Melanoplus femur-rubrum, the common or "Red-legged Locust," has been found at every point where collections were made but in lesser numbers than the two preceeding.

Melanoplus differentialis, commonly called "The Big Yellow Locust" by the farmers, has been very abundant and very harmful but within a limited area. In general its distribution has been limited on the north by the Minnesota River.

Certain of the *Locustidae* notably *Orchelimum glaberrimum* and *O. agile* may be harmful at times especially in lowlands, while among the *Gryllidae*, the common Cricket, *Gryllus pennsylvanicus* and *Gryllus abbreviatus* are usually present in large numbers, more especially the present year, possibly from the same cause as the Blister beetles, i. e., abundant food in the numerous grasshopper eggs last year. For the same reason *Nemobius* also is abnormally abundant."

In 1912 the Clear-winged Locust was found extremely abundant in portions of Polk and Norman counties, exhibiting a marked increase over conditions in 1911. In early August it was reported as being abundant in the northern part of the state from Dakota to Lake Superior. In the Iron Range it has become perhaps the predominant species, conditions there being especially favorable for its increase. Alfalfa was in many places attacked and ruined by this species.

The following is a list of Orthopterous species collected or reported in the state by field agents in 1911. We are indebted to Prof. Lawrence Bruner for the identification of eight or nine of the species listed:

Tettix granulatus
Tettix granulatus var. variegatus
Tettix hancocki
Tettix obscurus
Paratettix cucullatus
Tettigidea parvipennis
Eritettix tricarinatus
Orphulella speciosa
Dicromorpha viridis
Chlocaltis conspersa
Chlocaltis gladstoni
Stenobothrus curtipennis
Gomphocerus clepaydra
Ageneotettix scudderi
Opeia obscura
Mecostethus lineatus
Arphia arcta
Arphia (tenebrosa) pseudonietana
Arphia carinata
Chortophaga viridifasciata
Encoptolophus sordidus
Camnula pellucida
Hippiscus tuberculatus
Hippiscus rugosus
Hippiscus zapotecus
Dissosteira carolina
Spharagemon aequale
Spharagemon collare
Spharagemon wyomingianum
Mestobregma cinctum
Psinidia fenestralis
Circotettix verruculatus
Pseudopomala brachyptera
Hypochlora alba
Hesperotettix pratensis
Hesperotettix speciosus
Schistocerca alutacea
Melanoplus scudderi
Melanoplus dawsoni
Melanoplus blatchleyi
Melanoplus atlanis
Melanoplus spretus
Melanoplus femur-rubrum
Melanoplus gladstoni
Melanoplus extremus
Melanoplus angustipennis
Melanoplus packardi
Melanoplus luridus
Melanoplus collinus
Melanoplus differentialis
Melanoplus infantilis
Melanoplus femoratus
Melanoplus bivittatus
Melanoplus minor
Phaetaliotes nebrascensis
Scudderia curvicauda
Scudderia furcata
Amblycorypha oblongifolia
Conocephalus ensiger
Conocephalus nebrascensis
Orchelimum glaberrimum
Orchelimum longipennis
Orchelimum nigripes
Orchelimum agile
Xiphidium fasciatum
Xiphidium saltans
Xiphidium nigropleura
Xiphidium strictum
Xiphidium brevipenne
Xiphidium ensiferum
Ceuthophilus blatchleyi
Ceuthophilus devius
Nemobius fasciatus
Nemobius canus
Nemobius carolinus
Gryllus pennsylvanicus
Gryllus abbreviatus
Oecanthus fasciatus
Oecanthus quadripunctatus
Oecanthus niveus
Anaxipha exigua

This list has been added to during the current year (1912) by the following species reported by Mr. Somes:

Nomotettix parvus, of state-wide occurrence
Chlocaltis abdominalis
Tettix luggeri
Tettix ornatus
Melanoplus fasciatus
Melanoplus impiger
Trimerotropis citrina

Melanoplus foedus
Hippiscus haldemani
Spharagemon bolli
Podisma variegata, extremely rare, taken near Duluth, and a few other forms, some of which are not yet identified.

A popular key to the four most destructive species in Minnesota is here appended by means of which one should be able to tell, if he desired, to what species any one of the four which he had under consideration belonged. They all belong to the genus *Melanoplus* and are all characterized by a small conical spine between the front pair of legs.

LARGE BULKY FORMS; "HIND LEGS" NOT RED.

Two light colored stripes along the back (along upper edge of wing cover); body color variable from brownish to greenish yellow; "hind legs" yellow or partly dark but not red. This is known as the "Two Striped Locust" or sometimes as the "Yellow Striped Locust." Its scientific name is *Melanoplus bivittatus.*

As large or even larger; general color yellowish or greenish yellow, without the two light colored stripes along the back; "hind legs" yellow, never red. This is known as the "Clumsy Locust" or the "Lubberly Locust." Its scientific name is *Melanoplus differentialis.*

MEDIUM SIZED AND MORE SLENDER; "HIND LEGS" NEARLY ALWAYS RED.

General color tan or yellowish brown; larger part of "hind leg" has two distinct dark bars on the outer face; tip of abdomen in males, always with a distinct notch. This is the "Lesser Migratory Locust" and is very closely related to the "Rocky Mountain Locust." Its scientific name is *Melanoplus atlanis.*

General color reddish brown, without distinct dark bars on hind legs; usually smaller and shorter winged than the above; This is the "Red-legged Locust" or "Garden Locust." Its scientific name is *Melanoplus femur-rubrum.*

In the above list it will be noted that Mr. Somes includes the Rocky Mountain Locust, *M. spretus*, basing his statement upon the collection of one specimen. We figure the specimen herewith. While it has the ear-marks of the so-called species *spretus*, we are inclined to think that in its genital plates it resembles *atlanis* quite as much as it does *spretus*. At any rate, the finding of this one isolated example in the midst of so many other species, *atlanis* among the rest, would appear to throw doubt upon the validity of *spretus* as a species.

A noteworthy fact in connection with our operations in 1911 was the extreme abundance of *M. bivittatus*, which easily led in numbers of individuals in almost every infested locality. From be-

ing secondary in economic importance three years ago, it took the lead in that year as being the most abundant of injurious forms. As a fact accessory to the abundance of grasshoppers in Minnesota in 1909, 1910 and 1911, it is to be remarked that a Meloid beetle, *Macrobasis unicolor*, and possibly one other species, commonly known as Blister Beetles, were extremely abundant and injurious in our state during the early part of 1911. This, without question, is to be ascribed to the great abundance of grasshoppers upon the eggs of which the young of these beetles feed. See page 44.

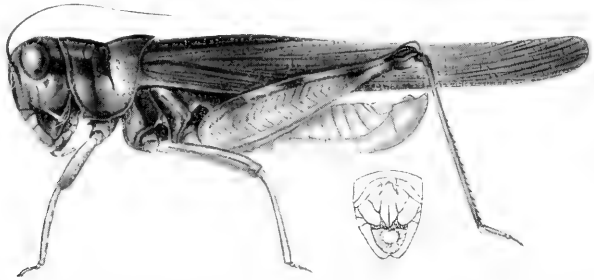


Fig. 10. Rocky Mountain Locust, (*M. spretus*)♀, showing genital plates of male Collected in 1911. Somes.

Ecological Notes:

From Mr. Somes' report for 1911 and Mr. Howard's for 1912, the following facts bearing upon life histories are deduced.

Mr. Somes noted *Melanoplus bivittatus* drilling in hard packed soil of roadbeds and on one occasion at Crookston one was watched for some time busily drilling in a hard cinder walk in a city park. All species appear to prefer dry and rather firm soil. The *Oedipodinae* will deposit in much softer or more friable soil than the *Acrididae*. In examining various localities for eggs this fall, they were found very abundant in a piece of land which had been plowed in July (the "nests" averaged 9 or 10 per sq. yd.) so that the statement so often made—that they will not oviposit in plowed land—is untrue. A number of counts made in corn land showed relatively few egg masses and these for the most part only at the edges of the fields. In stubble, especially in flax, they were most plenty, running as high in one case as 14 masses to one square yard.

The fact that eggs are deposited in low ground that may be under water in the spring does not necessarily mean that these eggs are doomed. Indeed it has been noted in portions of the Red River Valley that young hoppers emerge in July instead of May from some spots where water had been standing through the early part of

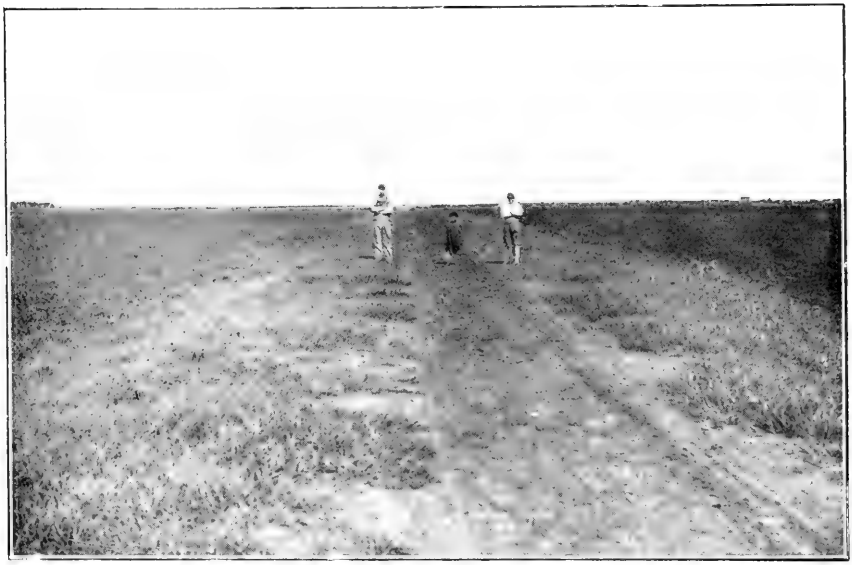


Fig. 11. Roadway and ditch showing character of ground where egg laying takes place. Normal habitat of three destructive locusts, *M. atlanis*, *M. bivittatus* and *M. femur-rubrum*. C. W. Howard.

the season. Thus the development was merely delayed—although of course we have no data on the percentage of the eggs that may have been destroyed by rotting or otherwise failed to hatch.

We have noted in the field throughout the summer young of various instars at all times. This may be because of somewhat sim-

Fig. 12. Natural breeding ground. The insects lay their eggs in stubble, also side of road, and even in road itself. C. W. Howard.

ilar retarding of development due to moisture or conditions of exposure.

Certain facts noted in regard to egg-laying and mating deserve consideration. As a result of very numerous dissections and counting of eggs in the bodies of female grasshoppers, it seems probable that more than one egg mass is deposited. It was noted that in case of females infested with fly larvæ (see under discussion of parasites) there were notably fewer eggs than normal. Blatchley, (Orthop. of Ind. p. 145) speaking of grasshoppers affected by these fly larvæ says, "they never mate"—this we (Somes) rather doubt, as we have found females so infested and yet having 24 to 40 eggs in the ovary.

The old figure of Riley showing that in oviposition the abdomen of the female is thrust downward and somewhat forward is evidently open to criticism, for in addition to Cooley's contribution on this point, Howard last summer observed in M. bivittatus a decided modification of the method as described by Riley. In other words, the egg pocket does not point directly down, or downward and forward, necessarily but may be directed somewhat backward, even to such an extent as to be nearly parallel with the surface. See Fig. 12a. That this fact has a definite bearing on the old theory of the advantages of "turning over the pockets with the plow" is self-evident.

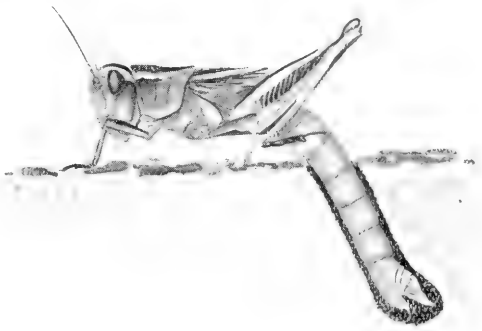


Fig. 12a. *M. birittatus* ovipositing. Wings worn and frayed. C. W. Howard.

To prove or disprove certain statements of farmers as well as investigators to the effect that amongst destructive locusts, the females far outnumber the males, counts were made at different localities with the following results. Each count is made up of the number caught in ten sweeps of the net where the hoppers occurred.

LOCALITY.	FEMALE.	MALE	REMARKS.
Meadow	6	5	Includes all instars and various species.
Weed land	17	10	
Roadside	11	12	Many in 3d and 4th instar.
Pasture	10	8	
Pasture	16	12	
Oat field, Edge	11	10	
Oat field, 10-12 rods out in field	6	5	
Oatfield 14-16 rods in field	4	5	
Edge of oats along corn field	20	14	Large adult M. bivittatus.
Edge of oats along corn field	15	20	Large adult M. bivittatus.
Totals	116	101	

Further "sweepings" were made later in other localities. A comparison of the two sexes made up of the number caught in twenty sweeps is as follows:

LOCALITY.	FEMALES.	MALES.
Reber's E. field Foxhome	31	27
Flax field E. of French edge of field	17	21
Ten rods out in same field	11	6
Weed patch two miles W. of Fergus Falls	19	14
Totals	78	68
June 26; Flats South of Foxhome, 20 sweeps of net	27	26

It is probable from the above evidence that the proportion of male and female in the species captured is very nearly equal.

Mr. Howard (1912) made some tests with the three leading injurious forms to determine what plants were eaten by grasshoppers. They may, of course, be regarded as general feeders, and will turn to anything edible if forced to. While grains and different varieties of grasses are preferred, the following plants, shrubs and trees attract them or not as indicated.

Mustard	eaten greedily
Sunflower	" somewhat
Chenopodium	" greedily
Dandelion	" readily
White Clover	" readily
Docks (Numex)	" slightly
Scotch Thistle	" slightly
Large leaved Dogwood	" readily
Onions	" readily
Radish	" slightly
Beets	" readily
Peas	" slightly
Alfalfa	" greedily
Wild Parsnips	" greedily
Mushrooms	" readily
Burdock	" slightly

Amaranthus	"	readily
Willow	"	readily
Boxelder	"	readily
Elm	"	readily
Lilac	"	slightly
Soft Maple	not	eaten

Methods of Control.

While experimenting with a poison spray we have at the same time urged farmers to use the old-time hopperdozer, personally showing them in many cases how to make the same, and have also been advocating late fall plowing, poison baits in gardens, but par-

Fig. 13. Hopperdozer in action.

ticularly to protect the latter, the placing of flocks of turkeys, which not only have an insatiable appetite for grasshoppers, but are a profitable adjunct upon any farm. Many farmers believe that a grasshopper striking the drenched sheet at the back of the hopperdozer, or falling into the pan and then getting out, is not killed, and we have been in the habit of assuring them that the slightest drop of oil upon an insect of this kind will kill, and that each one of these grasshoppers is doomed. Mr. Somes' observations this summer would seem to indicate that that statement must also be qualified, and that it must be acknowledged that although short-winged forms or wingless stages that are wet with the oil undoubtedly per-

ish, inasmuch as the oil reaches the spiracles, many long-winged forms do not die because of the protection to the spiracles afforded by the wings. This shows the importance of the early use of the hopperdozer, before wings are attained.

We have not advised the burning over of fields alive with young hoppers, believing the same to be dangerous and of questionable abiliay in a country where a hay crop is an important feature. In emergency cases, however, it may well be resorted to. We encourage co-operation, and we have especially advised action against

Fig. 14. A crude and cheap Hopperdozer.

grasshoppers, and vigorous action, when they first appear, even if it interferes with other farm work, for we find that whatever plan we follow as regards this pest, that they are much more easily handled, as would be expected, when they are young, than when they have attained their wings.

Our field workers reported only partial success with poison baits, represented by poison bran mash and Criddle Mixture, but have, in the course of their work, hit upon a rather unique poison which they have courteously called the "Minnesota Mixture." Finding that arsenite of soda used as a spray, and combined with a little molasses,

was very effective against grasshoppers, they substituted this for the Paris Green used in making the Criddle Mixture. They used the following formula:

Sodium arsenite 1 pound; horse manure 120 to 150 pounds; cheap molasses 1 pint. The arsenite of soda was dissolved in the water, then added to the manure, stirring it well.

This is cheaper than the Criddle Mixture and can be used in the same way. It forms a very attractive bait for grasshoppers. It was tested upon poultry to see whether these animals, in picking grain from such material, would be injured. Two roosters were fed upon it for some time with no bad results. Incidentally, it may be said that flies are attracted by this compound in enormous quantities, and are killed by the hundreds in feeding upon it. After this mixture had been exposed in the experiment with the roosters for a day over a quart of dead flies was found on the floor of the shed containing the poultry. This observation might be of value to those who are making a fight against the house fly, and it has been suggested that spraying piles of horse manure exposed in barns and livery stables with a solution of eight pounds of sodium arsenite in about twenty gallons of water, to which has been added about a half pint of molasses, would be a useful measure against the house fly.

Our most prominent work has been done with a poison spray. Aware of the success of arsenite of soda used as a spray in South Africa, it was decided to try it in Minnesota, thinking its use might be applicable to large tracts in the Red River Valley which call for treatment. We found that 3 pounds of commercial arsenite of soda, 1½ gallons of molasses, in 180 gallons of water, made a mixture which was fatal to hoppers and did not in any way injure crops. We used, in most of our experiments, field sprayers which covered 23 feet at one time. Approximately 50 gallons were applied to the acre at a cost of about 30c for material, this estimate based upon the retail price of arsenite, namely, 22c per pound. The location of water supply is an important feature in the cost of labor. Further, we believe that when vegetation is quite rank an acre would call for something more than 50 gallons. This poison did not kill immediately,—from 24 to 36 hours elapsing before the insect gave up the ghost, but it is to be noted that a partial paralysis was the immediate result of partaking of the poison. The insect was immediately made sick and ate nothing.

We received from various farmers congratulations upon this method, and statements of their success in using it.

Of course, the question at once occurs to the practical farmer as to whether this is dangerous to stock. We have made tests along this line, and while it must be remembered that any poison is detrimental and frequently fatal if taken in too large amounts, we feel convinced from our experiment, that, as ordinarily used by a farmer bearing the above fact in mind, no bad results will happen. A Holstein bull was fed with forage poisoned with this spray in the above proportions, being fed about 15 pounds of this each day for ten days, and showed absolutely no symptoms of poisoning.

Fig. 15. Our sprayer applying Arsenite of Soda.

As further proof that this compound if handled rightly will not affect stock we give here details of a final and to us convincing experiment: On May 20th, 1912, we sprayed an enclosed small pasture containing 1-10 of an acre with the above described arsenite of soda spray, applying it at the rate of 60 gallons to the acre. A young heifer purchased for the experiment was turned into the enclosure that evening, and (since she had been stall-fed for several days) she immediately ate heartily of the poisoned forage. May 21st, no bad effect noticeable. Heavy rain on night of 21st, probably washing a large proportion of the poison from the grass. May 22d, heifer in good condition apparently; bowels quite loose but doubtless due to abundance of grass feed. Heifer was then placed on untreated grass outside of lot for three days, during all of which

time she appeared in perfect condition. On 26th, sprayed enclosed area again, same proportions and amount as above. Heifer turned in on treated grass one hour after spraying. A heavy rain occurring a few hours thereafter, we again sprayed the grass as above, the heifer browsing on it immediately. For two and one-half days she was confined on this poisoned pasture, receiving no other food, after which period she was placed on outside grass and carefully watched for five days. No unpleasant symptoms of any kind appeared. At time of experiment she was within a month or two of calving and was sold to a party desiring a milch cow. At date of

Fig. 16. Another view of sprayer.

writing she is in fine condition. A week after she was taken from the pasture a pet horse was turned in and allowed to feed there for half a day without the slightest effect upon the animal.

As regards fall plowing it is possible it will be necessary to qualify recommendations in that connection, and the advice that we have given to this end in years gone by may represent an example of the general acceptance and promulgation of certain remedies, the thoroughness of which has not been properly tested,.

In the first place, farmers for the most part will not plow in the late fall. They have large tracts of land to handle, and as a rule, feel that they must begin their plowing immediately after the crop is off the ground. This is before egg-laying takes place. Our field agent, Mr. Somes, doubts the efficacy of the plow unless it is fol-

lowed by the harrow. He claims that more real good results from cultivation with a harrow, since that has a tendency to break up the egg masses and expose the eggs to the effects of bleaching and drying, and rendering them more easily accessible to their natural enemies. He further claims that at the time the young hatch the enveloping capsule has become soft and jelly-ilke, and that the young grasshopper may easily push up through that toward the surface in cases where the capsules are inverted by the plow. He does not believe that the alternate freezing and thawing of the eggs causes the death of the same, since, being close to the surface, they may be subjected to that in Minnesota every season. In fact he exposed to alternate freezing and thawing last winter newly hatched grasshoppers, twenty, according to his report, having been frozen and thawed twice with no mortality, except in the case of one individual, which probably perished through rough handling. In spite of his belief, as here cited, we still think that turning the eggs under deeply must materially lessen the number of grasshoppers which would naturally emerge the following season, and, plowing being in accord with farm practice, shall continue to recommend it until we know of something better.

Since special attention was given by the field workers to practical method of control, and since our recommendations are based upon this practical work, it seems advisable at this point to quote fully from the report submitted to this office detailing the work done in the field in 1911 under Mr. Somes' direction:

"The Hopperdozer, although widely known is so generally confused with the "tar pans" of the early days and with various other more or less similar devices that a detailed description of the hopperdozer as used in Minnesota may be of some value here. We may say that we have found this "dozer", when well designed and when used at the proper time of year, to be a cheap and effective method of exterminating grasshoppers and worthy of more general use. The essential part of a hopperdozer is a pan or trough of galvanized or sheet iron, to the back and ends of which is fixed a light frame of wood or iron extending vertically from 24 to 36 inches. This frame is to be covered with cloth. The pan is mounted upon a wooden frame which is dragged upon "skids" by two horses hitched to bars extending from the ends of the frame. The pans, being made usually of galvanized iron, are commonly made sixteen feet long, twenty inches wide and four inches deep since this size has proved very handy to use and can be made economically and without waste of material. On rough or hilly fields, however, we found it advisable to use pans eight feet in length to better follow the rough surface. We have found it advisable to fix several cross partitions of metal in the pan to lessen the waste from splashing and to brace the pan. We have advised the use of cloth for the vertical wing in preference to metal, largely because this material is less expensive and is very considerably lighter, which latter factor is of considerable importance as may be grasped when we recall the fact that the "dozer" is often to be dragged through fields of young and growing grain. We may add further that a wing of some soft cloth is in fact more effective than one of metal or even of oilcloth, although this may not be always apparent to the farmer. Our observa-

tions in the field, which were later confirmed by extended laboratory tests, convinced us that a very high percentage of the young "hoppers" which cluster upon this cloth wing become covered with kerosene and die within a short time although they may hop from the wing and apparently escape. The following is taken from Mr. Stoner's notes at the conclusion of a long series of experiments and observations testing the effect of kerosene in small quantities applied to the bodies of young grasshoppers and the effect of throwing the "hoppers" lightly against a cloth screen wet with kerosene: "These experiments would seem to substantitate the statement that "even if a hopper merely hits the canvas back of the hopperdozer, this canvas being well saturated with kerosene, the hopper will be killed."

In use the pan is filled about half full of water to which is added from one to two quarts of kerosene. The "wing" is then drenched with kerosene and the hopperdozer is dragged through the fields. Grasshoppers rising before this "dozer" strike against the "wing" or fall into the pan, in either case becoming wet with the kerosene which kills them in a very few minutes. The time of action with the hopperdozer, as with all other methods of control is very important. The best results can only be obtained if the "dozers" are used early in the season, that is, from the middle of May to the middle of June. At that time the young grasshoppers, not having developed wings, cannot fly over the wings and escape as many of them are sure to do when the use of the apparatus is delayed until late in summer. The cost of the "dozers" made as above, is very low. During the past summer they have been made throughout

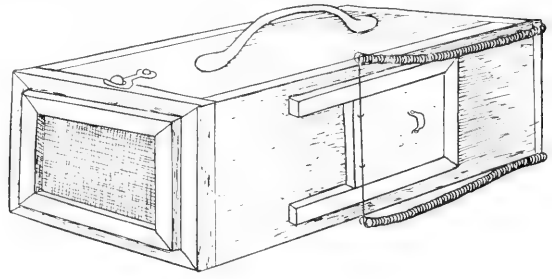


Fig. 17. A convenient grasshopper collecting box, used in field. C. W. Howard.

the Red River Valley at prices ranging from five dollars to eight or nine for the sixteen foot size. It is not necessary to use kerosene of a high grade, in fact in this case the cheapest is the best and grades of oil ranging from seven to ten cents per gallon (at the supply tanks) were found perfectly satisfactory.

As has been said, this device should be used early, practically the only test of time being that the grasshoppers must be able to jump high enough to fall into the pan and this they are able to do within a surprisingly short time after their first appearance.

In cases where fields adjoin large tracts of unused lands which are badly infested with grasshoppers, we found it possible to restrain these young hoppers within the unused land by plowing a strip two or three rods wide between the edge of the infested area and the cultivated area. This is of course merely temporary relief but in cases when the young hoppers are beginning to swarm out of such areas and into the young grain, while still too small to permit of the effective use of the "dozer". Young hoppers traveling as they do only by hopping, pass over such barriers only with the greatest difficulty, and in fact very few passed over such plowed strips when used early in the season. It is evident that the supply of hoppers within the infested area is in no way diminished by this and that unless some means of exterminating them there be applied they will presently pour out upon the fields in full force.

The plow has been said to be one of the most efficient tools to use against grasshoppers and while there is much truth in the statement, yet like many

others, it needs some qualification. Some of the causes given for this value from the plow are that this turns the eggs up and exposes them to the weather, by which is usually understood to the effects of "freeze and thaw." It is, however, extremely doubtful if this freeze and thaw have any bad effects upon the eggs. In the first place they are deposited so near the surface as to be always subjected to these alternations, even if left untouched. In a climate like that of Minnesota where the soil is frozen for long periods to a depth of several feet, the result of displacing grasshopper eggs from a depth of less than two inches to the surface certainly cannot subject them to very different conditions from normal. Apparently the real good resulting from cultivation lies in the breaking up of the egg masses and thus exposing the eggs not to freeze and thaw but to the effects of bleaching and drying in part, and in rendering them more easily carried away by such natural forces as running water, etc., than when protected by the earth blanket in which they were placed. With this thought in mind, the harrow suggests itself as an agent of equal importance to the plow. It has been argued that the plow "upends" the egg mass and that the young hatching are unable to penetrate the "capsule" and so perish. Without regard to the experiments upon which this idea was based, we must here take note of the fact that in natural conditions the "capsule" having been subjected to the varied agencies of the weather, has become, by the time of hatching, a soft jelly-like consistency that certainly could offer little resistance to a young grasshopper. Another theory has been that by deep plowing late in the fall the eggs are turned under to a depth so great that the young hoppers must perish before reaching the surface. While there may be something in this theory, it is evident that conditions must vary widely with the nature of the soil and with the amount of subsequent moisture, etc. Under some conditions the soil may not be sufficiently compact to offer any serious obstacle to the young hopper. Furthermore, we have been informed by observers that after trying this plan and plowing even as deep as seven inches, they have observed young hoppers emerging from the ground the next season, the only apparent result being that hatching was delayed somewhat. Taken all in all we must confess that at the present time we feel that the real value in cultural work against grasshoppers lies in breaking up the egg mass, and hence the plow, unless followed by the harrow, is of less real value than we have thought. Certain practical reasons which need not be here discussed tend to prevent late fall plowing but it is evident that even though early plowing is necessary and customary late harrowing may yet act to good advantage both as to the eggs and as to the soil itself. Spring plowing to be of value must be done just at the time when the eggs are hatching and to be of most value should be followed by the harrow. In fact the harrow should be used in spring on all lands that were plowed in the fall and should be used at the time when the young are just emerging from the eggs.

The plan of burning off large tracts to kill young locusts has been tried in many places with somewhat varying reports. In any case there is more or less danger of damage to the hay crop when the burning is applied late enough to be of any real benefit. Often there is also danger of losing control of the fire itself unless great care is taken. From the fact that grasshoppers are not so abundant in raw prairie as appears to be generally thought the burning over of wild hay land is not usually of much real value. In burning off the reverted areas and stubble where the greatest numbers of the young hopopers are to be found, it is frequently best to scatter straw over the area and burn this. * *

While the necessity for action early in the season has already been mentioned in connection with various methods of control, it is a matter of such prime importance that it may be treated again even though it may be in part a repetition. Among the reasons for this early action we may note first the fact that then the young hoppers are wingless and can travel only by hopping. They are thus more easily caught. Another fact is that at first they are much more gregarious and tend to cluster together in masses, while later in the season they scatter widely and any method of killing must be less effective than before. The nature of the vegetation offers another reason for early action, since then the plants, whether weed or crop, are low and do not interfere with control methods. For instance in early May it is easy to use a hopperdozer

since grain is low enough and "springs" enough to suffer no damage from the dragging of the dozer through the fields. At the same time there is not enough of the vegetation to cover up the grasshoppers and allow the dozer to pass over them without catching them as is the case later in the season. On the other hand, in using the sodium arsenite, while the grain is young, and the stems short, it spreads more uniformly on the vegetation. Also at that time the hoppers feeding as they do in solid masses are affected in proportionately greater numbers than later when scattered. The hoppers traveling more slowly and more steadily than the adults must feed continuously on the poison-zone and are more certain to eat enough poison to kill. The other advantages in methods of applying poison early, from the fact that at that time (and then only) can large fields be protected by spraying relatively few acres about the borders, has already been treated. While any of the methods described may be used later in the season it is evident that they cannot be as effective at any other time than when the grasshoppers are very young. Every week's delay after that time decreases the efficiency of any method of killing. When one sees, as I have frequently seen, whole fields totally destroyed by the hoppers, it must be admitted that there can be no work on the farm more important in the month of May, than earnest and intelligent work against this pest at a time when the work will be of most value. The need of co-operation is of course imperative but co-operation depends largely upon initiative and in every community there must be leaders who may take up the work and by their efforts sow the seeds of a community spirit that may result in general action against this common enemy. At the same time it must be remembered that the greater part of the real damage done by the grasshoppers is early in the season and each one of the leaders who is applying the various control methods is preventing a large part of the loss he would suffer otherwise, even though the others in his community do not co-operate with him. There is a real benefit to him, since the harm that may come later in the season must be thus lessened.

One of the principal objects of the summer's work is to plan if possible, a method of control which would be at once more effective and more economical than the use of the hopperdozer. With this in view, certain tests with poisons were planned. It was found that Paris Green, either in dry or liquid form, was not very satisfactory. Certain experiments with Arsenite of Sodium which had been carried out by the Entomologist during the previous year seemed to indicate that this poison was worthy of further trial. Reports upon the use of this poison against locusts in S. Africa were also highly commendatory, so it was determined to give some time to experiments with this compound. Most of our tests were made in small enclosed plats measuring two and a half by four feet, thus giving a definite area of ten square feet. Our first trials showed that the poison was satisfactory as regards killing the insects, although we were surprised to find that death did not occur until twenty-four to thirty-six hours after feeding. We noted, however, that the poison took effect within a few minutes and the grasshoppers ceased feeding, the hind legs became helpless and the insect, although alive for a considerable time, gave every indication of being very "sick." The first trials were made with a rather crude preparation of white arsenic and "sal-soda" boiled together but as this was found to vary somewhat in effect, we tried the soluble salt, Commercial Arsenite of Soda, which was found more effective, more uniform and much cheaper than the former. The formulæ used in S. Africa were found to be too strong for use here, since the grain or other vegetation was severely "burned" by the solution. Gradually reducing the proportion of "Arsenite" it was found that the most satisfactory solution was made by using four ounces of the "Arsenite" to fifteen gallons of water. This gave a spray which killed the grasshoppers without damage to the vegetation upon which it was placed. It is evident that any excess of poison must be wasted.

In the following table the solution in each case was made up of water, 15 gallons and molasses, 1 pint. The varying amounts of arsenite being shown in the table:

Strength	Effect on Grain	Effect on Hoppers
2 oz. Arsenite	No effect shown	45 dead; 4 "sick"
4 oz. "	No effect shown	49 dead; 5 alive
6 oz. "	Tips of leaves burned	64 dead; 4 "sick"; 5 alive
8 oz. "	Grain burned badly	51 dead; 5 alive

A stronger formula gave the following results.

5 lbs. Arsenite 1 qt. molasses 50 gals. water	Grain killed	206 dead; 11 alive

In the S. African experiments, the arsenical spray was found most effective when sweetened with treacle or molasses, hence we added molasses to our solution with very good results. Indeed we found the molasses valuable in more ways than one, since aside from rendering the solution more attractive to the grasshoppers, it serves to hold the poison on the plant. After once drying upon the plant the molasses is not readily washed off even by heavy rains and merely softens to sticky masses which drying again still hold the included poison.

Our working formulae may be given as follows (the formula is expressed in three different quantities for more ready use in sprayers of various sizes).

FOR WHEAT, OATS, BARLEY, RYE OR FLAX.

Arsenite of Sodium.....	4 ounces	1 lb.	3 lbs.
Water	15 gallons	60 gals.	180 gals.
Molasses	1 pint	2 qts.	1½ gals.

The Sodium Arsenite, which is a whitish powder, should be added to the water in small amounts and thoroughly dissolved before the molasses is stirred in.

This solution may be applied by any sprayer which is intended to use liquid poisons. Certain features, however, tend toward economy in operation as well as toward most effective results. We have found the best results when using spray at the rate of about fifty gallons to the acre. It is evident therefore that with small sprayers of fifty gallons, capacity or less there must always be a considerable item of waste of time from the frequent filling required. Another point is that the area passed over should be thoroughly covered and to do this the cones of spray must meet at the base, i. e., the nozzles must be so arranged that the whole strip may be covered. This is impossible or at least impracticable with most types of the so-called "Potato Sprayer" since in most of these the nozzles are arranged to spray the rows and usually leave the space between unsprayed.

Our field tests were conducted with large sprayers having a tank capacity of 165 gallons working by compressed air and having extension bars permitting us to spray a strip twenty-three feet wide at a time. On the extension bars were fifteen nozzles so placed as to thoroughly cover the strip. With such machines and an ordinary thresher tank wagon for hauling water we have been able to cover fields of eighty acres in one day.

After our preliminary tests in the test plats previously mentioned we began a series of tests upon a large scale by spraying fields of from twenty to eighty acres of various crops which we found to be badly infested with grasshoppers. The result shown in one or two representative fields may be of interest. On June 24th, Mr. Tanquary sprayed a field of 22 acres of wheat near Beltrami, using the formula given above. Two days later this field was carefully examined and counts made to determine the number of dead hoppers. In order to secure an idea as to the whole field these counts were made in several widely separated parts of the field. The number of dead hoppers found ranged from 30 to nearly 200 in spots ten feet square. To estimate the total number in the field the following plan was used. After several trials to secure uniformity it was determined by count that with the relative proportion of nymphs and adults present it took 370 grasshoppers to make one pint. Averaging results from the various spots counted it was found that the average for the field was 2 1-2 bushels of dead grasshoppers per acre of over fifty bushels to the whole field as a result of one treatment.

The following commendatory extracts are from letters received by the offices or from articles in newspapers. They serve to show the opinion of men who have tried this method of control against the grasshoppers.

(Morris, Minn., Tribune, Aug. 15, 1911.)

"Kill the Hoppers. Save crops by spraying with Sodium Arsenite. J. J. Gaffney is convinced that he saved his flax crop from the hoppers last week by the early application of a solution of Sodium Arsenite. After Mr. Gaffney had cut his wheat he noticed that the hoppers were very thick in his flax, and last Wednesday had decided to cut it while it was still green when he heard of the sodium arsenite treatment. He procured a sprayer and made the solution and went to work. The whole field was sprayed at a cost of about fifty cents an acre, and the next day the field was found covered with thousands of dead or nearly dead hoppers. Since then there are very few hoppers in the field. Mr. Gaffney is satisfied that his investment of 50 cents an acre saved his fine flax crop."

Morris, Minn., Aug. 28, 1911.

".....I am satisfied that in the Sodium Arsenite treatment we have the hopper problem pretty well solved for next year."

Yours truly,
(Signed) A. G. MARKS.

Extract of a personal letter. See reference to Mr. Marks' use of the Arsenite against hoppers in corn.

Beardsley, Minn., Aug. 9, 1911.

"Dear Sir:—In compliance with your request some weeks ago, when you were here looking after the 'grasshopper situation.' Will say that we have found the sodium arsenite preparation a very good exterminator, considering the way in which we have had to use it. All we had to use was a crude sprinkler that was made by our tinner; but it seemed to 'layout' quite a high percentage of the hoppers."

Yours very respectfully,
(Signed) AM. M. MORONEY.

In this, as in all control methods, the proper time for action is an element which must not be overlooked. The best results can be obtained by spraying early in the season, i. e., from about the middle of May to the middle of June, just as with the hopperdozer. Action at this time is best for several reasons. At that time the young hoppers are feeding steadily and move in greater numbers than after the wings have developed, and since they cannot fly it is easier to place the poison where they must eat it. When used at this time of the season it is possible to protect large tracts of land by spraying relatively few acres. For instance, in case a field not badly infested with grasshoppers adjoins a tract which is swarming with young hoppers these may be killed as they pass into the cultivated field by spraying a strip two or three rods wide along the edge of this field, through which "poison zone" the young grasshoppers must feed to reach the crop. In case a field is badly infested or to treat a tract of "reverted land" or other source of hoppers the whole area need not be sprayed but by spraying strips across the area in two directions, "checker board fashion," the poison may be so generally scattered as to be effective and yet the actual acreage sprayed is but half or less than half of the area. (There is reason to doubt the real efficacy of the "checker board" spraying, unless the unsprayed squares are very small.—F. L. W.)

In our formula given above, we made no mention of corn for the reason that we have found no practicable method of spraying corn. With this crop the damage by grasshoppers is normally late in the season when the corn is too tall to be sprayed. We are inclined to believe that the best way to protect corn from the grasshoppers is by killing the grasshopper early in the season while on small grains. At my suggestion, Mr. A. G. Marks of Marshall tried the following plan and reports gratifying results. His corn field adjoined a field of oats in which the grasshoppers were so thick that they had utterly ruined the crop and he feared that upon cutting the oats these hoppers would attack the corn. I suggested that he spray a rather wide strip of the oats—

five rods or so—with Arsenite of Sodium and leave this uncut as a "bait strip." After acting as above, Mr. Marks examined the corn field and reported that he saw numerous dead hoppers "even as far as five rods into the corn from the spray," and in the poisoned strip he noted many dead and many "sick."

While in some cases we found that the spray at the strength given above had a tendency to burn the tips of the leaves somewhat, this was neither general nor serious, and in all cases the grain had normal color a week or so later even though apparently somewhat burned immediately after spraying. We found however that young grain is far less sensitive, and wheat, oats and barley when sprayed when four or five inches high showed no effect even when the spray was used at one-half stronger than the above formula.

It was found in the experiments that certain plants, notably "Wild Mustard" and "Wild Buckwheat" were badly "burned" by the spray even when the grain was entirely unaffected thus there may be somewhat of a secondary value to the use of this spray.

The question in the minds of the farmers before applying this poison is whether it will kill or seriously affect his stock, should they get into the field so sprayed. No one expects to place his stock upon a steady diet of this poisoned grain for a long period but he wishes to be sure that should the stock get to the sprayed field for a time, they will not be injured. We feel no hesitation in saying that from the amount of poison shown upon the grain by actual analysis and from tests made by the State Entomologist, and quoted above, stock would be liable to no injury unless fed solely upon this poisoned material and even then, unless the feeding was continued for some days. It is of course evident that no such long continued feeding could occur unless purposely carried out as a test. It should always be remembered however in using this poison or any other poison that is strong enough to be of value, that reasonable care and intelligence is imperative in handling such materials.

Among other poisons which have been used with good effect against grasshoppers is the well known "Criddle Mixture" which is merely a mixture of Paris Green and horse manure—usually the proportion of one part of Paris Green to about one hundred parts by measure. The Paris Green is stirred into a quantity of water and then this aqueous mixture is stirred into the manure, adding enough more water to make the mixture of about the consistency of bran mash. This is an excellent means of killing grasshoppers but owing to the large amount of horse manure required to poison large areas, it is more feasible to use this in small tracts like garden patches. The mixture is simply scattered throughout the garden by means of a paddle. The mixture as normally used is not poisonous to poultry, although it might be harmful to young chicks.

Another device similar and no more efficient is a mixture of bran, Paris Green and water—usually about two parts of Paris Green to about twenty-five parts of bran. In some cases this mixture is sweetened by adding syrup or molasses. Care must be taken not to place this mixture where it will touch the plants.

Since we found the Arsenite of Sodium so satisfactory in our spray tests it was tried in a mixture somewhat similar to the Criddle described above and tests show the new mixture to be in some ways better than the former and certainly considerably less expensive. The best formula for this mixture so far as we have tested it is as follows: Sodium Arsenite one pound, horse manure one hundred and twenty to one hundred and fifty pounds, molasses (any cheap grade) one pint. Dissolve the arsenite in water and then add to the manure, stirring well. The mixture, which may perhaps be called the "Minnesota Mixture," may be used exactly as the "Criddle," but owing to the cheaper poison used and to the fact that so much poison is not required we have found it more economical. Its attractiveness as a bait is fully as noticeable as with "Criddle" and in fact we feel that the addition of molasses has improved the value as a bait. In order to test its effect on poultry we fed two roosters upon the mixture for some time with no bad effects. We tried also the effect of corn boiled in strong solutions of the Sodium Arsenite and by careful tests found that nearly one-half a gram of the poison was required

to kill a full grown rooster. Of course, this amount could not be obtained in a day's feeding upon the grain and foodstuff in the poisoned horse manure by any one chicken.

Aside from its value against grasshoppers another valuable point was noted in regard to this new mixture. Flies are attracted to this and we find that they are killed in great numbers by feeding upon the horse manure. In the experiments with the roosters above quoted, we found over a quart of dead flies on the floor of the shed after the mixture had been exposed for one day and careful tests and counts convinced us that the mixture actually attracts flies in considerably increased numbers. Following out the idea here presented we would suggest such measures as the spraying of piles of horse manure exposed at barns, etc., with a solution of eight ounces of Sodium Arsenite in about twenty gallons of water, to which has been added one half pint of molasses. This solution seems well adapted for spraying almost any exposed filth which may serve as a harboring place for flies. We hope to follow out several other experiments along this line if opportunity offers, since this poison appears to offer much promise and can be purchased at very much lower rates per pound than Paris Green or most of the better known insecticides.

During the summer (1911) numerous farmers had reported to us that they did not believe that the hopperdozers killed all of the grasshoppers; in fact, many of them believed that unless the grasshoppers actually fell into the trough and were thus drowned in kerosene they might revive. As soon as opportunuity offered we tried a long series of tests to show the actual effect of the kerosene under different conditions. As a result of these it was determined that the effect of the kerosene may vary somewhat when used very late in the season and with certain species. Trials made with hundreds of young grasshoppers of the harmful species showed that mere contact with the cloth wing, wet with kerosene, resulted in death within a very few minutes in every case. The same results held with crickets whether young or adult. With adults of a few of the species having notably long and ample wings, the results varied and while in some cases they were killed, some survived so long that it is possible that they might eventually recover. Our explanation lies in the fact that the ample wings, folded fan-like, serve to draw the kerosene from the surface of the body by capillarity. The action of the kerosene depends upon its reaching one or more of the spiracles and it is evident that this lessening of the amount of kerosene by the tube-like foldings of the wings must result in lessened effect.

The conditions thus observed simply add another reason why the hopperdozer, like sodium arsenite or any other control method, must be applied in early May and June to produce most effective results. There can be no doubt of the effect of these several methods when used early but when the man most affected will still delay, vainly hoping for the weather or Divine Providence to intervene, he should not attribute the failure of his trials to the methods but to his own delay.

Various grasshoppers lightly wet with kerosene on the under side of the body were affected as follows:

Species.	Helpless.		Dead.	
M. femur-rubrum	5	seconds	1	minute
M. atlanis	15	"	2¼	"
M. bivittatus	20	"	2	"
M. bivittatus	10	"	1	"
M. femur-rubrum	30	"	2	"
M. bivittatus	45	"	10½	"

This latter specimen is inserted to show the slower effects in long winged forms. This was very noticeable in such species as Dissosteira carolina, Arphia pseudonietana, etc.

In connection with our spraying experiments it may be well to include here Mr. Howard's observation in 1912, showing features to

be avoided in this process and incidentally recording results of certain experiments of his in 1912:

"Although I was not supposed to give any attention to the economic phase of the subject of grasshopper destruction, for my own information and that I might be armed for the future, I took occasion to make a few investigations. During the previous year you had been testing a modification of the South African locust spray, adapting it to Minnesota conditions, and thought it to be very effective. As one of the originators and perfectors of that spray, I was anxious to see how it acted under local conditions. I took it upon myself to find a farmer who had grasshoppers quite badly and watch *his* spraying experiments with the sweetened arsenical spray. It will be as well in this brief report to summarize results and give the gist of my opinion upon spraying. The work carried out upon this farm was not very effective. *It demonstrated all the mistakes which could be made by a farmer in spraying.* In the first place, spraying was delayed until too late; hoppers were already molting to the adult stage. In the second place the grain was too high, already heading out, and there was plenty of tender pigeon grass below, of which the grasshoppers are very fond. In the third place, the spray machine used was not suitable; the fans of spray were not wide enough to meet and it did not throw the spray downward, so that relatively only a small portion of the grain was covered with spray. In the fourth place, the field was sprayed in strips, checker-board fashion, which leaves intermediate squares with no spray. My opinion is that locusts are not attracted to the sprayed grass by the sense of smell but when they come to a sprayed patch are induced to stay there and feed because of the sweetening in the spray. Therefore, unless we have a species rapidly migrating, as is the case with the S. African locusts, the whole field must be sprayed.

Spraying to be successful must therefore be done early before the hoppers have passed beyond the third stage, and if possible while they are in the first or second stage. As most of our destructive grasshoppers oviposit along roadways and in abandoned land, these areas can be sprayed and no harm done before the grain is more than six or eight inches high, while the hoppers are still small and while it can be well covered with the spray. A suitable pump should also be used, one which will give an even pressure, and with nozzles which will throw fans of spray which will meet and insure the grain being covered thoroughly. I would not advise the checker-board system of spraying for the reasons given above.

To test more thoroughly the question of whether grasshoppers and locusts are attracted by any odor in the spray, I made a few cage experiments with such odors as oil of rosemary, karo syrup, and fermented molasses and syrup. My tests of these gave negative results, as none seemed more attractive than untreated grass. I am strongly of the opinion, after very careful consideration of the subject, that locusts are not attracted by odors, but by taste, i. e., when they come upon something which suits their sense of taste, they remain there and feed until satisfied or some other stronger factor causes them to move away. In this connection, I also tried a test in the field with several sweetening substances in the spray. The following substances were used: molasses, karo syrup, fermented molasses, beet sugar molasses and locusticide. The sweetening substances, except of course the locusticide, were combined in the usual formula for the spray as recommended by this office.

The spray was applied at Foxhome on July 5th, on a weedy and grassy roadside, along a field of grain where grasshoppers were very thick. The plots were 15 feet square and on July 9th the plots were examined and dead grasshoppers were looked for as far as 30 feet into the grain field. The following number of dead hoppers were found:

Molasses	40 dead
Karo syrup	192 "
Fermented molasses	102 "
Beet sugar molasses	409 "
Locusticide	136 "

The beet sugar molasses seemed to furnish the greatest attraction, although the odor is not more attractive than that of the other substances. The grasshoppers present were M. bivittatus, M. atlanis with a few M. femur-rubrum. They were mostly in the fourth and fifth stages and a few were molting to the adult age.

The objection may be raised to this experiment that no barriers were placed about the plots and thus we were unable to ascertain exactly how many were killed. My endeavor was to have conditions as nearly natural as possible; and the dead grasshoppers were traced for a sufficient distance into the grain field. Of course, we did not ascertain how many escaped destruction, but that was not the point for which I was working in this test.

I was disappointed in the effectiveness of the Locusticide and attribute it to the fact that there is a difference in the sweetening substance used in the American made product. The Atlas Preservative Co., of London, are now sending, free of charge, a couple of drums of the English made article, from the lot used in South Africa, and which was found so successful. This can be tested another season."

Mr. M. C. Tanquary of Illinois had charge of most of the field work in spraying in 1911. He began his work June 5th at Fergus Falls and conducted a series of tests to show the effect of Sodium Arsenite both upon grasshoppers and upon the growing grain. These tests were made in part at Foxhome (Wilkin Co.) and later at Beltrami (Polk Co.) and again in part at Redwood Falls.

Protection of Gardens.

There is no question but that poultry, where it is possible to make use of it, is a most valuable adjunct in keeping down the grasshopper pest around the house. Turkeys in particular have an insatiable appetite for these insects and are not only of great value in this connection, more so than in any other variety of poultry, but also as we all know, bring a very handsome price in the fall. This argument alone is one to induce all farmers to raise more poultry, particularly turkeys.

Poison baits for grasshoppers can be used to advantage in a garden, a poison bran mash, (two parts Paris Green and twenty-five parts bran by measure) or the "Criddle Mixture" (Paris Green one part, fresh horse manure one hundred parts, enough water to make the mixture soft) or some modification of it (see Minnesota Mixture page 30). We have found by experimentation that the Criddle Mixture can be safely used in places where full grown fowls have access, though it might be dangerous where there were young chickens.

In using poison baits in the garden, care must be taken not to place any compound containing Paris Green or arsenic in any form close to or in contact with a plant, since if rain occurs and the poison is washed down to the roots, the plant is likely to be seriously injured.

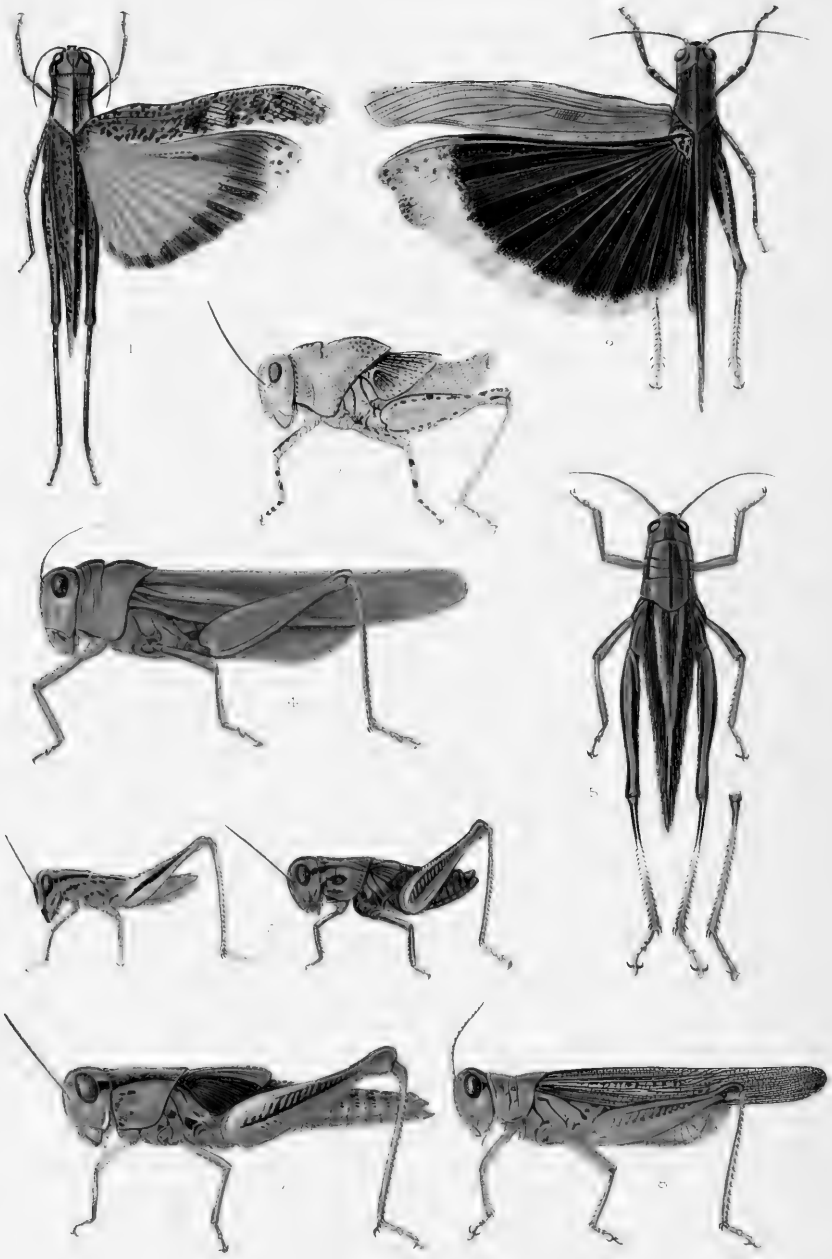
In the case of a small garden plot, practical protection could be obtained before the grasshoppers acquire wings, by placing twelve-inch boards on edge about the garden, thus making a complete fence twelve inches high and tacking on the upper edge a three or four inch strip, so that it will project two inches or more on the field side. On the outside of this twelve-inch board, just below the stripping, place a band of tar, and renew it in order to keep it sticky.

Mr. Blatchley in his report on the Orthoptera of Indiana, speaking of turkeys as a remedy for grasshoppers, states as follows: "Under the leadership of an experienced gobbler, almost their entire time during the summer and fall months is spent in wandering over the fields and pastures in search of the fat and juicy nymphs of locusts, grasshoppers and crickets. Indeed, most of the luscious white and brown meat of our Thanksgiving and Christmas dinner was once, grass, then grasshopper and finally turkey. No better and more practical remedy can be devised, for the damage which the insects do it, especially in these days of "turkey trusts" often more than compensated by the value of the pounds of flesh which this domesticated fowl stores up from its favorite food of locusts."

ENEMIES OF GRASSHOPPERS.

In spite of the fact that these insects appear to be the natural prey of many animals both large and small, the inroads made upon their ranks are so insignificant compared with the countless thousands left to attack our crops that we cannot rely upon these enemies as particularly helpful allies. Yet that they make some impression is evident and the species aiding man in this particular, even in a very slight degree should be mentioned here. Probably the help rendered is more extensive than would appear. We list the forms observed in this state preying upon grasshoppers.

Fig. 19. A Robber Fly, *Promachus vertebratus*. Original.



J. L. WOOD, del.

A. HOEN & CO. BALTIMORE

SOME MINNESOTA GRASSHOPPERS

Predaceous.

INVERTEBRATES. Insect: Various robber flies, (Asilidæ) notably *Promachus vertebratus, Erax aestuans, Stichopogon trifasciata, Proctocanthus milbertii* and others.

Predaceous beetles as follows: *Pasimachus elongatus, Ptersostichus lucublandus, P. sayi, Calosoma calidum, C. frigidum,* feeding upon adults and eggs; *Carabus sylvestris* and *C. sylvanus, Cicindella vulgaris, C. purpureaus, C. auduboni* and *Amara sp.*

The Meloid, *Macrobasis unicolor.*

Amongst the beetles it is quite possible that *Elaterids* and *Staphylinids* feed upon the eggs.

Fig. 20. *Calosoma frigidum.* Kirby.

Hymenoptera: *Sphex ichneumonius, S. pennsylvanicus, Chlorion cyaneum, Pompilius americanus, P. atrox, Ammophila intercepta, Bembex fasciata, Lampronota sp.,* and various ants, the latter attacking only small nymphs.

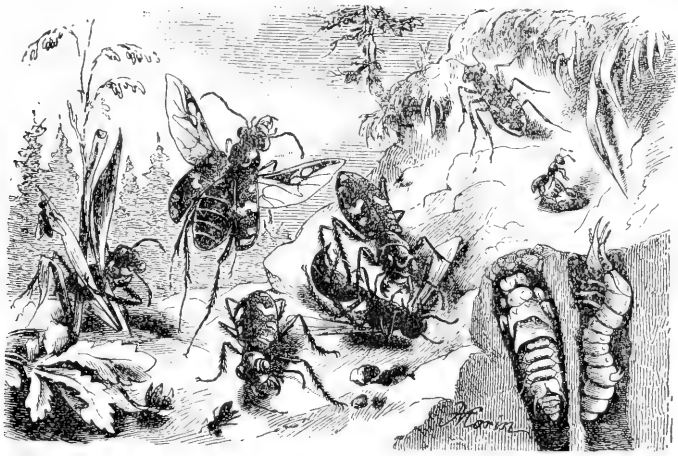


Fig. 21. Tiger Beetle, all stages. After Brehm.

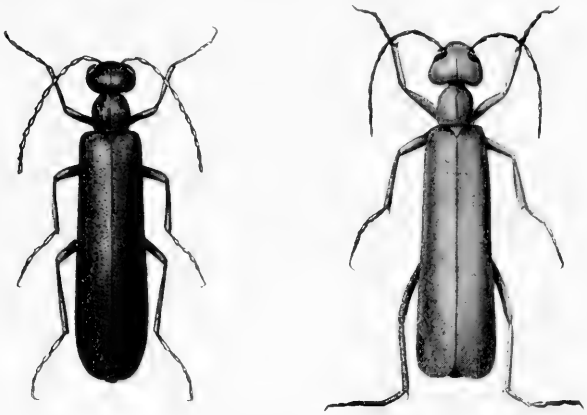
Orthoptera: The striped Ground Cricket, *Nemobius fasciatus,* feeds upon eggs.

Arachnida: *Trombidium sp.* Undoubtedly many small grasshoppers fall a prey to spiders also.

EXPLANATION OF PLATE II.

1. *Arphia (tenebrosa) pseudonietana:* 2. The Carolina Locust, *Dissosteira carolina;* 3. *Dissosteira carolina,* young stage; 4. *Dissosteira carolina.* showing color variation; 5. The Two-striped Locust, *Melanoplus bivittatus;* 6 and 7. *Melanoplus bivittatus,* immature forms; 8. The Red-legged Locust, *Melanoplus femur-rubrum.*

VERTEBRATES. Mammals: The thirteen-lined Gopher (*Spermophilus tridecemlineatus*) and probably other gophers. Skunks also known to have a fondness for grasshoppers.



Figs. 22 and 22½. Black and grey form of Blister Beetle, *M. unicolor*. Original.

Fig. 22a. Blister Beetle larva, seeond stage, in egg pocket of *M. bivittatus*. C. W. Howard.

BIRDS: A large variety of birds feed upon grasshoppers. Amongst these observed to thus feed here and reported by Mr. Somes are the Black Tern, Brown Thrush, Wren, Yellow Warbler,

Fig. 23. Thirteen-lined Gopher, *S. tridecemlineatus*, which catches and devours grasshoppers in the fall.

Northern Shrike, Rose-breasted Grosbeak, White-crowned Sparrow, Harris Sparrow, Bobolink, Cow-bird, Red-winged Blackbird, Meadow Lark, Crow Blackbird, Crow, Kingbird, many of the smaller birds of prey, also Prairie Chicken, Quail, Cuckoo, Turtle Dove and English Sparrow.

REPTILES: Reported by Somes. Garter Snake, Northern Swift, Northern Sand Lizard, Bell's Painted Tortoise.

AMPHIBIANS: Toads and Frogs.

FISH: Nearly all of our fish will take grasshoppers falling into the water or thrown in.

Parasitic.

INVERTEBRATES. Insects: *Muscina stabulans* (reported as distinctly parasitic in our work), *Helicobia helices* (possibly a savenger only), various species of Tachinids (Tachina and possibly other genera were found in August in the thoracic cavity of *Dissosteira carolina, M. bivittatus, M. atlanis, Melanoplus dawsoni, Spharagemon collare, Orphulella speciosa* and others.

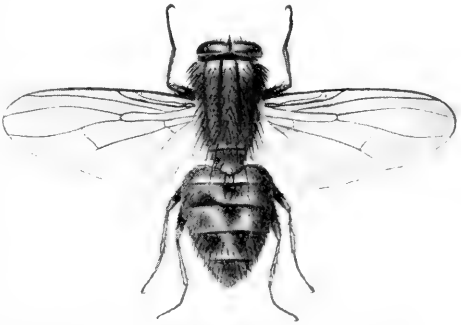


Fig. 24. The Non-biting Stable Fly. *Muscina stabulans.* Original.

A Bombylid: *Systaechus oreas.* Pupated but died before emergence of adult as reported by Howard. Several species of Phorids, parasitic, according to Howard, either in the grasshoppers themselves or upon the pupæ of fly larvæ found within the hoppers. From eggs obtained at Foxhome, a small hymenopterous parasite emerged late in the fall of 1912.

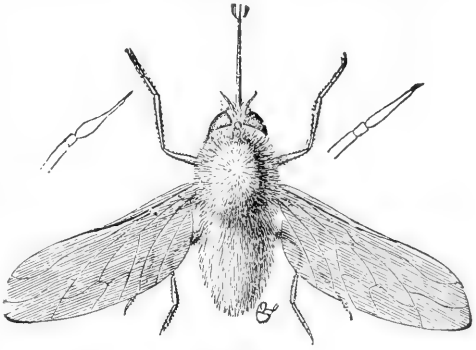


Fig. 25. A Bombylid Fly, *Systochas oreas.* After Riley.

Worms: Nematodes, "Hair-snakes" were found in the body cavities of *M. bivittatus* and *M. differentialis.*

Fig. 26. A nematode parasite, (Gordius?) found in body cavity of grasshoppers.

PLANT PARASITES. According to Howard's observations a bacterial disease was the most destructive enemy of grasshoppers this season, attacking practically every species, especially *M. bivittatus, M. atlanis* and *M. femur-rubrum,* and the Oedipods, such as *Dissosteira* and *Spharagemon.* Quoting from Howard's report:

"Even nymphs in as early as the fourth stage were attacked, especially of the Melanoplods. The rainy season seemed to encourage the spread of this bacterial disease the past season and many valuable observations were made. It is to be hoped that another season the causative organism may be found where we can have suitable laboratory facilities and equipments for the work."

Fig. 27. A grasshopper nymph killed by bacterial disease, C.W.Howard

The fungus *Empusa grylli* was as usual quite common. The rains of the summer encouraged its growth and spread, but had we experienced warmer weather, coupled with dampness, it would have been more destructive.

Fig. 28. Carolina Locust, killed by fungus, *Empusa grylli,* C. W. Howard.

Some of the above enemies deserve more than a passing notice. *Macrobasis unicolor,* for instance, adults of which do much damage when they are known as "blister beetles," is interesting in that, in the larval stage it preys upon grasshoppers. It was quite destructive in Minnesota in 1911, its being present in large numbers being undoubtedly due to the presence of an abnormal number of grasshoppers. Quoting from Mr. Howard's field notes:

"Two varieties of this species are common in the western part of the state, one black, the more common, and one gray. The eggs are laid in the ground. The young larvæ upon hatching find a grasshopper egg pod and feast on its contents, leaving only remains of shells when they have transformed to adult beetles. There are two generations in a season. Early in June larvæ in the last stage and pupæ were found in egg capsules in the field. By the middle of June adults were out in full force and were injuring flax, potatoes, peas and radishes. Many were found on wild vetch and milkweed. Eggs were laid late in June and early in July. The second generation of beetles appeared by the middle of August and lasted until early in September, their eggs hatching by the middle or end of September. The gray form did not appear to any extent in the second generation. See Figs. 22 and 22½.

The life history of these beetles is being worked out carefully and will be reported on after another season. They assist some in reducing the numbers

of grasshoppers, but not materially. The method of egg laying makes it difficult for the tiny larva to find an egg pod and when it does, each larva destroys only one pod and not always the whole of that. Their destruction to crops offsets the good they do in destroying grasshopper eggs. Only one case of injury (by the beetle) to a crop, flax, was reported this year, (1912), but the injury was so early that the flax was able to recover and mature a good crop of seed."

TROMBIDIUM SP. This red mite is another interesting enemy of the grasshopper, but we have always believed that too much importance was placed upon its services by our farmers, for we have personally observed many female grasshoppers ovipositing in late summer, although loaded with these parasites. It is in spring, then, when in the bright scarlet mature form, that it does its best work, consuming many grasshopper eggs and thus reducing the numbers of the pest. We quote from both Mr. Somes' and Mr. Howard's observations in 1911 and 1912.

"Our studies of the parasites of grasshoppers naturally began with Trombidium, the 'red mite' or as it is more commonly called 'the red bug.' There can be no doubt that this mite has a very decided economic value in its work against the grasshopper, but contrary to general opinion this really effective part of its work is accomplished early in the spring rather than in midsummer when it is so commonly observed. In my preliminary examination of the field early in May I found this mite present wherever I found grasshopper eggs in abundance and very frequently observed it actually feeding on the eggs. It is evident that every egg thus attacked means one less grasshopper to hatch. As regards the actual beneficial effect of the mites later in the season we are inclined to think that these are over-estimated. It has been frequently observed that grasshoppers bearing from several to twenty or more of these parasites still feed and appear normal in all their functions. In some cases where there has been very evident damage to the wings and even to the dorsum of the basal abdominal segments the hoppers appeared undisturbed in vigor or in appetite. When the hopper moults it frees itself from the mites but more or less of these soon become again attached to it. From our observations it appears that the really beneficial stage of Trombidium is the adult in early spring rather than the more numerous and conspicuous young in summer.

In our early examinations of the eggs we found small coleopterous larvæ associated with the Trombidium in the vicinity of masses of eggs. Through error these were not reared but they were doubtless Meloids and in all probability belonged to the genus *Epicauta*." Somes 1911.

* * * * * * * * * * * *

"Trombidium was very abundant everywhere I collected. Early in the summer engorged females were found in egg pods of grasshoppers in the soil. They apparently feed on the eggs of any grasshopper without distinction. By May 27th eggs of Trombidium were found in the soil and a life history study was begun. This will not be complete until next summer, so the details, all of which should be verified by another season's observations, are not given here. The Trombidium, while it does some good in checking the grasshopper plague, is not what has been claimed for it in the past. They do destroy some eggs, but at the most two or three eggs only are required for the engorgement of an adult, and a lesser number for the immature forms, so that only a small percentage of eggs is destroyed. The larval forms apparently do very little harm to the nymphs and adult grasshoppers. I have seen nymphs with thirty to forty engorging larvæ of Trimbidium going on successfully with their transformations." Howard 1912.

In 1911, Mr. Stoner, a field assistant, selected several specimens of *Melanoplus bivittatus* bearing abnormally numerous mites (26 to nearly 50 individually) and kept these under observation for a period of two weeks. He reported that the hoppers appeared normal in function and could observe no apparent injury due to the mites. During the second week, however, he reported that the mites on one of the hoppers were "drying up" or shrivelling.

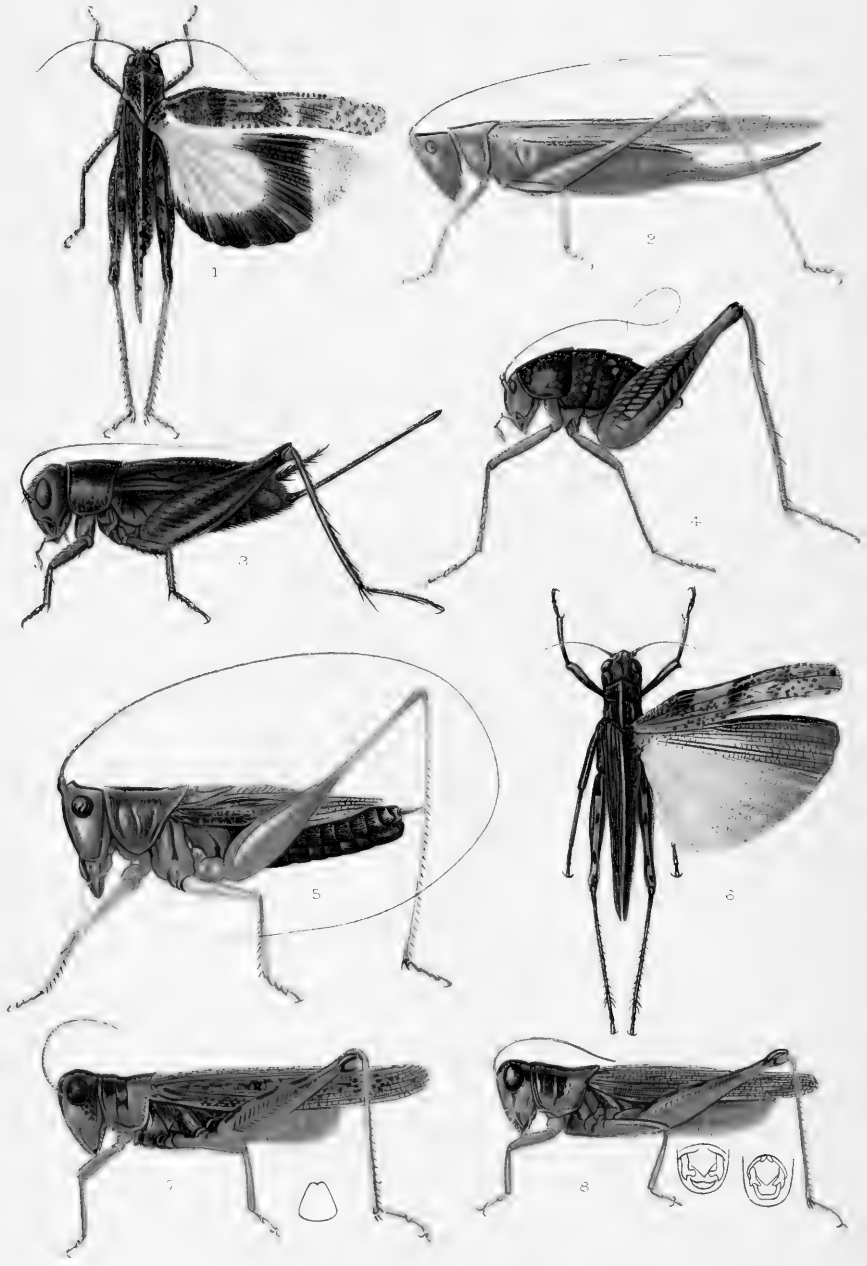
The Tern, so common about the prairie sloughs, aids the farmer materially as these dry up toward the end of summer, by catching countless grasshoppers. Mr. Somes was so impressed by this fact in 1911 that he writes as follows:

"The Black Tern is credited with destroying enormous numbers of hoppers; in fact, I have been told by two different farmers in widely separated parts of the state that this bird had virtually saved their crops by reducing the grasshoppers to normal numbers. In both cases the conditions were similar—the farms were located in a marshy area and as the marshes dried in summer the Terns turned to feeding on the grasshoppers and being present in large numbers they usually were very effective."

We also add here Mr. Somes' deduction from Mr. Zetek's notes on *Muscina stabulans* and *Helicobia helices.*

"At Fergus Falls two flies were reared from Melanopli. Of these *Muscina stabulans,* Fallen, is possibly a scavenger in habits rather than a true parasite. It has been known from a wide variety of hosts, ranging from the larvæ of *Aletia xylina* (The Cotton-worm) and bees to fungi and even rotting squash. In our studies however it was parasitic. The following taken from Mr. Zetek's notes gives the general data as to this species. 'July 17th. At the farm of Mr. Lomar, two miles west of Fergus Falls, I collected a number of *Melanoplus bivittatus* which contained dipterous larvæ in the thoracic region. They seem to be in the digestive tract. Placed in a tumbler cage. Several larvæ killed in hot water and preserved in alcohol. (Ac. No. 605.) Aug. 8, 10 A. M. Have examined the cage daily since the 17th ult. Adult flies observed this A. M. These have emerged since August 7th, 8 P. M. Pinned seven adults (Ac. No. 609) and placed in dry vial puparia of these as Ac. No. 610.' To go into more detail will say that the larvæ mentioned in this observation was found on numerous occasions in *Melanopuls bivittatus* in numbers varying from one to eight in the thoracic region as stated. The living larvæ were clustered close about the digestive canal in every case observed. Although this species belongs to the Muscidæ, as now limited, we think that it must be parasitic although possibly also a scavenger in habits.

Helicobia helices Towns. This Sarcophagid has previously been reared from *Lachnosterna, Pieris rapae, Leucania, Melanoplus differentialis* and other hosts. In the case of this fly our studies would tend to lead to the opinion that this is indeed a scavenger rather than a true parasite. (Zetek.) *Melanoplus bivittatus,* adult, collected June 30, by Mr. Stoner at Ada in a wire cage in a field of barley. It was placed in a cage for experiments with mites. July 11 it was found dead and infested with larvæ. July 12, transferred by Mr. Stoner from Ada to Fergus Falls. I placed it in a tumbler cage. There are seemingly two kinds of larvæ,—two specimens are large and are probably Syrphids. One of these shows indications of pupation. The other four larvæ are longer (about 4 mm.) and flattened dorso-ventrally. The jaws are well pronounced. None preserved as there are too few larvæ. Aug. 8, 10 A. M., Cage has been examined daily and this A. M. found 4 flies in it. Pinned as No. 612. Exopuparia placed in a dry vial as No. 614."



I. L. WOOD, del.

A. HOEN & CO. BALTIMORE

SOME MINNESOTA GRASSHOPPERS AND CRICKETS

While it is true that sometimes a decided check is placed upon the increase of an injurious insect by some of its natural enemies, these agencies must not be relied upon by the farmer. These checks almost invariably act too slowly to be of any great value, and the farmer who waits for them to act, before acting himself, may loose his crop in consequence. Mr. Somes in his report to this office voices our sentiments exactly. He says: "It is vastly wiser to accept all of these natural agencies for the good they will do and to augment the destruction by such methods as man may devise. The hesitation and delay on the part of the farmer is in considerable degree responsible for the continued increase of the pest. I am convinced that if but a small percentage of the farmers in the infested territory had, last spring, (1911), used such methods of control as were known, and had acted at the proper time the damage from grasshoppers could have been very materially reduced."

Fig. 29. Grasshoppers killed by fungous disease are frequently seen clinging to tops of grasses.

EXPLANATION OF PLATE III.

1. *Sparagemon aequale;* 2. The Slender Meadow Grasshopper, *Xiphidium fasciatum;* 3. The Small Striped Ground-cricket, *Nemobius fasciatus;* 4. A "Cricket-Like Grasshopper," *Ceytophilus sp;* 5. *Xiphidium nigropleurum;* 6. The Clouded Locust, *Encoptolophus sordidus*, female; 7. The Lesser Migratory Locust, *Melanoplus atlanis*, and sec. view of last segment of male; 8. *Melanoplus collinus*, and dorsal view of male genital plates of *M. luridus* on left and *M. collinus* on right.

MISCELLANEOUS NOTES.

Effects of humidity and degrees of atmosphere and soil upon eggs and hoppers were tested (Howard 1912) to some extent in connection with the carrying out of some preliminary experiments to test the efficiacy of plowing as a means of destroying grasshopper eggs in the soil. These experiments will be continued this winter.

As a result of our experiments in 1911, we had printed in the fall of that year, a "grasshopper poster" of some size, stating the situation and giving the remedial measures we had found good, including detailed directions for spraying. About 6,000 of these were distributed amongst those who had complained of grasshoppers, and through our field workers and institute men, to all farmers in infested districts who were interested in the problem. They were also given out to farmers at the State Fair of 1911.

One feature of our work was the formation of "grasshopper clubs" amongst the farmers and interesting commercial clubs by circular letters to take action, upon the ground that the interests of the farmer and the business interests of any town are closely allied. One commercial club promised to co-operate with us somewhat along the following lines:

Plan for Co-Operative Work by Commercial Clubs Against Grasshoppers.

The Commercial Club will buy two or more sprayers and a supply of several hundred pounds of arsenite of sodium. Believing that roadsides are one of the great sources of young grasshoppers, especially in the southern parts of the state, the club plans to spray all of the roadsides in four townships centering at the city.

The Club will hire a man to supervise and direct this work and two or more men and teams to handle the sprayers.

The man in charge will act also as a solicitor among the farmers and it is planned to ask each farmer to contribute $5.00 per quarter section.

The work will be begun early and carried out as rapidly as possible.

When the roadsides have been covered, it is planned to spray such of the enclosed fields as appear seriously infested if desired.

This plan appears to offer a means of securing the greatest possible amount of work with the minimum of expense and labor and permits of the work being carried on at the time when it may be most effective.

Our field workers this year both agree in saying that the seasonal conditions in the early part of the summer of 1912 are what saved us from loss this year, but that grasshoppers are still present and numerous and that *as soon as one or two seasons favorable to them are experienced, we will again witness their destructive work.*

In conclusion: After our special work of two years and more upon the grasshopper problem in Minnesota, we feel justified in saying that the control of injury caused by these insects is in the farmers' hands; they can, if they will, by following directions intelligently, and by co-operation, reduce this evil at least 75 per cent. Using the words of one of our field men, "every intelligent farmer should become a leader in this work". It is to be hoped that more grasshopper clubs will be formed, for organized effort in this direction is bound to meet with success.

BLISTER BEETLES.

One or more species of these soft-bodied Beetles, family *Meloidae,* were extremely abundant and destructive in 1911. This was to be expected on account of the great abundance of grasshoppers in 1909, 1910 and 1911, since the eggs of grasshoppers form the food of one or more species of these insects when in the larval stage. The relation of these beetles to grasshoppers is discussed in this report in the article on "Grasshoppers."

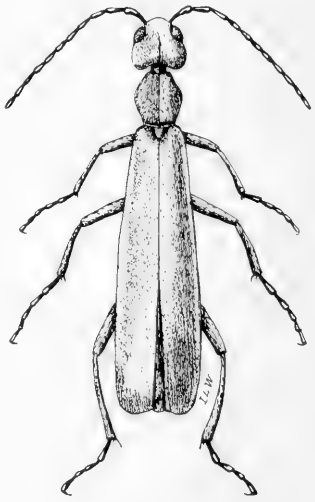


Fig. 30. A Blister Beetle. See also Fig. 22.

Unfortunately, the good done by them in the larval or young stage is more than offset by the injury done to various crops in the mature beetle stage. Specimens of these insects sent to this office in 1911 and collected in both 1911 and 1912 prove to be the black and gray form of *Macrobasis unicolor.* These beetles appeared in enormous numbers in different parts of the state almost simultaneously; i. e., about June 1st, and after that date letters of complaint gradually decreased until July 5th, or thereabout, after which there were, nevertheless, a few inquiries or requests for assistance with this insect until nearly the last of August. Alfalfa, clover, potatoes, various flowering plants, locust trees, etc., were sought by these insects, and we found them very difficult to poison in that they quickly left a crop so treated and went to another before the poison had had an opportunity to make any great impression on their numbers. We therefore advised sweetening an arsenate of lead spray, (three pounds of arsenate of lead in fifty gallons of water) where feasible to use spray. Where a spray could not be applied and the plants affected not too numerous, we suggested knocking them off the plants in the cool of the morning into a pan containing a little kerosene. Immediate action must be taken upon their very first appearance, otherwise they will

quickly defoliate plants attacked. When occuring on trees they may be jarred off onto a sheet and killed with kerosene. Potatoes well sprayed in summer with the standard bordeaux and paris green solutions for fungus diseases and leaf eating insects will defy attacks of blister beetles. In 1912 these insects were not so troublesome as in the preceding year.

THE WHEAT STEM MAGGOT.

From about July 6th to August 6th in 1912, an enormous number of letters were received expressing fear that the wheat crop was seriously injured by some insect, farmers basing their belief on the large number of "bald heads" noted in the grain fields. While in some few instances, individual fields showed serious loss, on the whole, the state probably lost on its grain crop only a very small fraction of one percent on account of "bald heads." Field workers reported these white heads to be most in evidence in the counties of Ottertail, Redwood, Swift, Yellow Medicine, Chippewa, Kandiyohi, Bigstone, Stevens, Traverse and Wilkins and complaints were received from Caledonia, Stephen, Kennedy, Deer River, Milaca, Northfield, Fargo, Windom, Perham, Osseo, Faribault, Litchfield, New Ulm and a score of other localities. This work was ascribed to the so-called "joint worm" by many, while a few called it the work of the Hessian Fly. As a matter of fact while the latter named insect caused a little loss possibly this year, and a few specimens of the pupal stage of a joint worm were received, these bald heads were due to the presence, in rather unusually large numbers, of the Wheat Stem Maggot, *Meromyza americana,* and each year witnesses more or less of its work, though as a rule it is not so much in evidence as it was in 1912. One need not confuse the work of these three insects. In the first place the Hessian Fly is never found *inside the steam,* the maggot being concealed beneath the sheathing leaf next the stem, and it is in this position that the puparium or "flax seed" is found. The joint worm larva on the other hand is found, in a gall-like growth, within the stem. The slender greenish wheat stem maggot is found also inside in stem, above the upper joint. The Hessian Fly maggot on the other hand works just above one of the lower joints, for the most part, and almost invariably causes the head to fall over and rest upon the ground.

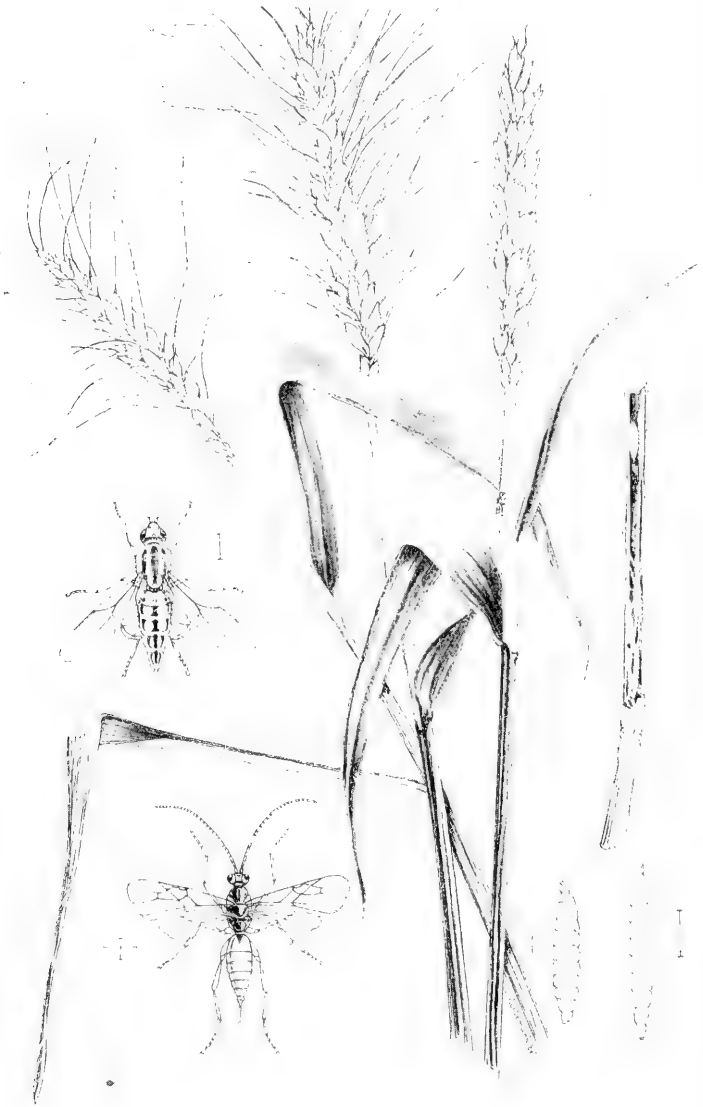


Fig. 31. Wheat infested with Wheat Stem Maggot. Puparium also shown inside stem. Maggot and puparium on right enlarged, and imago above on left enlarged. Below on left, a parasite of the Wheat Stem Maggot, much enlarged. Lugger.

The Fly which produces the Wheat Stem Maggot is much smaller than the housefly, yellowish or greenish yellow in color. It lays its eggs on the plants in the spring and after hatching the maggots enter the stem. Feeding as they do above the upper joint, sap cannot enter the heads and the latter die before the grain matures. Late in July or early in August these maggots change, within the straw, to pupariæ, from which in time come the flies which mate and lay eggs on wheat. It is also said to attack several grasses. In the volunteer grains and wild plants the maggots spend the winter, turning into puparia in the spring, the flies emerging a little later.

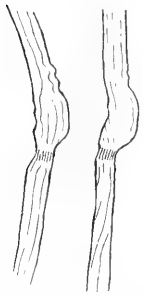


Fig. 32. Gall-like distortions of Wheat Stem caused by presence of joint worm.

Nothing can be done, of course, when "bald heads" are seen in the grain, it is then too late for action. In stacked grain the insects which are away from the surface, toward or at the center of the stack, never escape, and these perish. Hence, as regards this insect, threshing from the stack is better practice than threshing from the shock. Early threshing, say the last of July or in the first week in August, doubtless kills many of the flies. After harvesting, all volunteer plants and will stuff growing over the field and particularly along fence rows, should be plowed under. Rotate, after wheat, barley and rye, with some crop other than these grains. Corn might well follow wheat. Field men report that the injury from these insects last summer was largely confined to "Velvet Chaff" while "Blue Stem" was almost free from injury.

CUTWORMS.

Fig. 33. Cutworm, injurious in 1911. Enlarged about twice.

With the exception of a few localities no report of serious Cutworm injury reached this office in 1912, but from about May 8th to June 1st in 1911, more complaints regarding cut worms arrived in the mail than ever before and letters of inquiry came in from time to time up to the middle of June, the culmination of injury appearing the last of May, at which time letters complaining of this pest represented nine-tenths of the entomologist's mail. Reports of cutworm damage came from almost every part of the state; we note in our files communications from Sauk Center, Minneapolis, Starbuck, Windom, Fosston, Northfield, Duluth, Glenwood, Zumbrota, Mankato, Austin, Rush City, Madelia, Hutchinson and Warroad, and a host of other places, showing wide distribution. It will be remembered that cutworms were bad in 1909, much worse in 1910 and the climax appears to have been reached in 1911. We believe this to be due to the unusual dryness of those years, retarding the growth of weeds, thus forcing the worms to prey more assiduously upon cultivated crops, and being particularly unfavorable to the growth and spread of fungous diseases which in ordinary seasons undoubtedly kill large numbers of caterpillars.

We have recommended various methods of combating them. Poisoned bait, made of bran mash, sweetened with cheap sugar, or syrup, or molasses, and made decidedly green with a liberal application of Paris green, is a very good remedy in a garden. A tablespoonfull of this should be put at frequent intervals among the plants subject to attack, not, however, nearer than eight inches to the plant, for in case of rain, the Paris green might be washed against the roots, and would injure or kill the plant. Thorough cultivation is an aid; pieces of shingle or board placed at intervals over the garden serve as traps under which the cut worms hide toward morning, and can be found and killed. Frequently, the depredator will be found within an inch or so of the plant cut, buried an inch under the soil. Young plants, like cabbage, cauliflower,

etc., when first set out in a small garden, should be protected by paper, or tin collars, or a barrier of some sort, which should extend into the ground an inch or so, and two or three inches above the surface. This can be removed when the plant becomes tough enough not to invite attacks from the cutworms. On large acreages fall plowing and thorough cultivation is perhaps the most practical treatment. Cutworms are always bad the next year after sod since they normally live in sod.

WHITE GRUBS.

Every year we have to treat upon these troublesome and destructive larvæ of the well known May beetle or "June Bug" of which we evidently have two species. In 1911 we received a few

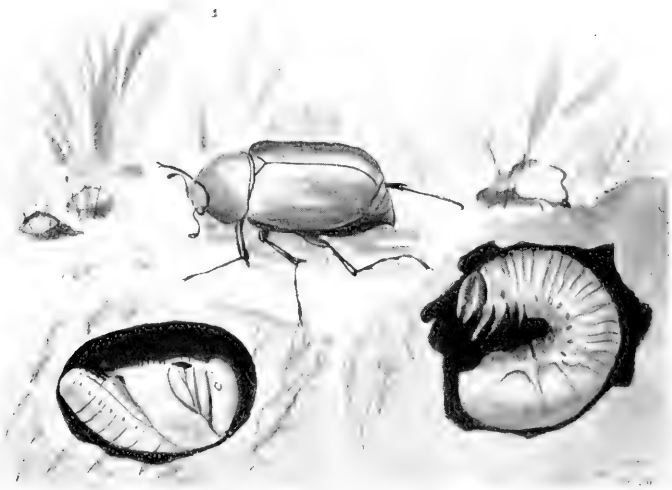


Fig. 34. May Beetle or June Bug, (Lachnosterna) showing larva or White Grub, pupa and adult. Natural size. After Linville and Kelly.

complaints of this insect, but in 1912 it was much more troublesome; in localities, very destructive, injuring corn, hay, timothy and potatoes severely. In case of corn the roots are eaten and the corn is then blown over. Timothy in many places did not produce seed as a result of the work of white grubs upon the roots. Potatoes following sod were severely injured, five or six grubs being sometimes found in one hill, and, in places, clover suffered severely. The period of the most damage in 1912 was between the last of June and the latter part of September. In the last named month, a

field assistant, Mr. Harris, found these grubs being turned over in the stubble field by the plow, "literally by the thousands." In a field of clover, containing about thirty acres, near Granite Falls about twenty acres, two-thirds of the entire piece, had been killed by white grubs. On corn the injury was even more marked. In two fields at least one-half of the corn was down as the result of its depredations. Our field worker reported the views of nine farmers as follows:

1. The grubs were much more prevalent on land which is spring plowed than that which is fall plowed.

2. They were more plentiful where horse manure has been used as a fertilizer and especially where it has been spread by hand rather than with a spreader.

3. They are found only on the higher cultivated or semi-cultivated fields away from swamps, bottom land or marshes.

4. They have never been reported in any serious numbers before.

While observations from non-scientific parties are not always to be relied upon, it would appear since the above opinions appear to be quite unanimous, that they are of value. In discussing No. 1 it may be safely said that grubs turned up by the plow in the fall would be exposed to many more dangers before spring (their period of activity) than when plowed up in the spring, and the observation therefore seems to be an accurate one, and also an *argument for fall plowing.* The beetles seem to be attracted to manure and it is natural that eggs should be deposited more freely upon lands so fertilized (No. 2) and particularly if the manure were left in small or large piles and not spread evenly and becoming quickly dry. The roots of grass appear to be the natural food of the white grub (note No. 4 above) and when sod is removed it is perfectly natural that the grub should turn to the food substituted for sod over the same area. This accounts for the fact that corn or potatoes following sod in some districts are likely to be injured. This is also true of strawberry plants if set upon new land. Young spruce or seedling spruce are sometimes attacked, particularly if in land used for strawberries the previous year. It would appear that this pest is on the increase, possibly because more land is coming into cultivation.

To be effective any treatment against this pest must be begun as soon as the first signs of injury to the lawn are observed. To wait until the grass is brown and dead is like shutting the door

after the horse is stolen. The most acceptable treatment at this date appears to consist of copious watering of the lawn where possible, accompanied by the use of some artificial fertilizer, like nitrate of soda, (from 250 to 350 pounds to the acre), thus enabling the lawn by vigorous growth to keep ahead of the grub. One should at least resort, in such emergency, to abundant watering where possible, even though fertilizer is not applied. The late J. B. Smith, State Entomologist of New Jersey, claimed to have obtained relief by the liberal use of ground tobacco stems scattered broadcast and liberally over an affected lawn, followed by copious watering. He states that grubs disappeared after this treatment. This suggests, naturally, the frequent sprinkling of lawns with a tobacco decoction. Evidently, this would have to be quite strong and used generously. We have killed them by the use of bisulphide of carbon without injuring the grass, but the process is a slow one and impracticable where large areas are involved.

After the lawn is dead in patches nothing remains for the owner to do but to re-sod or re-seed. Robins greatly aid in the extermination of the white grub, and may frequently be seen pulling them from under the dead grass. They should be encouraged in this good work. Moles and shrews eat them and we believe that skunks are also fond of them. If the grubs should be carefully removed and destroyed when brownish patches are *first* observed in the lawn their injurious work is at once stopped. They will be found just below the sod if they are responsible for its condition.

In addition to the above remedial measures, there is no question but that, in the case of injured field crops, hogs turned on to such ground as soon as the crop is harvested is one of the best methods of reducing their number, as they root out and devour them by the wholesale. Fall plowing and proper rotation are important practices where these pests are active.

THE CLOVER SEED CHALCID.

Bruchophagus funebris.

Quite a large amount of clover seed is annually harvested in Minnesota, but the possible output even with the present acreage is materially lessened through the work of this tiny, four-winged fly, whose grub, commonly referred to as "weevil", destroys the contents of many seeds which, as the result of the presence of this parasite, become distorted, dull in color and are easily crushed by the fingers, the seed coat having become very brittle; in fact, this last acquired quality is one means of detecting the presence of the insect in new seed. It is to be noted in this connection that many of these distorted and poorly developed seeds, so infested, are left behind when a clover huller is used, and while the farmer notes a decided shortage in the yield of seed, he does not see the reason for it.

In at least one section of our state the raising of clover for seed has been abandoned on account of the work of this pest, referred to, as we said above, as "the weevil," and undoubtedly the state loses many thousands of dollars and the country at large many millions as the result of its ravages.

This chalcid is undoubtedly distributed over Minnesota wherever clover is raised whether for hay or seed. We have collected it in the vicinity of the following places, Ada, Bemidji, Chatfield, Duluth, Fergus Falls, Hinckley, Long Lake, Meadowlands, Montgomery, Owatonna, Shakopee, Stewartville, Verndale, Wadena, Windom, Wayzata and in the neighborhood of the Twin Cities. For four years, the study of this pest has been an "Adams Fund" project, that is, work done under a special fund and controlled by the Federal Government. As such it belongs more properly to Experiment Station work than it does to the work of the State Entomologist, and hence we treat of it here only in a general way, leaving the report on details and results to a station publication which we expect to appear later.

The insect is four-winged, small, compact, blackish in color, and a brownish tinge on the forelegs and all of the feet. The female inserts her ovipositor into a young seed, (at the time of egg laying very soft) and deposits therein a whitish egg. The grub, after hatching, eats the entire contents of the seed, sometimes, it is claimed, entering seeds other than the one in which the egg was originally laid. The transformations from larva to pupa occur within a seed.

Plants attacked are in no way injured for hay, but it is evident that the method of handling the hay crop has a direct bearing upon the infestation of the seed crop following. Red Clover, Mammoth and Medium, and some species of Alfalfa are attacked. We have not found it on Alsike or on White Clover, nor does it apparently work on Sweet Clover.

While the chief interest was centered in an effort to discover some method by which a larger yield of seed could be harvested in Minnesota, certain ecological questions, having more or less bearing it may be said upon the practical treatment of the pest, presented themselves for solution. Therefore, the details of the work were classified under two heads:

1. Economic; i. e., methods of control.

2. Biological or ecological; under which may be included the study of food habits, oviposition, incubation period, parasitism, number of progeny from single adult, number of generations in a year, period of most abundant emergence, and of the most abundant oviposition, period of life development, and its variation if any, length of larval life, of pupal stage, etc.

As stated above the details of work and results will later probably be made a subject for a station bulletin, and it would be out of place to insert them here at this time. Briefly, however, it may be stated that from our work of several years upon this pest, we conclude that a farmer desirous of raising seed, can secure a much larger crop by cutting the hay crop preceeding the seed crop, while the heads are still green or just coming into bloom, thereby preventing the maturing of the Chalcid and the consequent attack upon the heads of the seed crop appearing later in the same field. Manifestly, co-operative action amongst farmers of a neighborhood is necessary in this work. Otherwise a stand of clover which promises well for seed may be infested from an adjoining field where the above precautionary measures have not been taken. The experiments leading to these conclusions were conducted upon one, two, four and five acre plots on farms near Wadena, Audubon, Chatfield, Simpson and Verndale, but were supplemented by very many field observations and laboratory experiments. The above recommendation applies to Medium Red Clover only, not to Mammoth Red Clover. In addition to the above recommendations we might also advise the destruction or early cutting of all volunteer Red Clover along roadsides, fences, etc., and also the cleaning up and destroying of all clover waste about the huller. It is probable that where little or no earth covers seed, the insect may emerge in

the field from infested seed harvested the year before. This would not be the case, however, when seed has been kept more than one year and is not so likely to occur when seed is drilled in.

For co-operation and kindly assistance, acknowledgements are due Mr. Herman Lentz of Wadena, Mr. Carl Billings of Audubon, Wm. Tvohy and Martin Sweeney of Chatfield, Christ. Schultz of Simpson, Joseph Jackson of Verndale. Our thanks are also due Messrs. Craig, Hostetter, Eva, LeBorious, and Ryan of Duluth, and Messrs. Reynolds, Burk, Schroeder and Anderson of Bemidji.

SOME SHADE TREE TESTS.

In the Thirteenth Report of the State Entomologist, issued in December, 1910, five injurious shade tree and timber pests were discussed, namely, Maple Borers, Elm Borers, Birch Leaf Skeletonizer, Box Elder Twig Borer and Larch Saw Fly.

Since that was written the mortality amongst our shade trees has markedly increased. This we believe has been due, in part, to the excessive dryness during the summers of 1910 and 1911, so weakening many of our oaks and other trees that they have succumbed to insect pests and various diseases much more readily than they otherwise would. A somewhat alarming feature of the trouble, however, is found in the fact that there has been found upon the dead oaks a disease somewhat akin to the Chestnut Tree Blight which is causing the death of valuable Chestnut trees in eastern states. It must be seen then that the passing of our oaks is due not entirely to the work of insects. Insect pests, however, play an important and possibly the most important part in the majority of cases, and in October of the present year, Mr. Ruggles, Assistant Entomologist, was asked to prepare a circular dealing with the more important shade tree insects. This he has done, the publication being issued from this office as Circular No. 25. It deals with the Two-lined Chetsnut Borer, probably the most important insect enemy of Minnesota oaks, the Bronze Birch Borer, the Elm Borer, (the two last were also discussed in the 13th Report), the Common Flat-headed Borer, Rustic Borer, affecting oaks, and the Thunderbolt Beetle. We reproduce the circular here in full.

Insect borers kill many Minnesota trees especially the oaks. Dead trees or entire groves left standing imperil living trees. The borers in the dead trees change into beetles much as the caterpillar does into a butterfly or a moth. The beetles fly to healthy trees

and there lay eggs in the bark. The eggs hatch into the borers which continue the destructive work.

The region principally involved in Minnesota extends over the southeastern portion of the State from Albert Lea to St. Cloud. A proportion of the trees die from disease. Many unquestionably die from insect work.

Hearty co-operation to check insect ravages is imperative. It may be voluntary if possible, or enforced by legislation if necessary. The situation is especially urgent in cities where shade trees are so desirable. Prompt preventive and remedial measures must be resorted to.

Boring insects cause most of this injury. The more important are briefly described in this circular. Some preventive and combative measures of general application are briefly stated.

The Two-lined Chestnut Borer.

Fig. 35. Two-lined Chestnut Borer larva. About twice enlarged. Ruggles.

The white, flat-headed grubs of the Two-lined Chestnut borer in Minnesota kill more oaks than any other species of insect so far discovered. The grubs make burrows beneath the bark in the growing layer. As these tunnels run for the most part across the grain of the wood, the food supply from leaf to root is cut off and next spring the tree thus girdled dies. One or two grubs in a tree would not cause death but where there are many of these burrows crossing and interlacing under the bark, the tree has no chance to recover. These burrows may occur anywhere from the base of the tree to the smaller limbs.

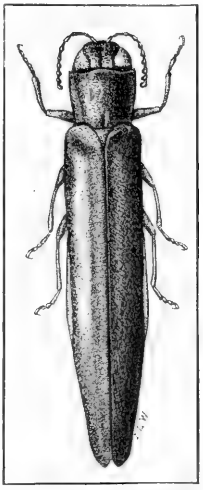


Fig. 36. Two-lined Chestnut Borer adult. About Twice enlarged. Ruggles

The adult insects are slender beetles about three-eights of an inch long. A light line runs lengthwise on each wing cover. They are found flying during the last of May, June and the first part of July. Eggs are laid at this time on the bark. They hatch into the grubs which burrow and make the mines as described. One year is necessary for the life cycle. (The period from the time the egg is laid until the adult insect emerges is spoken of as a life cycle.)

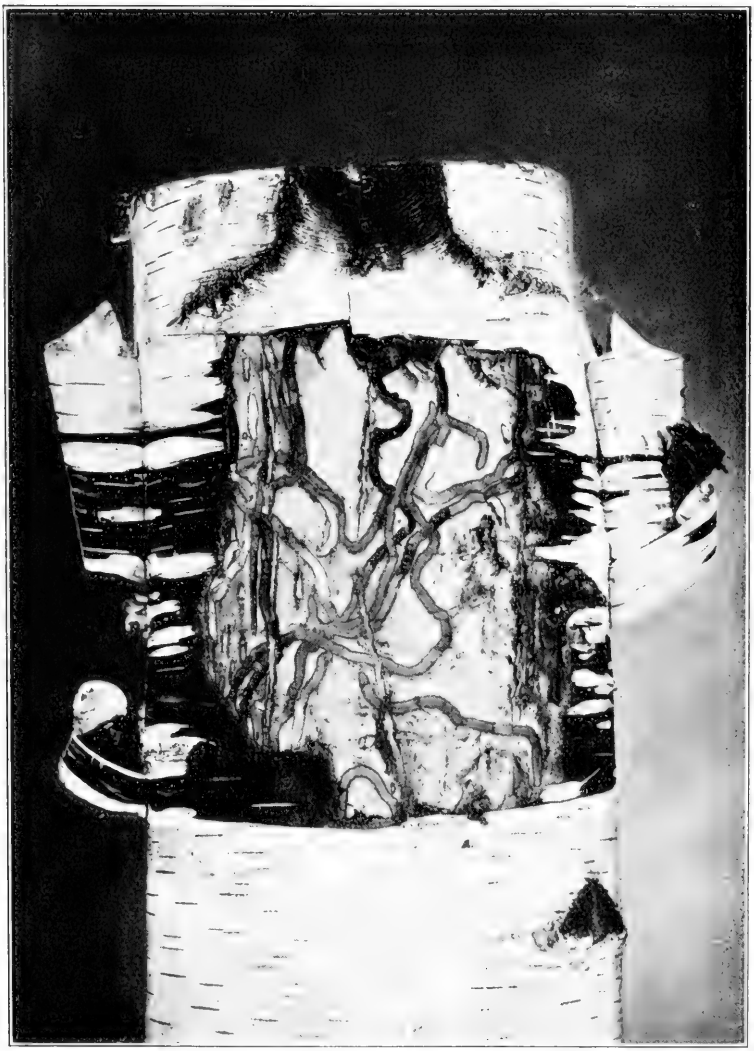


Fig. 38. Work of Birch Borer.

The Bronze Birch Borer.

The death of so many ornamental birches is almost entirely due to the work of the grubs of the Bronze Birch Borer (see Fig. 37). They make burrows somewhat similar to those made by the Two-lined Chestnut Borer. Sometimes the attack begins at the base of the tree but more often the upper branches are attacked first.

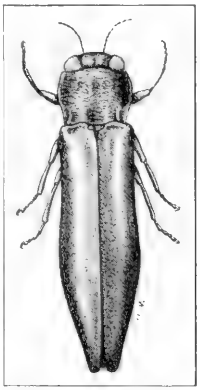


Fig. 37. Bronze Birch Borer. Ruggles.

The adult insect is a beetle about the size of the oak borer just discussed, but the body is bluish brown with no markings on the wing covers. The beetles are found flying during June and the first part of July. Eggs are laid at this time on the bark of the trees, one year being required to complete the life cycle. This insect attacks the different species of birch but seems to prefer the cut-leaf form. It also works on poplars and willows.

The Elm Borer.

The worst pest of the American elm in Minnesota is the yellowish-white footless grub of the elm borer. The presence of dead limbs and diseased areas of bark on the trunk of a tree are fairly sure signs that these borers are present. Often these signs are not noticed until the tree starts to leaf out in the spring, following infestation.

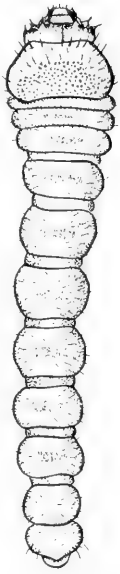


Fig. 39. Elm Borer larva. About twice enlarged. Original.

The adult Elm Borer is a grayish beetle about half an inch long. It has three narrow bands of red or orange markings across the wing covers. The beetles are found from June to August and probably eggs are laid on the bark of the elm trees at any time during that period. The eggs hatch into grubs which work beneath the surface. The first year, these grubs or larvæ work just beneath the bark and it is here that the most damage is done. The second year they work more deeply into the wood. If numerous in one region of the trunk, they cause the bark to shrink and shrivel at that place. The life history is not fully known. It is probable that it takes three years to complete the cycle.

The Common Flat-headed Borer.

The footless grubs of the common Flat-headed Borer with their large flat heads are found working just beneath the bark on a number of such trees as maple, boxelder, oak, basswood and apple trees. The adults fly during the period from May 15th to July 15th and deposit eggs in the crevices of the bark. The larval life is spent beneath the bark where the injury is done. In each instance where these grubs have been found in Minnesota, it was noticed that the infested area had been previously injured in some way, either by sun scald or by mechanical injury. The insect rarely or never attacks and kills a healthy uninjured tree.

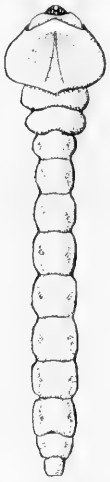


Fig. 40. Common Flat-headed Borer, larva, about twice enlarged Ruggles.

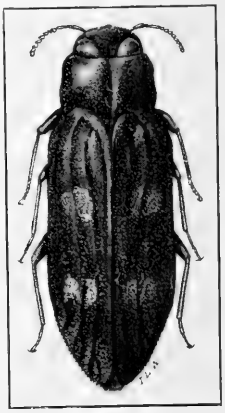


Fig. 41. Flat-headed Borer, beetle. Ruggles.

The Rustic Borer.

The grubs of the Rustic Borer have always been found associated with the Two-lined Chestnut Borer, particularly in oaks. This insect has never been known to attack and kill a healthy tree. The grubs live beneath the bark and often penetrate the wood to a depth of half an inch or more. The adult beetles are found in the spring at about the same time as the Two-lined Chestnut or Oak Borer.

Thunderbolt Beetle.

The Thunderbolt Beetle is very common. Its grubs burrow beneath the bark in the sapwood of oaks. They probably follow another insect's injury. The adult insects have been captured during the months of June, July and August. The life history is not well known.

In conclusion the following points are to be remembered:

1. The larvæ or grubs of these beetles make galleries in the growing layer between the bark and wood.

2. When these burrows are made across the grain of the wood, it is very evident that the food supply will be cut off and the tree practically girdled. The grubs of the oak borer and the birch borer work in this way.

3. It is difficult to detect an injury of this kind until too late to use a remedy.

4. A tree near a number of infested trees is quite sure to be infested although no outward sign of injury may be noted. Stripping off the bark is the only means of detection.

5. When once the grubs are at work in sufficient numbers, nothing can be done to save the tree.

6. As soon as detected that the tree is doomed, it should be cut down and burned together with the stump.

7. With some of the borers like the Two-lined Chestnut Borer, stripping the bark from the trunks and limbs would answer the purpose just as well as burning.

8. The felled trees instead of being burned may be cut into lengths and stored in closed basements where beetles cannot escape in the spring to lay eggs on other trees.

9. Valuable healthy trees in the vicinity of infested trees should, during the months when the beetles are flying, be protected by some repellant wash. This wash must have good sticking qualities and act in such a way that insects will not alight upon such a treated tree to lay eggs. As the important insects mentioned fly around during the last of May, June and the first part of July, it is at this period that the wash placed on these trees should retain its active qualities. These materials may be put on with a brush but it would be easier and simpler to apply them with a spray pump.

10. Some of the repellent washes that are recommended to be used are the following: Iron sulphide, ordinary whitewash, whitewash to which has been added one per cent of crude carbolic acid, and government whitewash. When one does not care to disfigure a tree in using the whitewash, lamp black may be added.

Iron sulphide is a fungicide and not an insecticide, but its sticking qualities, disagreeable odor and dark color make it valuable as a repellent wash.

11. As said in the beginning, co-operation among all concerned is essential. Individual work is practically useless. It is suggested that in the cities, park boards, and other boards or commissioners having charge of shade trees be given absolute authority to enter upon private property within the city limits and take the proper steps against infested trees.

Government Whitewash.

The whitewash used on forts and lighthouses may be made by slaking half a bushel of lime in warm water. Cover it to keep in the steam. Strain the liquid through a fine sieve or strainer. Add a peck of salt previously well dissolved in warm water, three pounds of ground rice boiled to a thin paste and stirred in boiling hot, half a pound of powdered Spanish whiting, and a pound of glue which has been previously dissolved over a slow fire. Dilute with five gallons of hot water. Stir well and cover for a few days. Strain carefully, and apply warm with a spray pump.

Formula For Iron Sulphide.

Lime, 10 pounds.
Sulphur, 10 pounds.
Water, 40 gallons.

Place ten pounds of unslaked lime of good quality in a barrel and nearly cover it with water. While the lime is slaking, add sulphur which has been run through a sieve to break up the lumps. Thoroughly stir it into the slaking lime, adding enough water to make a pasty mass. The barrel should now be covered, in order to retain the heat and the contents should be occasionally stirred. The time required varies with the quality of the lime. If it acts quickly, from five to ten minutes will be sufficient. If it acts slowly, fifteen minutes may be necessary. Now add a little water, stirring the mixture while it is being poured in. Add enough water to bring the total up to forty gallons. Then add three pounds of iron sulphate (copperas) disolved in about eight gallons of water.

* * * * * * * * * * *

Early in the fall of 1912 the writer sent the following communication to the press:

There is considerable alarm manifested at present over the condition of oak and maple trees, and to some extent birch and elm also. Some of this anxiety on the part of tree owners is well founded, but it must be borne in mind that toward the end of the summer, many of our trees are apt to look a little ragged,—a little the worse for wear as it were. Oak trees in particular, quite apart from the serious injury which may be inflicted by borers, are liable to a number of minor ills which though they may disfigure a tree and are sufficient to alarm the owner, are not liable to be of special importance. For instance, the oak pruner, larva of a beetle which cuts off the large twigs and smaller branches causing them to fall to the ground with leaves turned brown and withered, or which only partially broken off, hang in brown clusters among the living green, does no serious damage. In fact, the tree may be better off for a little pruning.

There are, too, several small leaf mining caterpillars which work between the upper and lower surface of oak leaves, frequently causing large propor-

tions of the foliage to turn brown and die. These causes for anxiety are for the most part unnecessary on the part of tree owners.

We believe that the very common and much to be deplored passing of some of our finest oaks and probably maple trees as well may be ascribed indirectly to the drouth of two summers ago and the unusual dryness of the early part of the summer of last year, a dryness which prevailed until late in the summer. Even after the copious rains of early autumn, as some of us will remember, a foot or two below the surface the earth was like dry sand. Manifestly, a tree not properly nourished is going to be less resistant to an attack of any kind than a tree well nourished, just as a human being with insufficient nutrition is going to succumb to disease, other things being equal, more readily than one in proper condition as regards nutrition.

Assuming that borers attack our trees every year, and they doubtless do, several on the oak and on the maple, one or more on the elm, the same on birch, the enfeebled trees succumbed, many of them last year, not a few this year, as the result of two years' attack, and partly because some of our borers require, we believe, two years to mature. Some of the trees, the condition of which are alarming the owners at present, were dead or dying last summer (1911) but their condition may not have been noticed at that time. During the year just passed such trees stood out in sharp contrast to the general dark green of the healthy growth about them.

It would seem too that the borers are not alone responsible for the death of so many of our oaks. One or more fungous diseases were found working on the roots of doomed trees last summer, and the present condition of our oaks may be due in part to a plant disease, something akin to the disease which is killing the Chestnut trees in the Eastern states.

It should lie within the province of city park boards to compel owners of real property to take care of trees which are a menace to the property of others and we believe that they should be appealed to in cases of this kind.

One can generally easily tell whether borers are at work or have worked on dead on drying trees. By removing a little of the bark the burrows of the worms and frequently the worms themselves can be plainly seen.

Our Cutleaf Birches are very apt to succumb to the attacks of the Bronze Birch Borer. This depredator, too, can be seen by removing a little of the bark from the affected portion of the tree.

It must be remembered also that leaky gas mains are frequently responsible. Many of our trees in the Twin Cities which have been dying owe their death to this insiduous cause. When this is found to be the case, the gas companies should be appealed to to repair the leak and replace the trees killed.

Where only a few branches of a tree are affected so that pruning is practicable without serious defacement, such branches should be cut off considerably below the injured portion and destroyed.

THE LARCH SAW FLY.

This, like the Clover-seed Chalcis, is now an Adams Fund project, and consequently is best discussed in detail, in an Experiment Station publication.

Mr. Ruggles, to whom this project was assigned, reported upon the work of 1909 and 1910 in the Thirteenth Report from this office, page 109. The work has been pushed as fast as possible during the past two years, and touching briefly on the results it may be said, (1) Only 1 per cent of the specimens reared from a large number of cocoons were males. (2) Young larvæ were observed the last of August, 1912, making it appear possible that there is a second generation, though no pupæ were seen. (3) In the Insectary larvæ fed impartially on American Larch (Tamarack), European Larch and Western Larch. (4) Many young larvæ in the Cloquet district were killed in the fall by some agency, possibly an early frost. (5) Large black ants (specimens not obtained by observer) were found to destroy larvæ. (6) Koochiching County, in northern part of state, bordering upon the Canadian line, appears to be the worst infested area.

THE CAMPAIGN AGAINST THE HOUSE FLY.

The campaign against the house fly in Minnesota, begun in 1909, has been actively pushed during 1911 and 1912. Some of the city dailies, notably the Minneapolis Tribune, have printed frequently "Swat the Fly" articles, pointing out the danger accompanying the toleration of flies about the house and containing common sense directions for lessening the evil.

In July, 1911, this office published an illustrated circular of information, entitled, "New Methods of Combating the House Fly." The chief purpose of this circular was to emphasize the fact that the female house fly, in its adult stage, *lives from eight to fourteen days before it begins to lay eggs*, and that if co-operative effort in a neighborhood was made to trap flies during that period, beginning early in the season, the tremendous increase of the pest resulting from continuous and unchecked breeding during the summer could be reduced to a minimum. In other words, the public were urged

to use approved fly traps, and one was figured and described which at that time was attracting much attention and proving very efficient. This was the Hodge Fly Trap, and it is Prof. Hodge's son who is credited with a remark which was perhaps responsible for this new method of handling the fly problem. In other words, it occurred to the young man that it would be much better instead of making ourselves prisoners, as it were, with screens, to trap the fly, or as the boy expressed it, "Why not put the flies in jail and let ourselves out."

Fig. 42. House Fly on lump of sugar. Brues.

In the spring of 1912, in co-operation with the State Board of Health, we prepared and printed 13,000 copies of a large illustrated poster showing the evils resulting from tolerating the house fly and how communities and individuals might successfully guard against disease from this source. These were distributed both by the Board of Health and from this office to schools, health offices, commercial clubs, hospitals, women's clubs and other organizations throughout the state, finding such appreciation that toward the end of summer the posters could be seen placarded in many public places in towns and cities all over Minnesota. Some communities started systematic campaigns against flies, resulting in more or less freedom from the pest, depending upon the thoroughness with which they were conducted. Results would undoubtedly be more satisfactory if laws were created tending to make the eradication of such insects compulsory.

In the summer of 1912 the director of the Minnesota Experiment Station felt the need of a fly trap which would capture flies in wholesale quantities without the necessity of the traps being frequently emptied. The Engineering Division of the Agricultural College was asked to construct such a trap on the principle of the Hodge Fly Trap, which in turn is an improved modification of the old fashioned traditional fly catcher of the cheap boarding house and the country grocery. The result was a trap twenty-four inches

long, as shown in our figures. Three of these traps were delivered to this Division, two rectangular, and one of the shape shown in illustrations, which by the way indicate very well the plan of construction. These traps have been given a thorough test with most satisfactory results, no difference being noted due to the difference in shape. The screen used is the ordinary wire mosquito screen, and that and the small amount of lumber required made each trap cost us forty-one cents for material. A skillful carpenter can make such a trap in about three hours or less. The upper oval part (c)

Fig. 43. Stable Flies, 10,211 caught over cow in one day. Hodge.

Fig. 44. An easily constructed fly trap. Hodge.

serves as a receptacle which the flies enter through the openings in the top of the middle portion (b) made of screen and shaped like the roof of a house. Under this is the base board (a), upon which rest two tin bait pans. All three parts are held together by the hooks at each end, as shown. Space between baseboard and middle portion (between a and b) about one-half inch, and between this and bait pans through which space flies enter pans, about one-fourth inch. Figure 3 shows a cross-section of the trap, the arrows indicating how the flies enter the bait pan and then ascend through the 10 or 12 openings above into the large receptacle. Thes contrivances were before we were aware of it, painted a dark green by the carpenter, but it appears to be no obstacle to their usefulness.

The bait is a very important factor in using this trap. *It should consist of bread and milk and frequently renewed.* That is, it should not be allowed to dry up and consequently lose its attractiveness. The flies in the upper part, or receptacle, should be killed by immersing that part of the trap in hot water or pouring boiling water over it, or in any other way devised by the user and not injurious to the trap itself. These dead flies may be emptied out of the trap, the bait renewed and the trap reset.

Fig. 45. House-fly on nipple of nursing bottle. Brues.

We append herewith the result of several different days' use of the trap illustrated. These results were reported to the Chief of this Division by Mr. Dan Nelson, an employee, who was placed in charge of the traps with directions to keep a careful record of the flies caught: Dairy barn, one day, 1,700 flies; two days, 2,000 flies; dining hall, rear of building, two days, 3,000 flies; same place, two days, 3,000 flies; same place, five days, 13,000 flies; dairy barn, two days, 1,800 flies; dining hall, rear of building, three days, 6,000 flies; same place, three days, 5,000 flies; same place, one day, 4,200 flies; on the back porch of a dwelling house not far from a stable contain-

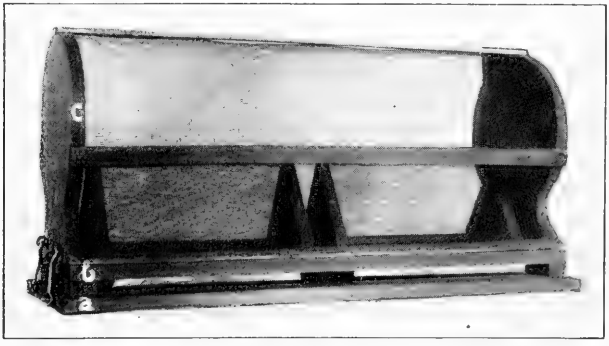


Fig. 46. The Minnesota Fly Trap.

ing a few horses, two days, 8,700 flies; same place, one day, 12,000 (twelve thousand) flies; same place, one and a half days, 18,800 (eighteen thousand eight hundred) flies.

While we wish to emphasize the importance of using bread and milk for bait, it should be noted that if anything more attractive is near by (tainted meat for example) drawing the flies away from the trap, manifestly the thing to do is to *place some of the more attractive material in the bait pans*, or add it to the bread and milk bait already in the trap.

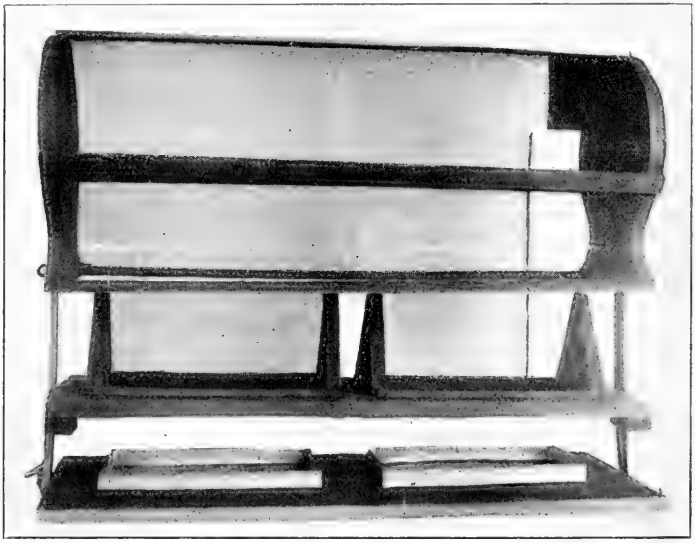


Fig. 47. The Minnesota Fly Trap, showing the three parts. The uprights at ends are not parts of the trap.

The recent statement of Prof. M. J. Rosenau and C. T. Brues, of Harvard, based on a series of experiments, that the biting stable fly, *Stomoxys calcitrans*, is largely responsible for the spread of

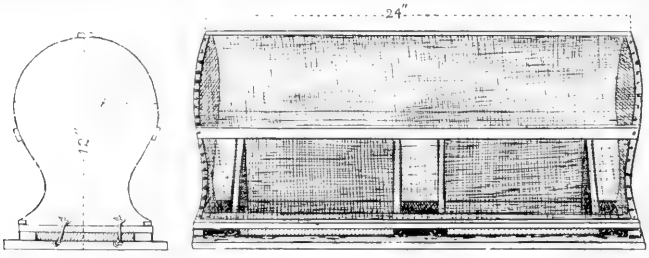


Fig. 48. Outlines of trap, showing structural details.

infantile paralysis, even though such claim may appear later to be somewhat premature, is another argument for trapping flies, destroying them before the eggs are deposited; since these eggs lay the foundation for an enormous increase of flies as the warm season progresses and a consequent increase in disease.

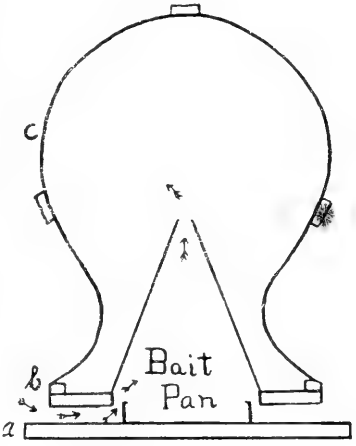


Fig. 48a. Sectional view of trap.

That the protection of garbage against flies and the quick disposal of same is most important in a campaign against the insect is shown by a report of J. H. Paine on some work along this line. Mr. Paine states (Psyche, Oct., 1912) that 22.4 per cent of immature stage of different flies found in garbage were those of house flies. In other words, garbage exposed for two weeks or longer is a menace to health.

ORCHARD SPRAYING IN 1911 AND 1912.

The results of this work are shown in detail by many tables, too voluminous to be included in a report of this nature. We append summary of results both for 1911 and 1912, as reported by Assistant Entomologist Ruggles, who had charge of these experiments. The co-operative orchard spraying both in 1911 and 1912 was for several reasons a failure in so far as any reliable results were obtained.

Summary of Apple Orchard Spraying in 1911.

"The flat orchard in the spraying experiment consists of eight rows of trees with fifty or sixty large bearing trees in each row. As said before, this orchard does not lend itself to a good spraying experiment, because the varieties are not placed in a satisfactory manner. The orchard was divided into five plots, each containing as nearly as possible the same variety of apples. One plot was left as a control or check. Three sprayings were given to each sprayed plot,—the first at the time the buds were bursting, the second just after the blossoms had fallen, and the third two weeks later.

On one plot three pounds of arsenate of lead was added to fifty gallons of 1-30 Commercial Lime Sulphur. Another plot was sprayed with three pounds of arsenate of lead added to the 4-5-50 Bordeaux mixture. Another plot was sprayed with two pounds of arsenate of lead in fifty gallons of iron sulphide. Another plot was sprayed with two pounds of arsenate of lead in fifty gallons of self-boiled lime sulphur.

In the control plot or check there was only 47.6 per cent of perfect fruit,—that is, saleable fruit. There were 17 per cent marked with curculio and 6 per cent injured by codling moth. The rest were diseased.

When two pounds of arsenate of lead were used the curculio injury was reduced from 17.1 per cent to 5.2 per cent in one case, and in another case to 5.6 per cent. When three pounds of arsenate of lead was used the curculio injury was reduced still more,—to 2.7 per cent in one case and 3 per cent in another. This shows that two pounds of arsenate of lead is an excellent insecticide against curculio, reducing the injury about 12 per cent, and three pounds of arsenate of lead will reduce the injury about 14 per cent. It is

probable that with four pounds of arsenate of lead to the spraying material the percentage of curculio injury would have been still smaller, but it is doubtful whether it would pay to use the extra pound of arsenate of lead. It is a question also whether it is advisable to use three pounds instead of two pounds of arsenate of lead, there being really only 2 per cent of difference in favor of three pounds.

The tables also show, as mentioned in previous reports, that the codling moth is not the primary pest of apples in this part of the state. Even in the checked plots only 6 per cent were injured by codling moth. It will be noted, however, that spraying reduced this to 2 per cent.

About 13,000 apples were counted in compiling these tables.

Work of 1912.

In spraying the apples in the flat orchard in 1912, the orchard was divided into three plots. One plot was a control. Three rows were sprayed with iron sulphide, and three rows, 6, 7, and 8, were sprayed with Commercial Lime Sulhpur plus three pounds of arsenate of lead. The data of times of spraying are appended.

The summary of the tables show rather interesting results. We started out in the season intending to use commercial lime sulphur plus arsenate of lead, and iron sulphide plus the arsenate of lead. After the commercial lime sulphur plots were sprayed, the arsenate of lead ran out and rather than to wait for the material to come from the cities, we started to spray the plot rows 3, 4, and 5, with the iron sulphide alone. Throughout the season, these rows, 3, 4, and 5, were sprayed only with iron sulphide. On the control plots, we obtained only 40 per cent of perfect fruit; 25 per cent were marked with curculio, and nearly 7 per cent were marked with codling moth. The rest were diseased. In the plots sprayed with iron sulphide alone, and with the commercial lime sulphur plus the arsenate of lead, the results are surprisingly similar. For instance, the perfect fruit with the iron sulphide was 63 per cent; with the commercial lime sulphur and arsenate of lead, it was 64 per cent. With the iron sulphide alone, the curculio injury was reduced to a little over 8 per cent. With the commercial lime sulphur and arsenate of lead, the reduction was almost to 8 per cent. With the codling moth, with the iron sulphide alone, the reduction was about one-half that of the control, namely, 3½ per cent.

The results are so striking that we think the iron sulphide should be experimented with next season very carefully to find out whether it is as good an insecticide as these tables seem to show.

In all about 16,500 apples were counted, 3,500 more than in 1911.

Spraying Plums.

The plum orchard on the hill of the station grounds was again divided into three plots. This year the merits of iron sulphide and commercial lime sulphur with three pounds of arsenate of lead were tried.

On April 12, two-thirds of this orchard was sprayed with commercial lime sulphur, one part; water, nine parts, and applied as a dormant spray, one-third of the plum orchard being left unsprayed, as check. On May 20th, one-third of the same orchard was sprayed with the 1-30 commercial lime sulphur compound with three pounds of arsenate of lead to every fifty gallons of the mixture. One-third was sprayed with self-boiled lime sulphur solution, 10-10-50, to which was added iron sulphate at the rate of three pounds to every fifty gallons of mixture. On June 20th, these two last sprayings were repeated, the remaining one-third of the orchard being left as control.

Brown rot was particularly bad in 1912 and the results were very good in spite of the fact that apparently there should have been an extra spraying later in the season. In all 32,640 plums were counted.

Results.

In the control or check plot (unsprayed) 31 per cent of the plums were perfect. 23.5 per cent were marked with curculio and the rest were diseased. With lime sulphur and arsenate of lead, 45.4 per cent were perfect; 10 per cent were marked with curculio; rest diseased. With iron sulphide, 60 per cent were perfect; 11.8 per cent were marked by curculio; rest diseased.

This shows that iron sulphide is not the best insecticide for curculio, but is an excellent fungicide for brown rot, perhaps the best we have at this date. Present results indicate, however, that it is nearly as good for curculio as arsenate of lead with commercial lime sulphur.

CORN BILL BUG.

This insect, first reported to us in 1910, is proving to be a serious pest in Minnesota. On June 13, 1912, we received a report from Mr. E. J. Pond at Shakopee to the effect that about twenty acres of corn on his land had been ruined by the Corn Bill Bug, *Sphenophorus parvolus*. Mr. Babcock, in charge of our insectary, was sent to Shakopee, and his report of his findings and upon the summer's work with this pest follows:

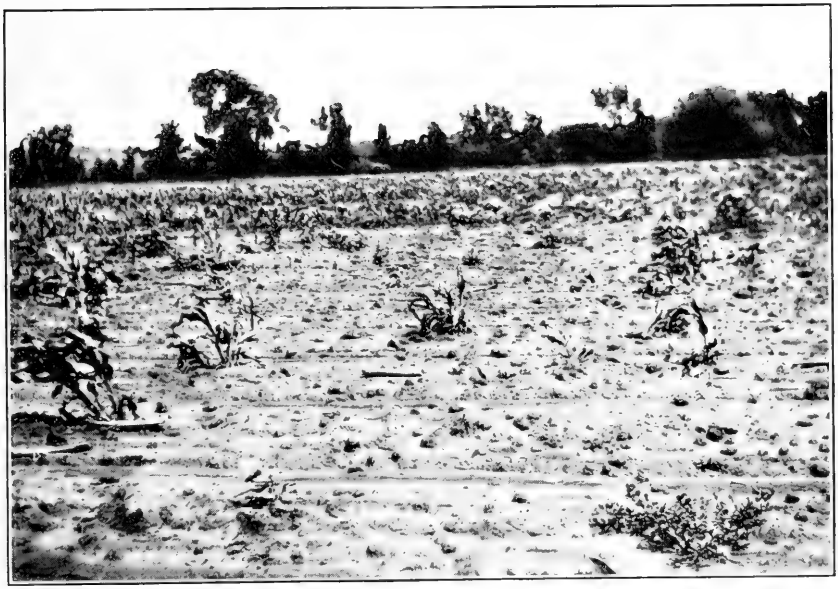


Fig. 50. A Minnesota corn field (about 20 acres), practically destroyed by the Corn Bill Bug. Babcock.

"Upon looking through the breeding cage records, reference was found relative to the corn bill bug for 1910. The injury was caused at that time in the above named locality. The record as entered by Mr. Spooner is as follows: 'The field had been cultivated for forty years. Previous to 1910 almost the entire corn field had been covered by high water from time to time, thus furnishing an ideal condition for the existence of this pest. In the spring of 1910 the field was planted to corn and wheat, the wheat being more severely attacked.' In the spring of 1911 the field was plowed to wheat and corn, the wheat being all destroyed except about half an acre. On June 9th the corn showed evidence of attack in practically every hill.

On July 5, 1912, I made an investigation to determine the extent of the damage and its probabilities in the future. The field was planted to corn in the spring of 1912. Out of 25 acres of corn at least 20 acres were practically ruined. The beetles were so numerous that they could be seen traveling over the surface of the ground from place to place, but two days later only two

beetles were observed moving about, while some of the others were secluded in moist places, and still others feeding. The reason for this is probably due to the fact that on July 4th it rained, but during the four days following the sun dried the surface of the soil. It must also be noted that this pest thrives best in low bottom land where there is more or less moisture. There were hills of corn here and there that survived the attacks. The highest number of beetles observed attacking a single hill of corn composed of three stalks were thirteen. There were several ears of corn scattered over the field and more or less buried in the soil. In every case beetles were observed feeding upon the kernels of these ears of corn. The highest number of beetles observed feeding upon a single ear of corn were 43. However, the average number was about ten. Mr. Spooner stated that he observed evidence of the corn bill bug injury as late as June 9th.

The spring of 1912 was late and this fact I believe is the real cause why similar injuries were observed during the first part of July.

The injury to the grain crop is not when it is well up, say 18 inches high or more, but it is all done when the corn or wheat is just coming up. The ground is barren and the over-wintered adults are hungry; hence, as soon as the young corn or wheat appears the beetles leave the native sedge and attack the more tender and attractive foliage.

Fig. 51. Details of injury to corn plant, before and after unfolding of first leaves. Babcock.

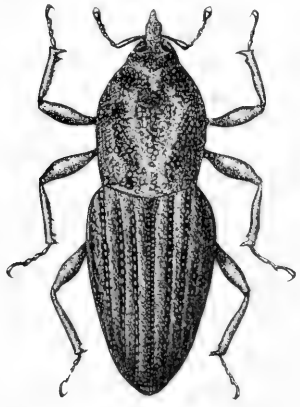


Fig. 52. Dorsal view of *Sphenophorus parvulus*. Original.

The method of attack is thus; The tender shoot is discovered, the pest climbs upon it, turns itself upside down, that is, head down and body up parallel to the shoot. The claws grasp the shoot firmly; with its beak against the shoot the pest eats a round hole into and often through it, which is only one-eight inch or less in diameter. While eating the head is kept moving a little from side to side and backward and forward, sometimes a very little and sometimes a great deal, enough so that in place of a round hole it would sometimes be a long narrow and deep slit. In no case did I observe in green foliage a hole to be deeper than the full length of the beak, however in kernels of moist corn where several beetles were feeding, the entire contents of the kernel would often be eaten out. Where two or more punctures to a single shoot was made, the plant was sure to die. This is when the real damage is done. In most cases, the punctures were made from one inch above the soil to at least three-eights of an inch below the surface of the soil.

From observations made in the field and at the insectary the beetles were found to feed upon the tender shoots, but during bright, sunshiny days, the

shoots were attacked at the surface of the soil and below. On old plants, say 18 inches and up, beetles were found, in rare cases, feeding a few inches above the soil, and they were always found in greater numbers on the shady side even on very young shoots.

On the 11th of July, copulating was quite general all over the field but I was unable to observe a single specimen deposit an egg either in the field or in the insectary.

A survey of the land adjoining the cornfield was made. On the east side was a creek and many trees, to the south was a meadow of wild sedge and red clover, on the west were weeds, shrubs, trees and the Minnesota river, to the north lay a small strip of land that was cultivated in 1911 but left untouched during 1912. Some wild sedge was growing here and there in the last named field. A few beetles were found feeding upon the sedge south and north of the field, but no larvæ could be found.

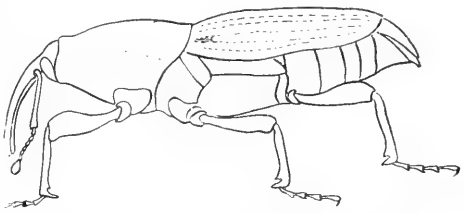


Fig. 53. Side view of *S. parvolus*. Original.

Over 150 adults were brought in to the insectary and kept in four large shell vials for seven days. No copulating was observed nor any eggs to be found but on July 18th, forty vials were used, four beetles in each vial. In about ten minutes two adults were observed in coition. The next day several pairs in coition were noticed. On July 20th, one vial contained three eggs and another one egg. These eggs are small elliptical and pearly, of about 1-16 inches in length. They were probably all infertile for I was unable to obtain any young.

In the insectary and in the out-door cage the corn bill bug was observed to feed upon corn, wheat, oats, barley, timothy, foxtail, and wild sedge, but I have never noticed it to feed upon any plant other than a grass or a sedge.

As late as October 15th, larvæ and *adult beetles* were found. The larvæ in every case were found on or partly in the inside of a bulbous root of the sedge, the open end of the cell being extended into the soil a short distance by silken threads mixed with soil particles. From this it is very probable that the corn bill bug passes the winter in two stages, one as larva in the bulbous root of the sedge and second as an adult in rubbish and other sheltered places.

Summary.

The corn bill bug is a snout beetle and varies from five-sixteenths to six-sixteenths of an inch in length, and is of a blackish color, with a few parallel lines, indented with pits, running lengthwise on the back. The beetles hibernate over winter in the adult stage, seeking shelter under grass, rubbish, in the soil and other suitable places. The larvæ also probably pass the winter in the bulbous root of the wild sedge, as they have been found as late as October 15th, the time this article was written.

In the spring the adults attack the wild sedges and grasses until the wheat, oats, timothy and corn start to come up, when they attack the tenderer and more palatable food supply. Egg laying takes place in late spring and early summer, the time varying according to the season. So far as known in Minnesota, there is only a single brood in a year.

Areas growing sedges or rushes, or any grass crop infested with the pest, plowed under in the spring and planted to corn, timothy, wheat, oats barley or rye is almost sure to be attacked. Since this insect attacks only grass crops, so far as is known, and the adults pass the winter under grass, weeds and in the soil, a preventive is suggested. Late summer or early fall plowing of grass land intended for corn the following year will probably destroy most of the beetles. It would be far better however to sow the field to some other crop than a grass or grain crop, instead of corn, as for instance, potatoes, tomatoes, beets, cucumbers, etc."

It is well to record here the occurrence last summer, 1912, of another "bill bug" larger and more robust than the one above described. It can evidently be referred to *Sphenophorus ochreus*.

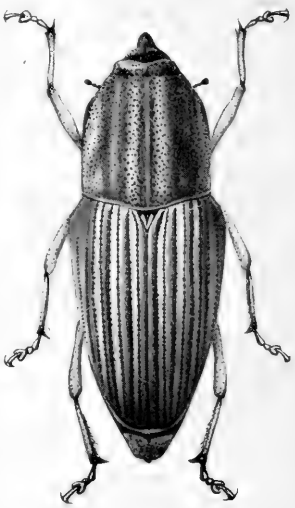


Fig. 54. *S. ochreus*, dorsal view. Original.

We received specimens of this insect during the summer from a farmer who complained that they were "killing his chickens." These beetles have very sharp claws, and when seized by chickens they probably scratched and perhaps bit the fowls in the soft parts about the mouth, being quite able, on account of their size and strength, to draw blood and cause some distress to the fowls so afflicted. A little later, July 11th, one of our field men discovered this same beetle causing considerable damage to wheat at Redwood Falls on the farm of Mr. Winn. He reports as follows:

"I noted the following conditions: Damage may be done in either or both of two ways depending upon the stage of plant growth at which the insect first attacks the wheat. In the first case, where the insect attacks the wheat before it has 'headed out,' the weevil's attack is made by slitting the stem and feeding upon the inner portions of this stem; in such cases when the head appears it is white and without substance in the berries. When the attack is made later and after the head had opened the weevil simply feeds upon the berries of the wheat while still in the milk. Its position in feeding is characteristic,—it forces its way down among the 'beards', head downward, clinging to the beards or spines and eating through the "husk" feeds at leisure upon the soft grain. To escape capture or to change its feeding place it backs up the spines until free.

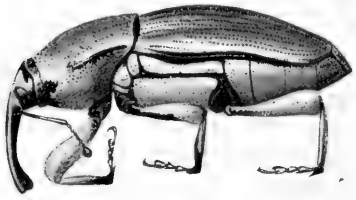


Fig. 55. *S. ochreus*, side view. Original.

All the damage which I have noted has been upon Velvet Chaff, a bearded wheat, while the Blue stem, a smooth or beardless variety was left notably untouched. Referring to map herewith attached, it will be noted that this first field examined, which was typical of others noted, is in large part a low tract of land, which in the meadow "A" is a rather marshy spot "a." The whole tract "B" is "Velvet Chaff" and throughout this we found the weevils present in large numbers—as many as three or four insects were found on single heads of wheat. The tract "'C" which is exactly similar as to soils and drainage is of "Blue Stem" and yet here although there is no interval between the fields (not even a ditch or furrow) we found none of the weevils. But another fact enters here which may have some significance although this is as yet uncertain; the tract "D" is also of "Blue Stem" but here we found a very few of the weevils in the low ground at "d." Upon my inquiry I learned that "B" and "D" were both plowed in the Fall

while the tract "C" was plowed in the Spring. It appears possible that this spring plowing may have affected the pupæ at a critical period and thus accounted for the absence of the weevil.

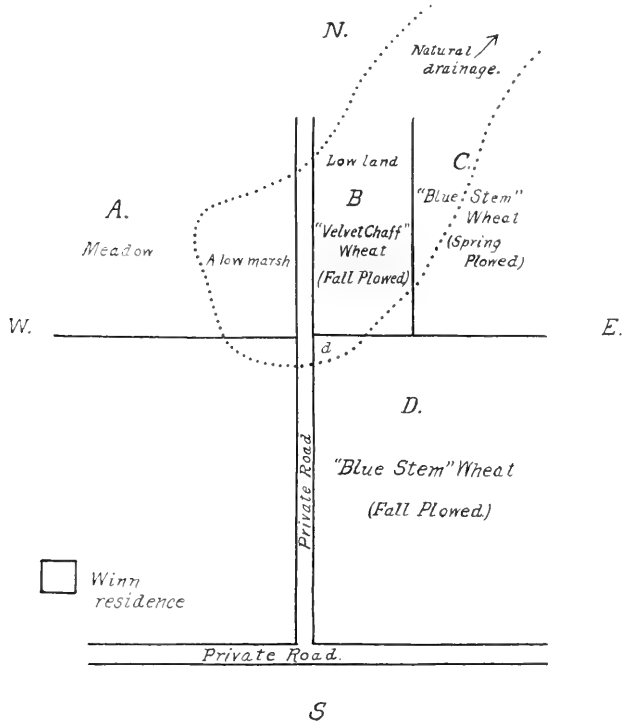


Fig. 56. Plan of wheat fields injured by *S. ochreus*. Somes.

This species of Sphenophorus, I have found rather sparingly in Iowa, and the southern parts of Minnesota during the past year, but never in large numbers such as were here presented. I may say that within a space one rod wide and three rods long, we picked over 100 of the weevils and some others escaped. I have always heretofore found the insect in low ground and associated with the "common rush" (Scirpus) of such marshy habitat. In the more southern states, it has been known to attack corn, but so far as I know, this is the first instance in which it has been known to attack wheat. The damage will doubtless be local and confined to fields in low ground such as the one here considered. Methods of control which suggest themselves are the planting of some less attractice crops on these low fields, such as flax, potatoes, beets or rape; drainage of the areas and possibly spring plowing and the thorough cultivation of the field."

A FEW HOUSEHOLD INSECTS.

This department has continued its practice of publishing circulars for free distribution from time to time, and among others three have been issued during the 1911 and 1912 biennium upon "Household Insects." These contained illustrated articles on Fleas, Bedbugs, Cockroaches, Carpet Beetles, Mosquitoes, Ants, "Silver Fish," Crickets, etc., and are in part reproduced herewith.

BEDBUGS.

Cimex lectularius Linn.

No housekeeper or landlord possessing any degree of pride is going to allow this disgusting pest to obtain a foothold upon his or her premises. Unfortunately its entrance into a house or hotel cannot always be foreseen or prevented; travelers coming in contact with people of careless habits, and occupying rooms, or berths in Pullman cars which may be infested are likely to carry this unwelcome pest either to another hotel or into one's own home, where the mere suggestion of "bugs" drives a housekeepr to desperation. To the credit of the sleeping car companies it may be said that sleeping cars appear to be surprisingly free from infestation, due probably to their process of cleaning.

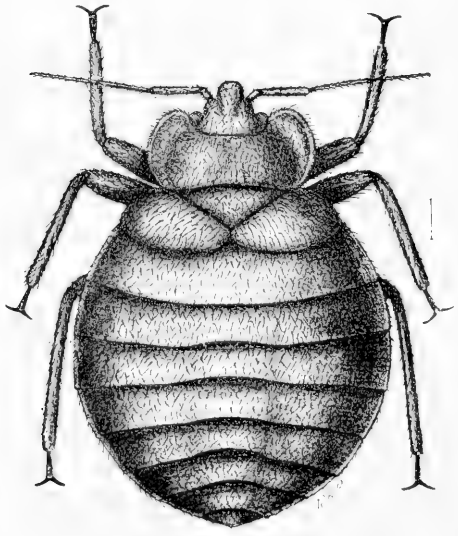


Fig. 57. Adult Bedbug, enlarged. Lugger.

Then, too, servants coming into a house or hotel from no one knows where (frequently from cheap lodging houses) sometimes bring the pest with them. They may be, as is the case with some people, absolutely indifferent to the presence or bite of this insect, and therefore, the bugs increase unmolested in the ser-

vant's quarters, until some day the housewife, not dreaming that the house is afflicted, is dismayed to note their presence in one or more rooms occupied by the family.

Life History.—The bedbug belongs to the order Hemiptera, the family Cimicidæ, and is a true bug. The accompanying illustration may give one an idea of the insect, which is pale yellow, more or less translucent, or brownish, or mahogany color if filled with food. It may show different degrees of red, depending upon the amount of blood it has absorbed. Like other true bugs, it feeds by inserting its beak-like proboscis through the skin, and as is very apparent, may well be the cause of infecting a human being with an infectious or contagious disease, the germs of which it may have obtained from a previous victim.

That bedbugs can go a long time without food is a well known fact (one is recorded as having been kept alive in a bottle for a year without nourishment) naturally losing color as the result of prolonged fasting, and even migrating, it is said, from one dwelling left unoccupied for some time and, in consequence, foodless, to another house, where the presence of human beings promises an abundance of nourishment. Fortunately for those of us who are obliged to travel considerably, these bugs are not active in winter. Associated with man, practically everywhere in the world, they have from time immemorial, apparently, regarded him as their special prey, not only to feast upon, but also to be avoided at times when he is awake, for they are strictly nocturnal in their habits, scurrying to their places of concealment in cracks or crevices of bedsteads, walls, mop boards, and the like, and under torn wall paper, at the coming of daylight. Depressed in shape, they are especially adapted to crawling into narrow cracks, and between two flat surfaces quite closely opposed.

Fig. 58. Eggs of Bedbug. Enlarged. Lugger.

The yellowish, white eggs, varying considerably in number (from six to fifty some writers state) are laid in cracks on bedsteads wainscoting, mop boards, under torn wall paper possibly, and wherever concealment is offered. These eggs hatch in about a week, and the cycle from and including the egg stage to the adult is said to be about seven weeks. Young and old have the offensive "buggy" odor,

shared by many others of this order, which odor is always indicative of their presence, even if one cannot see them. Personally the writer believes the odor of carbolic acid in a bed room to be quite as offensive as the bedbug smell, for the former odor advertises the fact that bugs are or have been present, and at once fills the guest with alarm, whereas in its absence he might remain peaceful in imagined security until he retired for the night.

It is believed that these bugs must at times get at least some nourishment from the moisture in newly felled logs, used while green in building log houses, but it must be borne in mind that there are bugs closely resembling bedbugs, and frequently believed to be the same, and yet not the real bedbug, found in cottonwood logs. So firm is this belief that the writer has had Westerners (Montana and Dakota residents) declare that they were absolutely sure of the identity of the bugs, and dared him to prove to the contrary. These insects, while quite close resembling the bedbug, belong to a different genus and species. Another species commonly taken for a genuine bedbug occurs sometimes in the nest of barn swallows, another on bats, or rather, where these animals "roost." According to Marlatt, species closely allied to the real bedbug, but not the same species, occur in England, one in pigeon lofts, another in martin nests, and the third in locations frequented by bats.

Remedies and Methods of Prevention.—The old proverb, "an ounce of prevention is worth a pound of cure," is applicable here. A housekeeper, either in a private house, or in a hotel, lodging house, or boarding house, should be extremely careful not to have any brought into the house, or at least, if suspecting their entrance, she should make heroic efforts immediately, before they become numerous, to eradicate them. Wooden bedsteds should be dispensed with in houses likely to be subject to bedbugs, and metal ones substituted.

Once well established in a house they are very hard to eliminate. This is particularly true, for obvious reasons, if a flat is infested. Fumigation with formaldehyde is hardly to be regarded as satisfactory. The same might be said of burning sulphur candles, though the latter, barring the unavoidable tendency to tarnish metal noted in the use of sulphur will, if used at sufficient strength, and for a long enough period, kill most or all of the bugs which are reached. Since some may not have come in contact with the sulphur fumes, and since the eggs may not have been destroyed by the first treatment, a second or third application would be necessary in bad cases

of infestation. The candle, or candles (for this remedy calls for a heavy dose of sulphur) should be placed in a metal dish, and this dish in a much larger vessel containing water, thus taking all precaution against a boiling over of the burning sulphur, and setting fire to the carpet. Close all apertures, including the keyhole, set fire to sulphur and shut the door, leaving the room closed for five or six hours. All metal such as nickel or brass, or silver (or gilt) will be tarnished if exposed to the fumes of sulphur, and should be removed from the room before the operation, or coated with vaseline.

Other more radical treatments are those of fumigation either with bisulphide of carbon or with hydrocyanic acid gas, the latter so dangerous to human life that it should only be used in extreme cases and under the direction of a practical entomologist, familiar with its dangerous properties. In fumigating with bisulphide of carbon about one pound of the liquid for every 1,000 cubic feet of space should be the proper proportions, placed in flat dishes, earthenware, crockery or wood. The operator should avoid breathing the fumes arising from this compound, and as this gas, when mixed with air, is highly explosive no light of any kind should be brought near the liquid, or into the room which is being treated until such room has been thoroughly aired. As bisulphide of carbon tarnishes, as it volatilizes, all metal, nickel, gilt, silver and the like should either be removed or covered with a coat of vaseline which will protect them. Close the room or rooms tightly for forty-eight hours, then open and ventilate. As the fumes coming from this compound are not only disagreeable, but also when breathed to any extent, cause sickness which might even, in extreme cases be fatal, the house should be vacated during treatment, and where one house of a duplex, or a "flat" is infested, there are serious objections to this method.

This division has found the following solution very effective: Corrosive Sublimate, 1 oz., alcohol, ½ pint, turpentine, ¼ pint, thoroughly mixed. Spray this into cracks and crevices on bedsteads and elsewhere where the bugs may be secreted. Two or more applications at intervals of two weeks may be necessary. If an atomizer cannot be obtained use a feather, or very fine brush. Label the compound *POISON,* and keep it out of the reach of children.

An old remedy is as follows: Spray joints and cracks with equal parts of kerosene and turpentine, then fill all cracks so treated with hard soap.

To make them leave a bed at least temporarily, the following is proposed. We have never seen this tried, and do not speak of it

from personal experience: Saturate cotton wads with oil of pennyroyal and place in various places about the matress.

This suggests the possibility of protecting one's self when obliged to sleep in a bed suspected of being "buggy," modyifying the method by putting a little oil of pennyroyal on one's body. The writer has secured immunity from fleas during the night by anointing his body with spirits of camphor. This might be effective with bedbugs also.

COCKROACHES OR "CROTON BUGS."

Ectobia (*Phylloderma*) *germanica.*

This pest is distributed practically over the entire globe. While it is not as obnoxious as the previous two insects in that it does not, like those, attack man personally, yet its presence in or about food is sufficient to elicit expressions of disgust from any but the most callous. The species under discussion is only one of several but it is the only one to be considered here in that it is the species which is most annoying to housekeepers of this section.

It is brownish in color, with two darker stripes on thorax, the adults furnished with thin wing covers under which are a pair of true wings. In the younger stages it is wingless. The adults are rapid runners, and both old and young are lovers of darkness, and quickly hide in cracks and crevices at the approach of light. The opening of a drawer or a cupboard in the daytime often send them scurrying away to more secure retreats. The female, which like the adult male, is a little over half an inch long, may frequently be seen dragging about behind her the oblong egg case, quite as long as she is. This case is packed full of eggs, and in a short time the eggs hatch, each egg case or capsule giving rise to a large number of young roaches.

It is claimed that this particular cockroach requires from four and a half to six months to reach maturity. It feeds upon all kinds of starchy food, is frequently a great pest in bakeries, and at times startles the patron of some restaurant by scuttling across the table under his very eyes. It is, therefore, one of the most obnoxious and disgusting of pests, even though it does man no direct harm.

Remedies and Methods of Prevention.—The cockroach has evidently, like the bedbug, learned discretion in its attitude toward man, and is extremely wary and on its guard against all poison baits. Once thoroughly established in a dwelling it is extremely dif-

ficult to eradicate. Particularly is this the case when it has taken possession of a flat or hotel, where, by running along the water pipes, it can avoid danger, traveling from room to room or from house to house.

This Division has tried various traps, and practically all the proprietary remedies, besides certain poison baits of our own invention, only to find that almost any remedy is useless as soon as this insect realizes, as it appears to, that it (the remedy) is aimed toward its extermination. We find, however, that they are frequently caught in small numbers in the Hodge Fly Traps.

Perhaps the most important advice to offer in connection with this insect is that the housekeeper should *at the very first appearance of the pest, begin a war of extermination immediately.* Every day of delay means a probable increase in the ranks of the enemy, and, as stated above, when once well established, it is a Herculean task to eradicate them. A careful and painstaking housekeeper, therefore, who aims at cleanliness in pantry and kitchen, has the advantage over one of more easy-going habits.

Powdered borax in some form appears to be the chief agent to be used against them, and probably forms the base of the well advertised and rather high priced roach powders.

A private house badly infested, where the housekeeper followed the advice of this Division, was completely freed of the pest by a faithful and continuous use of powdered borax. This was scattered along the mop-board in the kitchen, about cracks and crevices wherever they occurred, in kitchen drawers, about the water piper, kitchen sink, etc., every evening after the day's work was finished, and continued for about a week.

We, and others, have found that a compound known as "Hooper's Fatal Food," carried by druggists, is probably the best remedy for the cockroach evil, if its use is persisted in. It comes in flat cans, and should be dusted liberally and frequently in places where these insects occur.

ANTS IN HOUSE AND GARDEN.

The few species of ants found in this state constitute a very small fraction of the ant fauna of the world, represented as it is by probably nearly or quite 4,000 species, 2,000 or more of which are already known.

All or our common ants swarm at the mating season, at which time the males and females are winged, losing these temporary ap-

pandages later. The true fertilized females, or "queens" are the egg producers in a colony and it should be noted in seeking measures of relief, that unless these queens are killed, the colony goes on increasing in numbers, no matter how successful one may be in killing of the workers or imperfect females. The grubs hatched from the eggs are helpless and cared for by the workers, but the small white bodies one sees being carried about by the workers when a large ant hill is broken into, or a colony uncovered, are not, as a rule, either the eggs, or their grub, but cocoons spun by the grubs, and enclosing the pupæ. These are the precious burdens which the ants, terrified by the catastrophe to their dwelling, first seek to carry to a place of safety.

Ants are very persistent in their food-seeking instinct, as many a housekeeper has had occasion to observe, and yet frequently the casual observer in a garden misjudges these insects, thinking they are injuring a plant or a tree when they are really doing nothing of the kind. For instance, the ants seen on peony buds rarely if ever bite into the bud itself, but are attracted to it only on account of the covering of "varnish" over the bud, which is to their liking. Again, one frequently sees ants ascending snowball bushes, fruit trees, and various garden shrubs. These ants are not injuring the shrubs or trees frequented, but a little search on the part of the observer will disclose numerous colonies of plant lice on the tree or shrub in question, busily engaged in sucking sap through the bark or leaf. These plant lice give up to the ants a sweet liquid, elaborate within their bodies, referred to sometimes as "honey dew" of which the latter insects are very fond. In fact, so fond are they of this exudation that they take every means in their power to protect these creatures, which may be justly regarded as the ants' "cows." At least one form of plant lice is so well appreciated by one of our small species of ants that the latter take the eggs of the former into their burrows at the approach of cold weather, and bring them up again in the spring. Indirectly, then, by conserving injurious insects, the ants *do* injure our trees, shrubs and plants. For that matter the writer has seen a large snowball practically girdled and finally killed by large black ants. Further, our lawns and fields are sometimes disfigured by large mounds made by one or more species, and even the small red ant may be a serious nuisance, though in a lesser degree than the first named, when its nests get exceedingly numerous in grass or in the flower bed.

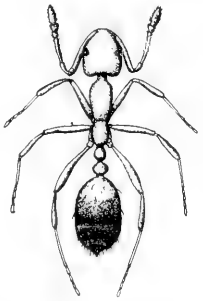


Fig. 59. The Small House Ant, *Monomorium pharaonis*. Enlarged. Original.

It is in the household, however, that ants cause the greatest annoyance, mostly confined to the larger species which, *though nesting outside, sometimes find their way into the house,* and to the very minute red ant, *Monomorium pharaonis,* which usually does not nest outside, but starts its colonies in some warm location within the house. Ants are frequently found in bee hives, seeking such locations partly, we believe, for the warmth, and partly attracted by the honey. Ordinarily, however, in such situations they do little or no harm, for a good colony of bees can easily protect themselves and annihilate the ants if they become too numerous.

Remedial Measures.—The housekeeper's fight against ants within doors can be classified under two heads, first, protecting food material from their attack, and second (and far more satisfactory), destroying the colony or colonies, including the queen or queens, and thereby putting an end to their depredations. Under the first head we list, (a) the old remedy of scattering powdered borax about the shelves; (b) the placing of the legs of the refrigerator, or of the table or cupboards holding food in pans filled with water covered with kerosene; (c) placing a sponge or sponges full of sweetened water upon shelves frequented by ants, and when they are covered with these insects, dropping them into boiling water, and repeating the process; (d) poisoning syrup and molasses with an abundance of Paris green or arsenic, and placing it in shallow dishes in places frequented by the ants; (e) *a saturated solution of alum applied over shelves with a brush and allowed to dry, appears to leave a deposit which is obnoxious to the ants, and they avoid it;* (f) another poison said to be effective consists of 1 part powdered lead arsenate (probably ½ part of arsenic, or less, would be equally effective) mixed with five or six parts of honey; (g) oil of pennyroyal on wads of cotton, said to be effective in driving away; (h) removal of the special food which appears particularly attractive. One would have to exercise care in using the above poison baits, for if children or others ignorant of their nature should have access to them very serious results might follow.

However, all of the above, while remedial in their nature, fail frequently, to bring permanent relief, in that they do not reach the queen in the ant nest, and the numbers of the ants continue to in-

crease until she is destroyed. Therefore, it is of the greatest importance to seek for the nest, out of doors in the case of most of the species entering dwellings, but usually indoors in the case of the very small ant, almost microscopic in size, known as *Monomorium pharaonis* which, if it once gets a foot-hold in a house, is very hard to eradicate. In case of infestation by this species, find the nesting place, which, by the way, may be in a warm spot in the cellar, perhaps between the stones of the foundation walls, perhaps back of baseboards or other protective matter. When *absolutely sure* that the nest is found, try first squirting with oil can or syringe such liquids as kerosene, or bisulphide of carbon (gas explosive in presence of artifical light of any kind other than electric bulb) in an effort to wet the queen with kerosene, or kill her with the fumes of the second named compound. Bisulphide of carbon, by the way, has a most disagreeable odor, is very volatile, and the gas, if long inhaled, may cause sickness or result even more seriously if an individual is exposed to the fumes for any length of time. Gasoline might be used in place of kerosene, bearing in mind its dangerous nature. In case of failure with the above agents one must resort to either freezing (if conditions favor this process) or fumigation with hydrocyanic acid gas. Our experience in ridding a private house in Minneapolis of this pest, where it had been established and a great nuisance for eight years, may be helpful.

We first traced the ants to their nest in the walls of the furnace cellar, and tried injecting kerosene, gasoline, bisulphide of carbon into the crevices between the stones where the ants entered. This did not meet with perfect success, so in the middle of winter, with the family out of the house, we fumigated with the deadly gas known as hydrocyanic acid gas, and afterwards by opening all the windows, secured a temperature in the house something like 4 degrees below zero for three or four days, and the ants have not appeared since, although four years have gone by since the treatment. This, as will be seen, is heroic treatment, but sometimes the exigencies of the case demand it.

Sometimes some of the sticky "tanglefoot" mixtures, which can be brought in bulk quite cheaply are useful when applied to the outer side of foundation wall, in keeping out various kinds of pests which, normally outside, sometimes overrun a house. A three inch band of sticky tanglefoot of the right consistency applied with a brush would form an effectual barrier. As long as this is kept sticky no ant or other insect can cross it.

Ants in Lawn or Garden.— The large mounds out of doors, each of which is occupied by hundreds of ants, can be easily treated with bisulphide of carbon. Make eight or ten holes with a cane or croquet stake, about eight inches deep, in each mound. Into each hole pour a good tablespoonful of bisulphide of carbon, closing each hole with earth, and then throw a couple of wet burlap sacks over the hill, leaving them over night. One might have to do this twice possibly; or, in other words, until the queen or queens are killed. Where no mounds are present and there are only a few small hills, say three or four or five or six holes, a different method is advisable. We find that by pouring gasoline into the holes of such small colonies we can stop their work, using from half a teacupful to one teacupful when from three to six holes are involved. We frequently have to make applications at intervals of a few days, and sometimes even three are necessary. Do not be afraid to use plenty of gasoline, in order to reach the queen or queens which lay the eggs. This liquid, however, will kill grass or plants where it comes in direct contact with them.

The small and very common red ant which makes tiny hills on our walks, lawns and in flower beds is sometimes a nuisance. It can be destroyed by pouring a little gasoline into each hole; this, however, is a big job where they are numerous and is hardly worth while unless they are extremely troublesome. When ants are girdling a snowball or other shrubbery, we first have recourse to strong tobacco water to see whether we can drive them away. If they still persist in eating the bark, we advise uncovering the crown and larger roots, mixing up arsenate of lead with a little water, and applying it as thick whitewash to these parts. Arsenate of lead is a poison, which, however, applied in that way, would not injure the bush. Wood ashes placed around base of bush will sometimes drive them away.

THE SILVER FISH.

Fig. 59½. A "Silver Fish."

The illustration accompanying this article gives a good idea of the appearance of this insect, which, at times, is a pest in households. About half an inch long, silvery-white in color, almost fish-like in shape, quick in its movements. It is sometimes seen rapidly scurrying about among unused books on shelves not often disturbed, and in bureau drawers where clothing is stored. It belongs to the lowest order or group of insects, which ordinarily furnishes us with but few, if any, insect pests. Sometimes, however, the silver fish not only injures books, but also has been known to injure rugs made of silk, and evn destroy silk dresses by eating holes in the same. It also eats holes in wall paper in seeking the starch or glue beneath it. These injuries are brought about apparently by its appetite for the glue and starch used either as sizing in cloth or paper, or in the binding of books.

Remedies.—Careful housecleaning in severe cases should help in eradicating or lessening the number of this pest. Dusting shelves and drawers generously with Pyrethum (Persian Insect Powder, Buhach, Dalmation Insect Powder) would be beneficial. The insect should be killed whenever individuals are met with, and it should be borne in mind that frequent handling of starched and silk clothes will tend to render the goods so handled less likely to be attacked. Since they are fond of starch, the poisoning of starch with an abundance of arsenic, smearing the same on pieces of cardboard, and placing these poisoned baits on shelves and drawers where the insects are known to occur, presents an effective means of reducing their numbers. A similar poisoned bait prepared with glue in place of starch might be equally effective, though we cannot speak as frankly of this medium as we can of the starch. Inasmuch as this insect sometimes eats the sizing off of heavily glazed paper, leaving, however, the inked parts (text) untouched, indicating *a marked dislike for printer's ink*, we recommend when silk material, or anything in fact containing starch or glue, has to be stored away for any length of time, that the same be wrapped in several layers of newspaper.

CRICKETS.

One or more of our common field crickets may be at times a nuisance and a destructive pest when domiciled in a dwelling. However pleasant the chirp of "The Cricket on the Hearth" (and the writer confesses to being very fond of their music), when their song indicates the presence in the house of an insect which eats holes in clothing and is otherwise obnoxious, the particular housekeeper desires to take measures to remedy the evil. These insects are practically omnivorous, partial to almost any food product, are cannibalistic, and as stated above, will occasionally riddle an article of clothing. Marlatt in an article on the House Cricket (Bul. 4, Series, U. S. D. A. Bureau of Entomology) emphasizes the fondness of crickets for water and accounts for their wanton cutting and gnawing of clothing by their fondness for moisture, the intimation being that damp clothing is more likely to be injured than dry. He goes on to say, however, that any of the common field grasshoppers or crickets entering the house are apt to gnaw curtains, wearing apparel, etc.

We have been appealed to for help in ridding a house of crickets which, on account of their abundance, had become a nuisance. At our suggestion the afflicted parties used "Hooper's Fatal Food," dusting it about in places frequented by these insects, and report success. Note also what was said in the article on Ants, with reference to the use of tanglefoot mixture on the outside of foundations to prevent insects crawling into houses. Mr. Marlatt (op. cit.) claims crickets can be destroyed in large numbers by taking advantage of their fondness for liquids, and setting in places where they occur vessels filled with beer or other liquid. Many will doubtless drown in such receptacles. Uncooked vegetables, small pieces of carrots, or potatoes, thoorughly poisoned with arsenic may be used, taking proper precautions to prevent accident.

Crickets may be prevented from eating binding twine in the field by soaking it before use in a solution of bluestone.

MICE AND RABBITS.

Last winter field mice were exceptionally severe in Minnesota and complaints came to us in the spring, from many sources, of trees destroyed. One party lost a large number of fine young maples, a loss representing several thousand dollars; others lost fruit trees through their being girdled, still others shrubbery, etc. A girdled tree may leaf out and even blossom in the spring, but it is sure to die in the fall.

To all of these complaints this office has answered practically as follows: We have advised against early mulching (mulching if done

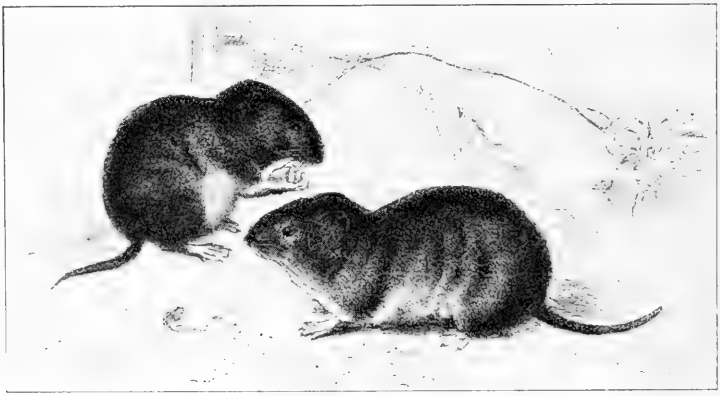


Fig. 60. Field Mice.

at all should not be done until cold weather after the mice have sought winter quarters) and we regard cover crops, such as oats, buckwheat, clover, etc., as conducive to mice injury. For that matter, all weedy growth and trash of any kind beneath the trees are likely to harbor mice. It is undesirable to leave an orchard in sod. These animals, it will be remembered, work on a tree at or just beneath the surface of the ground, and any application or barrier must thoroughly protect that portion.

Further, the work of mice can be easily distinguished from that of rabbits. The latter work higher up on the tree and the marks of their large incisor teeth are plainly visible. The finer marks of the small teeth of the mice can be seen in the wood from which they have removed the bark, and, as stated above, they work near or below the surface of the ground.

An application of a thick white wash (made by slaking quick lime in water) rendered a deep blue by the addition of a blue-stone (blue vitrol) solution appears to be a good repellant for both mice and rabbits. We have personally used this, and have known of nurserymen making use of it with success. It should be applied late in the fall and it would do no harm to make a second application during the winter if possible. This could be applied with a brush or with a spray and nozzle used for whitewash. The latter method would be preferable in treating shrubbery, and perhaps also rows of nursery trees, insuring more rapid and probably more thorough work. The now well-known commercial lime sulphur

Fig. 61. The Common Cotton-tail.

spray, (one part stock solution, 10 parts water) used as a dormant spray is also very useful as a preventive of attacks of rodents, both rabbits and mice.

Mechanical guards of various kinds are absolutely reliable and we figure several from an excellent bulletin issued by the Ohio Station. These may be of paper (the writer has used successfully several thicknesses of newspaper) securely tied on and extending a few inches below the surface. Rabbits have been known, however, to tear off paper wrappings under extreme conditions. We would advise against the use of tarred paper in this connection and of course all such coverings, except perhaps wire screen, should be removed in the summer. More durable are the guards of wood veneer, and

better yet, wire screen with small enough mesh to keep out the mice. This latter should be about 24 inches wide, thus covering the trunk for nearly two feet. Such protection can be used for several seasons. Of course, all guards should extend below the surface a short distance, (two or three inches). Wood and paper guards should always be removed in summer as they harbor insect pests.

A farmer should provide for "tramping" down about his fruit trees occasionally during the winter, tramping the snow down hard. If one can mound young fruit trees with earth, coal ashes, or leached wood ashes, or, best of all, cinders in the late fall so much

Fig. 62. Baby Rabbits. Ohio Experiment Station.

the better, first clearing all rubbish away from the trunk and making sure there are no mice runaways or burrows in the soil next to the tree. These mounds need to be only about twelve inches in diameter and about five or six inches in height. Mounding should be done late in the fall, and these mounds may be permanent, possibly requiring some renewal each year. They may also be used in connection with the wire screen employed against rabbits.

Cornstalks two feet in length, fastened closely about the trunk of a fruit tree with hay wire, make an effective barrier against rabbits. Ballou (Ohio Bulletin No. 208) recommends that they be cut into two foot lengths when brought from the field before being fed

to the stock. After the stock have stripped the blades off, the stalks of uniform length can be gatherd up and tied in blades for future use. Care should be taken to remove the wire when the stalks are taken away, otherwise, if left on, a tree may be eventually girdled and die.

POISONING: Finally, we can resort to poisons in our warfare against mice, and probably the best agent is sulphate of strychnine (be sure to purchase the sulphate). This may be used in two ways; (a) upon crushed wheat, or (b) upon alfalfa hay or green alalfa,

Fig. 63. Four little rabbits. How cute! Protected through sentiment. Ohio Exp. Station.

the employment of the last named being of course limited to summer. The Department of Agriculture recommends *crushed wheat* for this purpose in preference to whole wheat, (Farmers' Bulletin No. 352) and the process of preparing this poison bait is as follows: Dissolve 1 oz. of strychnina sulphate in 2 gals. of water by boiling in a closed vessel; pour this over 60 lbs. of crushed wheat, stirring it through the mass thoroughly until all the wheat is thoroughly wet. This should be used at once, and care should be taken to scatter the grain where birds or other animals we desire to pro-

tect cannot reach it. Perhaps wide boards with inch crosspieces nailed under them to keep the boards raised from the ground, as recommended in an Ohio bulletin is the best contrivance, or employing pieces of drain tile and placing the poison inside with a long handled spoon (op. cit.) We would also suggest placing this bait, pro-

Fig. 61. "They promise to be good." Ohio Experiment Station.

tected from birds of course, at the base of trees we wish to save or along nursery rows. This bait can be used at any season and young mice are said to eat it greedily in summer. In using it over an extended area, where it would not be practical to use board or tile, one is naturally obliged to take advantage of all the natural covers offered, in order to protect birds, etc.

During the winter the best vehicle for carrying the poison it is claimed in the government bulletin referred to, is Alfalfa hay. It was advantageously used in a mouse plague in Nevada up to the time green food appeared in the spring. The formula recommended is as follows: Good green alfalfa hay chopped into two inch lenghts, 30 lbs.; sulphate of strychnia, 1 oz.; and water five or six gallons or as much as the hay will absorb. Dissolve the strychnine as recommended above. Place 30 lbs. of chopped hay in a large metal receptacle and first sprinkle it with three gallons of fresh water, thoroughly mixing it. Then sprinkle the poison over this dampened hay and thoroughly mix it. The hay can then be sacked and is ready for immediate use. It cannot well be kept for several days but should be used while fresh. This can be distributed by hand, near mice burrows ar along surface trails. In cold weather drop into the underground burrow. Stock should be keut out of fields for several days after treatment until rain and weathering makes this bait harmless.

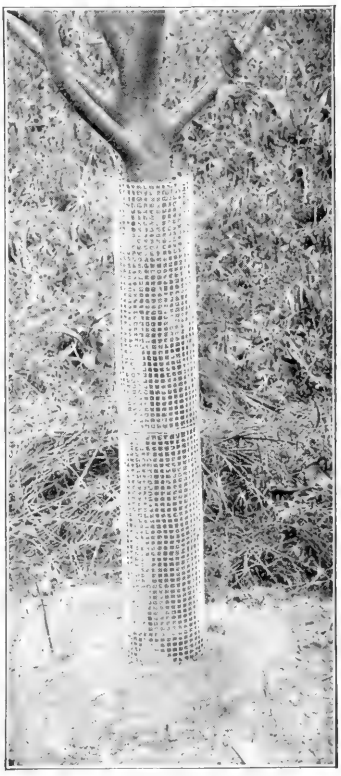


Fig. 65. Apple tree, protected by wire screen. Ohio Exp. Station.

While green alfalfa, prepared in practically the same way as the hay, was used with considerable success in the Nevada mouse plague by Government workers, even in the spring when green food was abundant, it calls for greater care in distribution, quickly withers, and does not particularly commend itself to the writer as being equal to the other two baits described.

Strychnine, of course, is a deadly poison, and the greatest care should be observed to prevent accidents both with the sulphate itself, with the solution and with the utensils used, and with the bait itself. The sulphate costs wholesale, in the neighborhood of 75 cents per oz., and being more soluble in water than any other form of strychnine should always be used. Farmers interested in com-

bating mice on a large scale should see the Government bulletin above referred to.

Inasmuch as mice are devoured by skunks, foxes, weasels, owls, and hawks, it would seem desirable to protect all or most of such animals which are commonly regarded as "vermin" and destroyed.

Rabbits.

A more foolish law than the one created by recent legislative enactment making it illegal to hunt rabbits in Minnesota with ferrets can hardly be conceived since they are amongst the worst pests of horticulturists, nurserymen and farmers, and yearly cause losses in the one state of Minnesota amounting to many thousands of dollars. The more rapid and complete their extermination in this State, the greater the satisfaction in owning nursery stock, fruit trees and ornamentals. While they show preference to certain cultivated trees and shrubs, when snow is on the ground they are apt to turn to anything which offers in a most unexpected way. They appear to be particularly fond of *Spirea Van Houtei* and last winter we noted Japanese Barberries which had been cut down to snow line. Even the spines on Rugosa Roses appeared to offer no obstacle. As a rule injury is done after the arrival of snow, yet this fall, 1912, we found them attacking young apple trees early in October while abundance of green food was still at hand. An ounce of prevention is certainly worth several pounds of cure in

Fig. 66. Guard made of wood veneer. Ohio Experiment Station.

connection with these animals. They begin to produce young in the spring, in Minnesota perhaps as early as April, and continue during the summer. Hence destruction of adults in early spring will mean, if co-operation amongst neighbors is practiced, a marked lessening of their numbers to work havoc the following winter. We find them very susceptible to poison in the spring before they can get green food and have destroyed them by powdering crystals of sulphate of stychnia, in the small bottle in which it is sold (use the head of a heavy nail) and putting in slits in small pieces of apple, a very little of the powder, as much as can be held on the point of a penknife. These poisoned baits should be distributed in such a way that other animals or children cannot get at them, and in general it may be said that one cannot be too careful with poisons of any sort. The use of poisoned baits need not necessarily be confined to early spring, but they are probably more effective then. Evidently rabbits get wary of certain bait, seeing individuals of their kind perish after partaking of it. It is well, therefore, to substitute parsnip or carrot for the apple, when the latter ceases to be effective. The bodies of poisoned rabbits should be carefully buried.

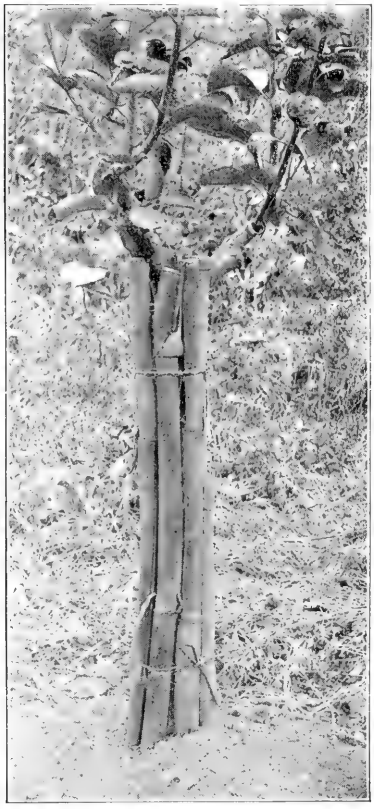


Fig. 67. Corn stalks used to protect trunks. Ohio Experiment Station.

Another method of poisoning, applicable in winter or spring, which has the advantage of not endangering the lives of birds and other valuable animals, is the poisoning of new twigs or suckers, freshly cut from appletrees, by dipping them in a sweetened strychnine solution and placing them about the orchard or nursery in the neighborhood of trees needing protection, or in rabbit runways. See that these twigs bear buds and that the buds are poisoned. When using poisoned fruit, unpoisoned fruit should be kept

out of their reach. If poisoned pieces of apple or carrot are used in winter, it is a good plan to place the baits on the end of little sticks so that they are conspicuously above the snow.

A gun, or gun and dog are useful agents to use against rabbits. They also readily fall victims to the old-fashioned "figure four" trap, and in the woods to snares, as every boy knows. Among raptorial birds, found in Minnesota, which prey upon rabbits are

Fig. 68. A tree "bridge-grafted." Ohio Experiment Station.

Marsh Hawks, Coopers Hawks, Red-tailed and Red-shouldered Hawks, the Long-eared and Short-eared Owl, the Barred Owl and the Great Horned Owl; the indiscriminate slaughter of these must have a more or less direct effect upon the number of rabbits. The fact, too, that in some states, the open season for rabbits is very short, and that on many farms and large estates, no hunting is allowed, help their increase.

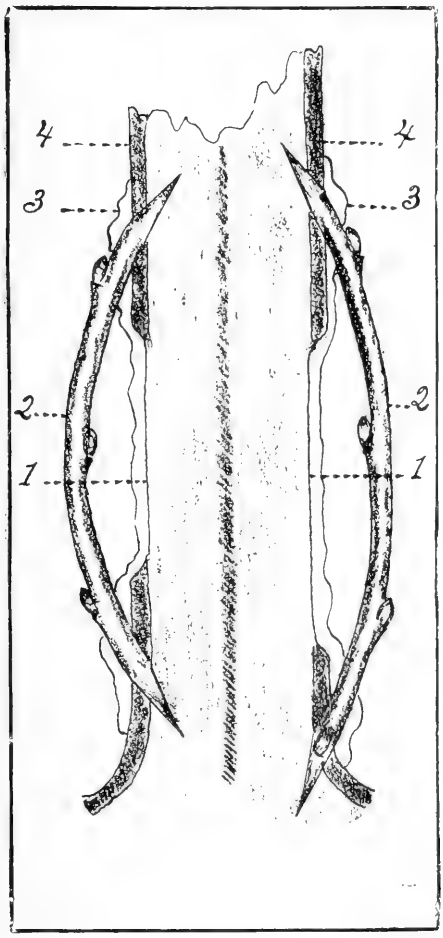


Fig. 69. Diagram, showing plan of bridge-grafting. Ohio Experiment Station.

ally worth several pounds of cure.

Applying repellent washes to tree trunks and shrubbery (see above) is strongly recommended by this office, as is also the mechanical guards described on a previous page.

We have not much faith in the low so-called "rabbit-proof" fence, since in times of drifted snow it is no obstacle, and unless a barbed wire is buried below the fence or the lower edge of the fence itself inserted a few inches in the ground, the animals may burrow beneath it.

A valuable tree girdled by rabbits (or mice) can sometimes be saved by bridge-grafting, which consists of inserting the end of several scions into incisions in the live bark below and above the injury, the ends of each scion being first cut into a wedge-like shape. Grafting wax should be carefully and liberally aplied at points of union of scion with stock, and all wounds thus carefully covered, This requires some technical skill, and, as said above, "an ounce of prevention" is gener-

INSPECTION OF MINNESOTA NURSERIES AND OF IMPORTED STOCK: RECENT FEDERAL LEGISLATION AFFECTING NURSERYMEN.

In 1911 fifty-two nurseries were inspected and the $232.75 collected therefor was deposited with the State Treasurer. Nurseries receiving certificates in 1911 are as follows:

Vine Grove Nursery
Rose Hill Nursery
Thos. Redpath Nursery
Deephaven Nursery
Hawkinson Nursery
Hoyt Nursery Co.
Park Nurseries
Howard Lake Nurseries
Strand Nursery
Wright Co. Nursery
Jewel Nursery Co.
Sacred Heart Nursery
Madison Nursery
Orton Park Nursery
St. John Nursery Co.
Amber Lake Nursery
Wedge Nursery
Turtle Lake Nursery
Fairmont Nursery
Tolleson Nursery
National Nursery Co.
Friedhohn Nursery Co.
Albert Lea Nursery Co.
Hutchinson Nursery
Johnson Nursery Co.
Minnesota State Nursery Co.
The Faribault Nursery
Dodge County Nursery
Pioneer Nursery
Vinegar Hill Nursery
Clinton Falls Nursery
Farmers Seed & Nursery Co.
Winnebago Nursery
Mankato Nursery
Mitchell Nursery Co.
Fillmore Co. Nursery
Preston Nursery
Andrews Nursery
West Concord Nursery
Byron Nursery
Plainview Berry Farm
Wilwerding's Nursery
Northwestern Nursery Co.
Sivert's Nursery
Mayfield Nurseries
Deerfield Nursery
Spring Valley Nursery
Hiawatha Gardens Co.
Old-Fashioned Flower Garden
Chicago Lake Nursery
Luverne Nursery
Norway Poplar Forest Grove

On account of the drought of the summer of 1910 and the dryness during the first part of 1911, some nursery stock was not in particularly good condition. Strawberry plants suffered severely; on the other hand, apple trees did surprisingly well. San Jose Scale was found in two nurseries (shipped into Minnesota during the spring of 1911) on currants, fruiting and flowering kind, on plum trees and golden spirea from New York and Pennsylvania. This infested stock was at once destroyed. The Poplar Beetle was quite destructive, but it may be easily controlled. The existence of Putnam's Scale, Oyster Shell Scale and Scrufy Scale on trees adjacent to nursery stock was pointed out to nurserymen and the necessity for cleaning up was emphasized. While these are not to be particularly feared in Minnesota, a shipment of nursery stock bearing any one of them to a western state where laws are stringent

would certainly be destroyed. Grasshoppers, in places, injured apple grafts noticeably. In one nursery spraying was resorted to to kill this pest. Crown Gall, Anthracnose, Rust and Black Rust were in evidence in localities. Two diseases of apple trees hitherto unknown in Minnesota were discovered. One of these was identified by the Division of Plant Pathology—as *Coniothyrium fuckelii.*

On foreign stock in 1911 we found no nest of Brown Tail Moth and no egg clusters of Gipsy Moths, but pupal cases and larval skins of the latter insect were present on imported Azaleas, showing the necessity for keeping up a rigid inspection of all imported stock.

In 1912, fifty-four nurseries were inspected and certificates issued. The list follows:

Hoyt Nursery Co.
Rose Hill Nursery
Vine Grove Nursery
Park Nurseries
Old Fashioned Flower Garden
Deep Haven Nursery
Thos. Redpath Nursery
Minnetonka Nursery
Howard Lake Nursery
Strand's Nursery
Chisago Lake Nursery
Mitchell Nursery
Dodge Co. Nursery
Jewell Nursery Co.
National Nursery Co.
Andrews Nursery Co.
Deerfield Nursery
Brand Nursery Co.
Clinton Falls Nursery Co.
Hutchinson Nursery
Amber Lake Nursery
West Concord Nursery
F. E. Cutting Nursery
Minnesota State Nursery
Farmers Seed & Nursery Co.
Winnebago City Nursery
Southside Nursery
Hawkinson Nursery
Spring Valley Nursery
Johnson Nursery Co.
A. J. Lindert Co.
Turtle Creek Nursery
Fairmont Nursery
Sugar Loaf Valley Nursery
Luverne Nursery
Orton Park Nursery
Albert Lea Nursery
Pioneer Nursery Co.
St. John Nursery Co.
Vinegar Hill Nursery
Sivert's Nursery
Mankato Nursery
Preston Nursery
Fillmore Co. Nursery
Madison Nursery
Tolleson Nursery
Wedge Nursery
Sacred Heart Nursery
Mayfield Nurseries
Northfield Seed Co.
Hiawatha Gardens Nursery
Greenway Fruit Farm
Ritchell Nursery
E. A. Farmer

Mr. C. C. Hunter and Mr. Emil Sahler were inspected in 1912 but have not been granted certificates at date of writing. In 1912 the nurseries were found to be for the most part in good condition. Various injurious insects of minor importance were present to some extent, some crown gall on raspberries, anthracnose, blight and rust, but by no means of universal occurence and not strikingly abundant.

Suggested Changes in Our State Inspection Law.

The newly enacted Federal law, establishing a Quarantine Board which has power to quarantine any part or the whole of a state as far as nursery stock is concerned, should, of itself, show us the need of a more stringent inspection law in Minnesota, since under those conditions Minnesota nurserymen could ship no stock out of the state and intra-state shipments would in all probability be restricted.

Our present law is faulty in many respects, viz.: the entomologist cannot legally inspect ornamental or nursery stock on private grounds where stock it not grown for sale, although there may be the most startling evidence of the presence of dangerous insect pests, imported or domestic, thereon. At present, inspection only takes place once a year and then only upon request of the owner. It is evident that a pest may have established itself in the nursery subsequent to inspection, and the owner, not desiring and not asking for inspection the following year, unconsciously be the means of a very undesirable insect gaining a firm hold.

Our law as now worded directs the inspector to grant a certificate to *anyone* raising nursery stock, if such stock is free of pests. Such a party may be merely an agent, owning only a quarter of an acre, or even renting said ground, which is frequently merely a place where left-overs or unsalable stock is planted. This condition of affairs should be provided for and guarded against.

The entomologist believes that the State, not the nurserymen (as at present) should pay the expense of inspection, for manifest reasons.

Post office authorities and express companies have recently become quite careful in insisting upon a certificate of inspection being attached to every package of stock, stating that it "was grown where inspected." This has given rise in Minnesota at least to some peculiar requests upon the part of one or two parties selling stock. Without mentioning names we will say that A represents a Minnesota dealer who buys stock and has it shipped directly from a grower in some other state to his customer, but A does not wish to advertise the nurseryman (in New York, let us say, or in Pennsylvania) from which he purchases and he also desires his customer to think, if possible, that the order comes from his (A's) establishment. Therefore, A asks the Minnesota inspector to sign his name, officially, to a statement to the effect that the stock shipped "was inspected where grown," said declaration to be attached to each

package shipped by the firm from whom A buys the stock. Manifestly, we have no authority to act outside of this state, and have felt obliged to refuse to do this, such decision being endorsed by the Attorney General.

It is to be noted in this connection that officials in one or two states to our certain knowledge are willing to certify (and have done so) that A owns a nursery (in locality from which purchases are made) etc. This is manifestly a misrepresentation. Some provision, however, should be made in our law for dealers in our own state who buy from inspected nurseries *in Minnesota,* and, not wishing to advertise same, are nevertheless obliged to place a certificate on stock shipped outside the state.

We append here an address by Mr. H. B. Scammel, our deputy inspector in 1911, delivered before the Minnesota State Horticultural Society at its winter meeting in December, 1911. It indicates very plainly upon what points our law is weak and how such weakness may be remedied.

Needed Changes in the Horticultural Inspection Law.

The present law applying to horticultural inspection in Minnesota was enacted by the legislature in 1903 and revised in 1905. It filled a long felt want and served its purpose fairly well during the past eight years, but there are some features embodied in this bill which do not cover the situation existing today, and it is earnestly hoped that some changes and additions may be made, desirable from the standpoint of the inspector as well as from that of the nurseryman, which will became part of the law at the next session of the legislature.

Some states in which fruit growing has become one of the leading industries need, and have adopted, laws sufficiently stringent to afford good protection within their borders; other states, such as our own, the Dakotas and lesser fruit raising states have horticultural laws less severe, and it seems right that differences in the state laws should exist because of the differences in conditions which are found in various parts of this country.

Our own law is of a type quite different from that of California or New York, but our nursery and fruit growing interests are not developed to the same extent as in the former states, and it would seem that with some changes we could secure a law which would better satisfy Minnesota conditions.

The most noticeably weak point in our law is that which limits inspection to places where trees or plants are grown for sale. This may be done at the request of the owner, or when the inspector has reasonable ground to believe that any injurious insect pests or dangerous plant diseases exist, but bear in mind that none other place than that where stock is grown for sale may be inspected. Minnesota nurseries and orchards have been comparatively free of serious insect pests but suppose an orchard is found infested with San Jose scale and the owner refuses to spray. In such case he cannot be reached under the inspection law, but possibly something might be done under some other law, such as maintaining a public nuisance.

It should be required that every nursery be inspected at least once each year, and the right granted to examine any place which the entomologist may have reason to believe needs attention. It cannot be too strongly advocated that a list of the places from which buds and scions are secured by nurserymen be obtained from them and a careful inspection be made of the tree from

which the buds and scions are taken. These are often responsible for the outbreak of an infestation of scale insects, such as San Jose, Oyster Shell, Putnam and Scurfy. The first named is not known to exist in our orchards, but the latter three are quite common, and should trees bearing them be shipped into a state where all stock received is inspected they would undoubtedly be destroyed.

In no section of the law can there be found a statement saying that shipments within the state should have a certificate attached. Shipments destined for other states require it, and it was to meet that requirement that the present law was passed. The idea being to enable nurserymen to do business outside the state, but not being sufficiently particular about the business done at home. Certificates should be on all shipments, whether outside the state or within. To revoke or withhold a certificate at present means only that the nurseryman is prohibited from shipping to other states requiring certificates, and still allows him to do business within his own state. To require only those nurseries which ship to other states to be inspected aims at protection for those states chiefly and not sufficiently protection for our interests at home. Minnesota needs protection for her own sake as well as for the benefit of surrounding states.

This leads to the question of who shall pay for inspection, the nurseryman or the state. The Minnesota law states that a fee of five dollars per day and expenses shall be collected for the inspection of a nursery. When a number of nurseries are on a circuit it is a most difficult matter to determine the sum to be collected from each, especially the apportioning of the expense account, and it is almost impossible to do this in any way except approximately. The important point in connection with the matter of fees is that the inspector does not always feel at liberty to spend as much time as he would like in a nursery because such time is being paid for by the nurseryman, and it is only fair to him to keep expenses as low as possible. There are two nurseries here, perhaps a third, that, were they in a state where San Jose Scale is common, each would require the time of two men for six or seven days to be properly inspected. This scale having been found in two nurseries this year, received in both cases from eastern states, it has become necessary to spend more time in these examinations, and it is recommended that either the work be done at state expense or a small fee without expenses be charged in order to give the inspector every opportunity to spend a sufficient amount of time in the inspection. An examination of the horticultural inspection laws reveals the fact that in approximately one-fourth of the states inspection is made at the expense of the nurserymen, and usually a fee is charged in addition, while in the other three-fourths the states appropriate funds for this purpose.

The time allotted for this paper permits me to speak of one other point which is that the term "nursery stock" should be defined in the law. Such definition must be broad enough to cover the florist's stock which is received here in the fall from Europe, and permit of its inspection. This stock is often classed as greenhouse stock in this country, but being field grown in Europe it should be inspected for Brown Tail Moths nests and Gypsy Moth egg clusters. A word of advice to those who ship greenhouse stock will not be out of place here. This may be shipped into the state or out of it without a certificate and in order to avoid any delay which might arise if an inspector should hold up a shipment for inspection because of a lack of certificate, every greenhouse manager should clearly label each package with the words "Greenhouse Stock."

This gives an opportunity for an unscrupulous man to practice deception, but if the necessity arises a means will be found to detect such an act.

Horticultural inspection laws are still in the formative period, but constantly changing for the better, weaknesses are being found and corrected, and it is only by continually striving for their improvement that laws can be evolved which will effectually control the situation."

While inspection of nurseries is not compulsory under the Minnesota law, as now worded, our nurseries are compelled by the laws

of other states to have their stock inspected before it is shipped to them. Many of the nurserymen who do not ship outside realize that it is a very good thing to have their stock looked over by an expert from the Agricultural College and his stamp of approval placed thereon, also ask for inspection.

This relation between the Experiment Station and the nurseries works to advantage in a double way; it protects the public, and it insures to nurserymen a careful oversight of their stock and information and help if a dangerous foe is found. The nuserymen are as anxious to keep out undesirable insects and destructive diseases as their patrons are, hence inspection by a representative of their own experiment station appears to them a highly desirable thing.

In a few states, a very few, fortunately, the office of nursery inspector is a political one, and therefore, unfortunately, results in a lack of thoroughness in the work, and loss to both nurserymen and the public. A political appointee, not only may be unfit by knowledge for this work, but, and the more the pity, he may not feel free to act with severity where such is necessary. On the other hand, a member of the experiment station force is not fastened by political strings, he is unhampered in his actions, and by the very nature of his training and position, in a way to help the nurserymen and those who buy nursery stock. The nurserymen, in these days of increasing plant pests brought in from Europe, is in a position to spread these destructive foes to horticulture over the entire country unless the business is safe-guarded by proper inspection. Let us hope that in Minnesota this work may never become a matter of politics and that the state's reputation for clean stock, not only at home, but in other states into which Minnesota nursery stock is shipped, be always retained. The moment Montana Wisconsin, Wyoming, North and South Dakota, Iowa, and other states begin to suspect laxity and looseness in Minnesota nursery inspection, which might come with a politically-appointed inspector, they would shun our stock, buy from states where station inspection was the rule, and profits of Minnesota nurserymen would fall off from fifty to one hundred per cent.

Inspection of Foreign Stock.

The country is to be congratulated, florists as well as nurserymen and their patrons, on the final passage of the so-called Plant Quarantine Act (passed Congress August 20, 1912) which went into effect October 1st of the present year. Under this law a Federal Horticultural Board has been established which has the power

when necessity arises to quarantine any state or portion of any state in this country or to prohibit the importation of stock into the United States from any country or countries. The following conditions of entry have to be complied with by an importer of nursery stock.

(1) He must take out a permit therefor in advance. This permit should preferably be taken out by the person who is to receive the goods at final destination. A broker or commission merchant may take out a permit in his own name, if he imports for his own account, or he can act as agent for and take out the permit in the name of the actual purchaser.

(2) He must see that each package on arrival bears the proper certificate of foreign inspection. (See Regulation 6.)

(3) He must see that each package is marked in accordance with Section 3 of the Act. As a matter of convenience, this marking should also contain the additional information called for in Section 4, to avoid the trouble or remarking before the goods can be delivered for interstate shipment. The certificate and marking should preferably be on the goods before they leave the foreign port.

(4) After December 1, 1912, each shipment must be accompanied with the consular declaration called for in Regulation 9. This declaration must accompany the consular invoice and is not to be attached to the individual container.

What the Importer or Broker Must Do Before the Goods Can Be Shipped or Removed from a Port of Entry.

(1) He must immediately (before shipping or removal) advise the Secretary of Agriculture and State Inspectors in accordance with Section 2 and Regulation 8.

(2) He must see that each container is marked in accordance with Section 4; that is in addition to the information in the label of entry, each container must bear the name and address of the consignee at destination, where the stock is to be inspected by the State, territorial or district official. (See Section 2 and Regulation 8.)

Importers are warned that failure to meet the requirements of the law as outlined above subjects them to the penalties fixed in Section 10 of the Act.

Would-be importers should send to the U. S. Department of Agriculture, office of the Secretary, for Circular 41—"Rules and

Regulations for carrying out the "Plant Quarantine Act." The circular also contains the actual wording of the Act.

This new law, originally introduced and known as the Simmons Bill, will strengthen the position of the inspectors in the various states materially from the fact that they have the backing of federal authorities, not only in the inspection of imported stock, but also, in reality, in inspection of domestic stock as well, for, if a serious insect pest or dangerous plant disease once gains a foothold in a state, either through neglect on the part of a nurseryman, or from any other cause, quarantine would undoubtedly and unquestionably follow.

A weak point in the federal law is the fact that it does not require inspection by state authorities. *It does* require that the inspector be notified, and evidently assumes that each state will be sufficiently interested in clean horticulture to take care of this stock after it has arrived. Minnesota is certainly anxious to be kept free of introduced pests, and both nurserymen and florists are only too glad to co-operate with the entomologist to that end. Further, the Minnesota law gives authority to the State Entomologist to inspect stock "where he has reason to suspect the presence of injurious insects, etc.," thus legalizing the compulsory inspection of this stock imported by nurserymen and florists, but the entomologist *cannot legally inspect stock imported* by *private individuals.* The inspector should be given this authority by the state and also be empowered to inspect orchard or ornamental stock as well as nursery stock, *wherever found.*

This work in Minnesota is increasing and placing added work upon the State Entomologist every year. It is evident that the Department should have one practical, well-qualifed man to take care of all inspection, and that funds should be provided sufficient for such an employee and his expenses. It is a striking fact that however good an inspector a man may be technically, if he is not in a position to give nurserymen information regarding spraying outfits and compounds, and best method of controlling pests found in a nursery, he is hardly acceptable. Therefore, such an employee must of necessity be an all around man along these lines.

OUT STATION APIARY.

Last winter was a severe one upon bees and loss in wintering was in some cases as high as 75 per cent. Therefore, although the summer of 1912 has been an excellent one as regards honey flow, the total amount of honey produced in the State this season is below the average. White Clover and Sweet Clover both did well and Bass Wood was in bloom at a time when bees could take care of the nectar. Notwithstanding favorable conditions during the summer, it looks on account of the above winter conditions, as though there would be something of a shortage in the honey supply this fall.

Fig. 70. "Who's afraid of bees?" Photo taken in our College Apiary by A. A. Aamodt.

Bees in our apiary are going to their winter quarters in good condition.

The Entomologist gives a course in the elements of bee keeping to college students and a certain number of lectures on this subject to senior school students. Of necessity, all college and school instructions has to be given at a time when one cannot work in the

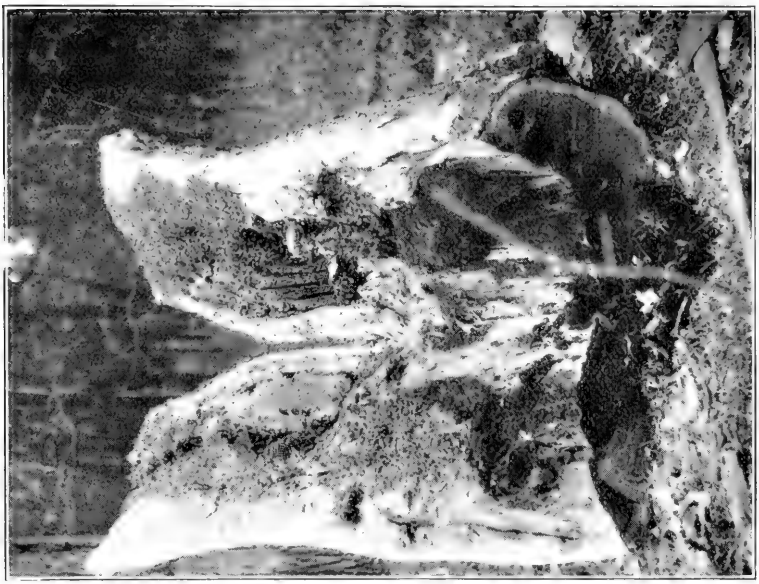


Fig. 72. The bee-tree, shown in Fig. 73, opened. Aamodt.

Fig. 71. A home-made observation hive in our College Apiary. Aamodt.

field with bees, and therefore, we have recommended to the Dean of the College that sufficient funds be appropriated to insure a man being placed in the field during the summer to demonstrate to farmers and others throughout the State the practical points of bee keeping.

One of the accompanying photographs, Fig. No. 71, shows a small observation hive used in our apiary in order to watch the bees while at work. Fig. No. 73 illustrates a felled tree containing a colony of bees which had made their home in the hollow trunk. This was found just outside of Minneapolis near Brooklyn Center. This colony, by the way, was put into a modern bee hive and in addition to the honey necessary to carry it over winter, a surplus of 30 pounds was obtained.

Fig. 73. Smoking bees in felled bee tree. Aamodt.

The published report of the State Bee Inspector indicates a falling off in the amount of foul brood disease, which may be possibly in part due to the comparatively small percentage of bees which came through the winter.

We believe that the industry of bee keeping is as yet in its infancy in this state and that from the abundance of bee pasturage in almost every section it can be made a most remunerative occupation, to say nothing of the advantage to a farmer of having bees upon the place to assist in pollination.

MINNESOTA INSECT LIFE.

This publication, issued during the spring and summer, has been continued, and is evidently meeting with approval. Through it we are enabled to get timely information to those who need it. An endeavor is made to have the information contained therein in popular form. The publication is intended primarily for citizens of Minnesota. A free copy is mailed on the first of April, May, June, July and August to each address on the rapidly growing mailing list. We insert here contents of the numbers published during 1911 and 1912.

Vol. I, No. 4, April, 1911: Spraying; Self-Boiled Lime Sulphur; Spraying Machine Manufacturers; Insecticide and Fungicide Manufacturers; The Plum Curculio; Strawberry Pests; Codling Moth; Bordeaux; Grape Pests; Black Leaf A Good Contact Insecticide; Naked Snails or "Slugs" in Cold Frame, Greenhouse or Garden; "Sow Bugs" or "Wood Lice.;" Grasshoppers; Plant Lice In Spring; Items.

Vol. I. No. 5, May, 1911: Protection of Seed Corn; Summer Work with Grasshoppers; "Red Spider;" Ants in Garden and Household; "Buffalo Bugs," Carpet Beetles, "Buffalo Moths;" Elm Borers; The Oak Twig Pruner; Mosquitoes; Chicken Hawks; Items of Interest.

Vol. I, No. 6, June, 1911: Save the Birds; Ants in Lawn and Garden; The Currant Worm; White Grubs; Poultry Pests; Scale Insects; The State and Federal Insecticide Laws; Grasshoppers; Items of Interest; "The Poor Little Bugs."

Vol. I, No. 7, July, 1911: Wire Worms and Cut Worms in Field Corn; San Jose Scale in Minnesota; Scale Insects Hatching and Spreading Now; Catching Cut Worm Moths; The Fecundity of Plant Lice; The Grasshopper Situation; Remedies for Mosquitoes and Black Flies; Remedies for Jiggers; Pocket Gophers and Moles; Remedies for Woodchucks; The Corn Bill-Bug; Items.

Vol. I, No. 8, August, 1911: Spraying Machinery; Paris Green vs. Arsenate of Lead; Fall Plowing for Grasshoppers; Borers in Birch Trees; Oaks Killed by Borers; A Late Cut-Worm Attacking Cabbage; Another Gohper Remedy; Flies on Stock, Buffalo Gnats, Etc.; Some Remedies for Rats and Mice; Winter Treatment for Scale Insects.

Vol. I, No. 9, April, 1912: A Word to Orchardists; Winter Spraying; Be Prepared for Insect Pests; Spraying Machine Manufacturers; Insecticide and Fungicide Manufacturers; Weevils in Peas and Beans; Clothes Moths and Carpet Beetles (Buffalo Bugs); The "Silver Fish;" More About the Oak Borer; Recent Appointments in Entomological Division; Publications of Entomologists during 1911 and early part of 1912. Items.

Vol. I, No. 10, May, 1912: Spraying Apples and Plums; The Oak Tree Borer; Proof that Spraying Pays; Cut Worms; The White Grub and "June Beetle;" Strawberry Weevil; Winter Injuries by Mice; Pocket Gophers; The English Sparrow; Campaign Against the House Fly; Our Annual Plea for Insect-Eating Birds; Suggestions for Protecting Corn After Being Planted; Some Mosquito Suggestions; Back Numbers of Insect Life; Items of Interest.

Vol. I, No. 11, June, 1912: Notes from the Orchard; Nursery Inspection Under Auspices of Exp. Station; General Treatment for Insects Eating Leaf or Stem: More About Cut Worm; How to Destroy English Sparrows; Currant Worms; Strawberry Grub; Plant Lice on Snowball and Elsewhere; Flies on Stock; Cabbage Maggots on Radishes; "Weevils" in Flour; Items of Interest.

Vol. I, No. 12, July, 1912: Grasshoppers Serious; Larch Saw Fly; Orchard Spraying; The Onion Maggot; Chironomus Sp.; Clover Seed Chalcis; What Our Men are Doing; Remedies for Bed Bugs; Cheese Maggots or "Skippers" Infesting Ham; Lectures to Farmers During July; Chiggers or Jiggers; Items of Interest.

Vol. II, No. 1, August, 1912: The Wheat Stem Maggot; A New Minnesota Pest, (The "Corn Bill-Bug."); More About the Onion Maggot; A New and Useful Fly Trap; Notes for the Orchard; Slugs on Cherry, Plum and Roses; Ants and Aphids; Birds and Insects; Nursery Inspection; A Short Glossary of Entomological Terms.

NAKED SNAILS OR SLUGS.

During the summer of 1912, naked snails or slugs have been extremely troublesome, their unusual numbers being mostly due to the abundance of rain. These so-called slugs never form a snail. In other words, they never assume a shell. Their eggs are small, round or oval, clear, translucent, with a membranous shell, and are about the size of clover seeds.

We have found lime water to be an excellent preventive against this pest, made by slaking a pound of quick lime in a large pail of water, poured, either with or without the lime that settles at the bottom, upon the infested plants. It might be used possibly a little weaker. The strength required can be easily ascertained by experiment. A touch of this liquid will cause these naked snails to curl up and die, and plants coated with it seem so distasteful to them that they are repelled. This lime water will in no way injure vegetables for table use, and it can be easily washed off from lettuce when necessary, with clear water.

Lime dusted about the plants attacked is extremely helpful in keeping them away. They may also be trapped with slices of potato or turnip, and pieces of board may be placed in the garden under which they conceal themselves toward morning. Turtles, it is claimed, will eat them, and toads also destroy them.

INDEX

G

H

I

L

M

N

O

R

S

T

W