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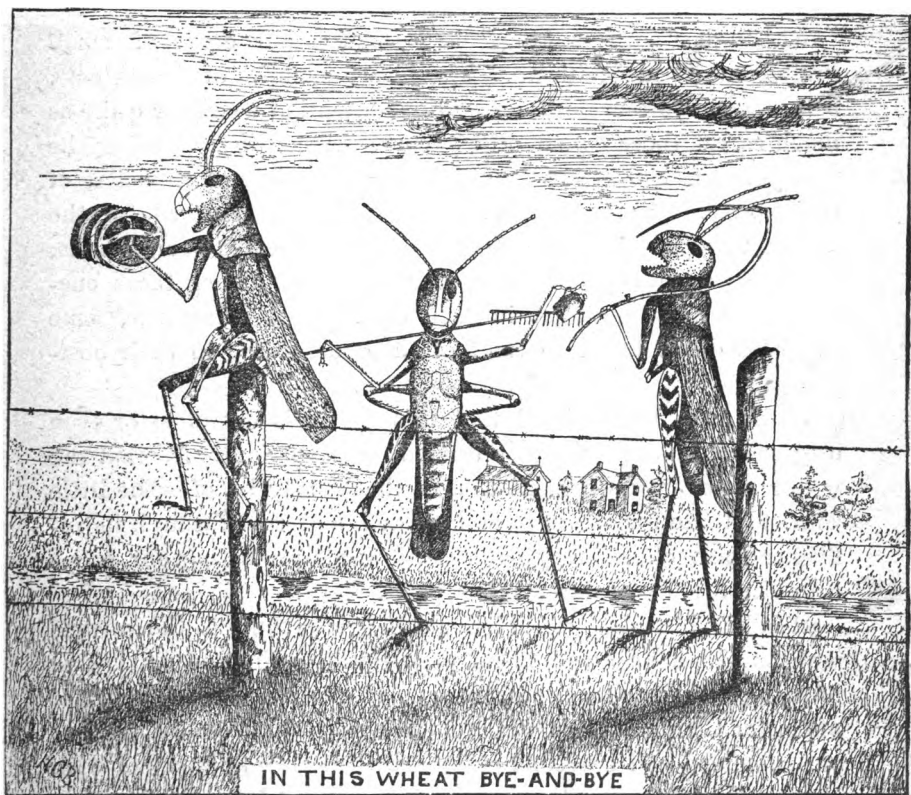
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THE Insect Enemies of Small Grains.

By LAWRENCE BRUNER,

University of Nebraska.



[EXTRACT FROM THE ANNUAL REPORT NEBRASKA STATE BOARD
OF AGRICULTURE FOR 1893.]

LINCOLN, NEBRASKA,
1893.

54

REPORT OF THE ENTOMOLOGIST.

INSECT ENEMIES OF THE SMALL GRAINS, BY LAWRENCE BRUNER,
UNIVERSITY OF NEBRASKA.

INTRODUCTION.

Although "corn is king" in Nebraska, our crops of small grains are not insignificant. The insect enemies of wheat, oats, barley, and rye therefore demand our attention nearly or quite as much as do those which attack corn. Accordingly, during the past year much time has been given to the study of this class of insect pests. While many of the species are identical for the different crops, the nature of the plants themselves being unlike, it necessarily follows that the mode of attack among these enemies must vary somewhat in each case. This being true, some pains has been taken to treat of them according to their host-plants.

While it is not claimed that this paper is complete or even original, it cannot strictly be termed a compilation. All that the writer hopes in its presentation is that it may be of some little value to those for whom it is intended, and that through its influence some efforts may be made towards protecting our crops from the ravages of these insect pests.

It is but just that credit should be given here to the various persons who have aided in its preparation. First of all, I wish to thank Mr. H. G. Barber, a special student and assistant of mine, for the pains with which he has gone over the literature at our command and searched out the insects here treated. I wish also to thank him for the drawings for some of the original figures contained in the body of the work. Mr. David Griffith, Mr. Fred Clements, and Miss Maysie Ames should be remembered for like services rendered.

LAWRENCE BRUNER,
Entomologist to State Board.

LIST OF THE SPECIES OF INSECTS TREATED.

DIPTERA.

HESSIAN FLY (*Cecydomyia destructor* Say.)
 UNFRIENDLY MIDGE (*Cecydomyia inimica* Fitch.)*
 WHEAT STEM MIDGE (*Cecydomyia culmicola* Morr.)
 SPOTTED-WINGED MIDGE (*Cecydomyia caliptera* Fitch.)
 GRAIN MIDGE (*Cecydomyia granaria* Oliv.)
 RYE GALL GNAT (*Cecydomyia secalina* Loew.)
 WHEAT MIDGE (*Diplosis tritici* Kirby).
 TWO-HORNED CRANE FLY (*Tipula bicornis* Loew.)
 NARROW-WINGED CRANE FLY (*Tipula angustipennis* Loew.)
 BORDER-WINGED CRANE FLY (*Tipula costalis* Say.)
 THICK-NOSED CRANE FLY (*Pachyrrhina* Sp.?)
 WHEAT-STEM MAGGOT (*Meromyza americana* Fitch.)
 VARIABLE WHEAT FLY (*Oscinis variabilis*? Loew.)
 SHANK-BANDED OSCINIS (*Oscinis tibialis* Fitch.)
 YELLOW-HIPPED OSCINIS (*Oscinis coxendix* Fitch.)
 THICK-LEGGED OSCINIS (*Oscinis crassiformis* Fitch.)
 COMPANION WHEAT FLY *Oscinis* — Sp.?)
 COMMON CHLOROPS (*Chlorops vulgaris* Fitch.)
 FEATHER-HORNED CHLOROPS (*Chlorops antennalis* Fitch.)
 WHEAT CHLOROPS (*Chlorops proxima* Say.)
 OBESE SIPHONELLA (*Siphonella obesa* Fitch.)
 WHEAT MOW FLY (*Agromyza tritici* Fitch.)
 DECEIVING WHEAT FLY (*Hylemyia deceptiva* Fitch.)
 SIMILAR WHEAT FLY (*Hylemyia similis* Fitch.)

-HYMENOPTERA.

WHEAT SAW-FLY (*Nematus marylandicus* Norton).
 GRASS SAW-FLY (*Dolerus arvensis* Say.)
 COLLARED SAW-FLY (*Dolerus collaris* Say.)
 WHEAT-STEM SAW-FLY (*Cephus pygmaeus* Linn.)
 WESTERN STEM SAW-FLY (*Cephus occidentalis* Riley).

* Possibly some of the names of insects presented herewith are synonyms. I have not had the time to work out the synonymy of these myself; and without going over all the literature myself I feel justified in leaving the names stand as they are.

WHEAT JOINT WORM (*Isosoma hordei* Harr.)
 WHEAT STRAW WORM (*Isosoma tritici* Riley).
 LARGER WHEAT STRAW WORM (*Isosoma grande* Riley).
 RYE STRAW WORM (*Isosoma elymi* Fitch.)
 YELLOW-LEGGED JOINT WORM (*Eurytoma fulvipes* Fitch.)
 ANT (*Formica schauffusii* Mayer.)

LEPIDOPTERA.

DINGY CUT-WORM (*Agrotis subgothica* Haw.)
 GRANULATED CUT-WORM (*Agrotis annexa* Treat.)
 W-MARKED CUT-WORM (*Agrotis clandestina* Harr.)
 VARIEGATED CUT-WORM (*Agrotis saucia* Huebn.)
 CLAY-COLORED CUT-WORM (*Agrotis Morrisoniana* Riley).
 BRONZY CUT-WORM (*Nephelodes violans* Guené.)
 GLASSY CUT-WORM (*Hadena devastatrix* Boisd.)
 YELLOW-HEADED CUT-WORM (*Hadena arctica* Boisd.)
 WHEAT CUT-WORM (*Prodenia commelinæ* Guen.)
 FALL ARMY WORM (*Laphygma frugiperda* Guen.)
 STALK BORER (*Gortyna nitela* Gn.)
 ARMY WORM (*Leucania unipuncta* Haw.)
 WHEAT-HEAD ARMY WORM (*Leucania albilinea* Guen.)
 GARDEN WEB-WORM (*Laxostegc similis* Guen.)
 MEAL SNOUT MOTH (*Pyralis farinalis* Linn.)
 MEDITERRANEAN FLOUR MOTH (*Ephestia kuehniella* Zeller).
 EPHESTIA INTERPUNCTELLA Huebn.
 VAGABOND CRAMBUS (*Crambus vulgivagellus* Clem.)
 BURROWING WEB-WORM (*Pseudanophora acarnella* Clem.)
 GRAIN MOTH (*Tinea granella* Linn.)
 ANGOUMOIS GRAIN MOTH (*Gelechia cerealella* Oliv.)
 WHEAT LEAF-MINER (*Elachista præmaturella* Clem.)

COLEOPTERA.

LESSER GRAIN BEETLE (*Silvanus Surinamensis* Linn.)
 LÆMOPHLEUS ALTERNANS Er.
 TENEBRIOIDES MAURITANICA Linn.
 TENEBRIOIDES DUBIA Mels.
 AGRIOTES MANCUS Say.

- PUBESCENT WIRE WORM (*Agriotes pubescens* Melsh.)
 DRASTERIUS DORSALIS Say.
 DRASTERIUS ELEGANS Fabr.
 COMMON WIRE WORM (*Melanotus communis* Gyll.)
 MELANOTS FISSILIS Say.
 SITODREPA PANICEA Linn.
 ROSE CHAFER (*Macrodactylus subspinosus* Fabr.)
 MAY BEETLES, WHITE GRUBS (*Lachnosterna*).
 VARYING ANOMALA (*Anomala varians* Fabr.)
 COLORADO POTATO BEETLE (*Doryphora 10-lineata* Say.)
 PARIA NIGROCYANEA Cr.
 TWELVE-SPOTTED DIABROTICA (*Diabrotica 12-punctata* Oliv.)
 CHÆTOCNEMIS CONFINIS Cr.
 CHÆTOCNEMIS PULICARIA Mels.
 PSYLLIODES INTERSTITIALIS Lec.
 EUROPEAN MEAL WORM (*Tenebrio molitor* Linn.)
 AMERICAN MEAL WORM (*Tenebrio obscurus* Fabr.)
 FERRUGINEOUS FLOUR BEETLE (*Tribolium ferrugineum* Fabr.)
 PHILETHUS BIFASCIATUS.
 SITODREPA PANICEA Linn.
 GNATHOCERUS CORNUTUS Fabr.
 PALORUS DEPRESSUS Fabr.
 OAT WEEVIL (*Macrops porcellus* Say.)
 GRAIN WEEVIL (*Calandra granaria* Linn.)
 REMOTE-PUNCTURED GRAIN WEEVIL (*Calandra remotepunctata* Gyll.)
 RICE WEEVIL (*Calandra oryza* Linn.)
 SMALL BILL-BUG (*Sphenophorus parvulus* Gyll.)
 STORED GRAIN RHYNCOPHORID (*Brachytarsus variegatus* Say.)

HEMIPTERA.

- CHINCH BUG (*Blissus leucopterus* Say.)
 FAISE OR BOGUS CHINCH BUG (*Nysius angustatus* Uhl.)
 FLEA-LIKE NEGRO BUG (*Corimelæna pulicaria* Germ.)
 TARNISH PLANT BUG (*Lygus pratensis* Linn.)
 LARGE-EYED GROUND BUG (*Geocoris bullata* Say.)

EUCHISTIS FISSILIS Uhl.

DREOCORIS RAPIDUS Say.

PODISUS——Sp?

Sub-Order HOMOPETRA.

JASSUS INIMICUS Say.

BLACK-FRONTED LEAF-HOPPER (*Cicadula nigrifrons* Forbes.)

FOUR-LINED LEAF-HOPPER (*Cicadula quadrilineatus* Forbes.)

DESTRUCTIVE LEAF-HOPPER (*Cicadula exitosa* Uhl.)

DIEDROCEPHALA FLAVICEPS Riley.

TENDER FOOT LEAF-HOPPER (*Diedrocephala mollipes* Say.)

STICTOCEPHALA LUTEA Walk.

STICTOCEPHALA INERMIS Fabr.

ATYNIA VIRIDIS Emons.

WHEAT APHIS (*Siphonophora avenæ*.)

GRAIN APHIS (*Siphonophora granaria* Kirby.)

APPLE APHIS (*Aphis mali* Linn.)

APHIS——sp.?

MYZUS——sp.?

MEGOURA——sp.?

TOXOPTERA GRAMINUM Rond.

CALLIPTERUS——sp.?

RHOPALOSIPHUM——sp.?

TOXARES——sp?

SCHIZONEURA——sp.?

THYSANOPTERA.

WHEAT THRIPS (*Thrips tritici* Fitch.)

THREE-BANDED THRIPS (*Coleothrips trifasciata* Fitch.)

ORTHOPTERA.

WESTERN CRICKET (*Anabrus simplex* Hald.)

CONE-HEADED GRASSHOPPER (*Conocephalus attenuatus* Scudd.)

RED-LEGGED LOCUST (*Melanoplus femur-rubrum* DeG.)

LESSER MIGRATORY LOCUST (*Melanoplus atlantis* Riley).

ROCKY MOUNTAIN LOCUST (*Melanoplus spretus* Thos.)

DEVASTATING LOCUST (*Melanoplus devastator* Scudd.)

- ASA-COLORED LOCUST (*Melanoplus cinereus* Scudd.)
 DETESTIBLE LOCUST (*Melanoplus foedus* Scudd.)
 ROBUST LOCUST (*Melanoplus robustus* Scudd.)
 DIFFERENTIAL LOCUST (*Melanoplus differentialis* Thos.)
 TWO-LINED LOCUST (*Melanoplus bivittatus* Say.)
 AMERICAN LOCUST (*Schistocerca americana* Drury.)
 PELLUCID-WINGED LOCUST (*Camptula pellucida* Scudd.)
 LONG-WINGED LOCUST (*Dissosteira longipennis* Thos.)
 GREEN-STRIPED LOCUST (*Chimarocephala viridifasciata* De Geer.)
 FIELD CRICKET (*Gryllus abbreviatus* Serv.)
 GRYLLUS PENNSYLVANICUS Burm.
 GRYLLUS LUCTUASUS Serv.

THYSANURA.

- GARDEN FLEA (*Smynthurus hortensis* Fitch.)
 PRETTY GROUND FLEA (*Smynthurus elegans* Fitch.)
 MARKED GROUND FLEA (*Smynthurus signifer* Fitch.)

ACARINA.

- STORED GRAIN MITE (*Tyroglyphus longior* Gervais.)
 RED SPIDER (*Tetranychus telarius* Linn.)

THE HESSIAN FLY.

(*Ceatomyia destructor* Say.)

The Hessian Fly is possibly quite as important an insect enemy of the small grains as the Chinch Bug. Certainly it has occupied the attention of entomological writers to as great an extent as has that insect.

Briefly summed up: "The Hessian fly is a small, two-winged fly about one-eighth of an inch long and of a dusky color (see illustrations), and appears during May and June and again in September and October. The eggs are deposited on the upper side of the leaves, and the young, as soon as they hatch, make

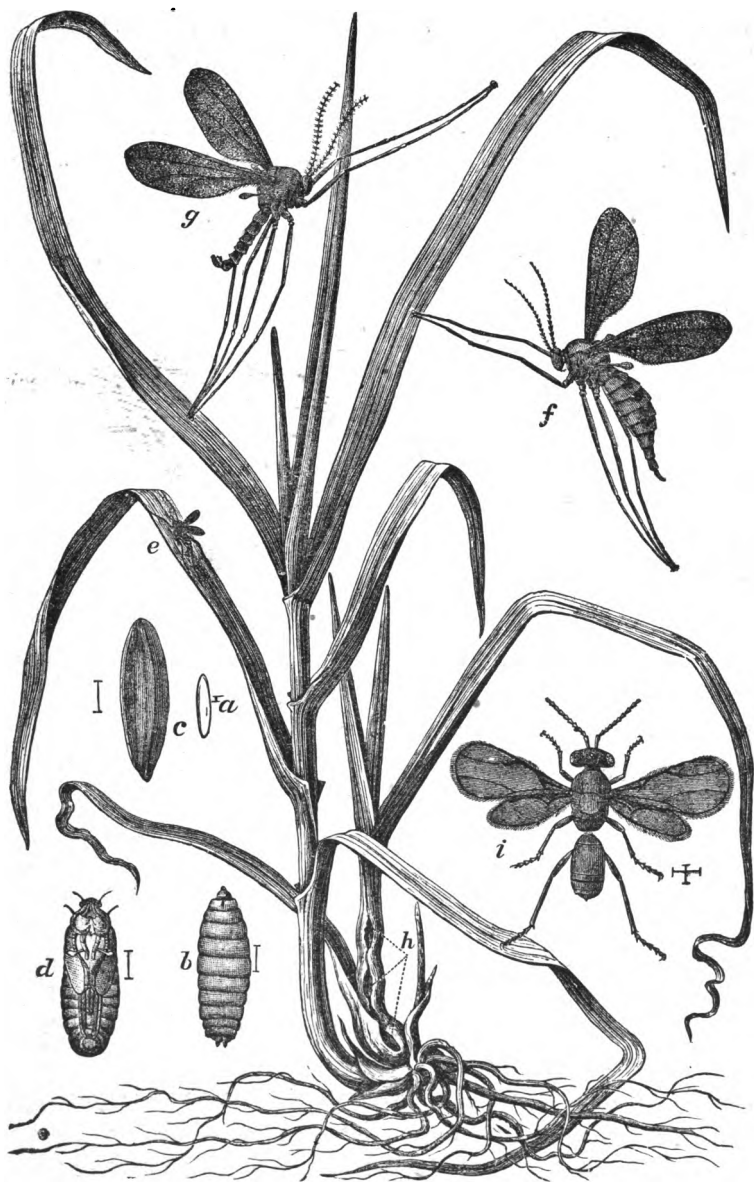


FIG. 1.—Hessian Fly: *f*, female; *g*, male fly; *a*, egg; *b*, larva; *c*, puparia or flaxseed; *d*, pupa—enlarged; *e*, fly natural size, laying eggs; *h*, injured plant showing flaxseeds; *i*, parasite of Hessian fly. [After Riley.]

their way down the plant, behind the sheath, to near the lower joints and there become imbedded in the soft part of the stem. Here they pass the winter and also the summer, in the former case in young wheat, and in the latter case in the stubble. The adults appear and the eggs are deposited at dates varying with the latitude, being earlier in the fall to the northward and later to the southward."*

REMEDIES.

This insect is best fought by choosing preventives rather than remedies after the insect has made the attack. Such as waiting until after the flies have issued and laid their eggs in fall, the selection of the very best seed that will produce strong, healthy plants, etc. Professor Webster, in writing of remedies, says:

"After the fly has gained possession of a field, I know of no application that can be made which will destroy it. Doubtless pasturing the field, if early sown, will often result in reducing the numbers of the pest, besides giving to the ground that compact, pulverized nature, which it should have had at the first. No doubt many larvæ and 'flax seeds' by this means would be crushed, but very few would enter into the food of the animals grazing thereon, unless the plants were pulled up both stem and roots."

This is chiefly an enemy of winter or fall wheat, and for that reason has been mostly absent from our state.

Several other species of these Cecidomyiid larvæ have been mentioned by different writers as working upon wheat. They are such as

THE UNFRIENDLY MIDGE. *Cecidomyia inimica* Fitch.

THE WHEAT STEM MIDGE. *Cecidomyia culmicola* Morr.

THE SPOTTED-WINGED MIDGE. *Cecidomyia caliptera* Fitch.

THE GRAIN MIDGE. *Cecidomyia graminis* Oliv. and

THE RYE GALL GNAT. *Cecidomyia secalina* Loew.

* F. M. Webster, in Bul. Ohio Agr. Expt. Station, Vol. IV., No. 7, pp. 157-58, Nov., 1891.

THE WHEAT MIDGE.

(Diplosis tritici, Kirby).

A second wheat pest that is of very great importance in this country is that shown herewith. (Fig. 2). It belongs in the same family with the preceding, but differs in its mode of attack. The Midge attacks the heads where the little red colored larvæ often occur in such numbers as to give these heads a rusty appearance. It has also been pretty definitely settled that these larvæ are also occasionally found under the sheaths of growing young plants.

REMEDIES.

On this subject Professor Webster, our best authority on the insect enemies of small grains, says, "The only thoroughly practical preventive, and also the one promising the best results, is deep plowing of wheat stubble in the fall, thereby covering the midges so deep in the earth that they are unable to reach the surface in the spring. This should be done as soon after harvest as possible. Burning the stubble before plowing will also destroy any which have remained therein, and a rotation of crop will add greatly to the efficiency of deep plowing. Sowing the wheat in the fall, at a distance from stubble fields,

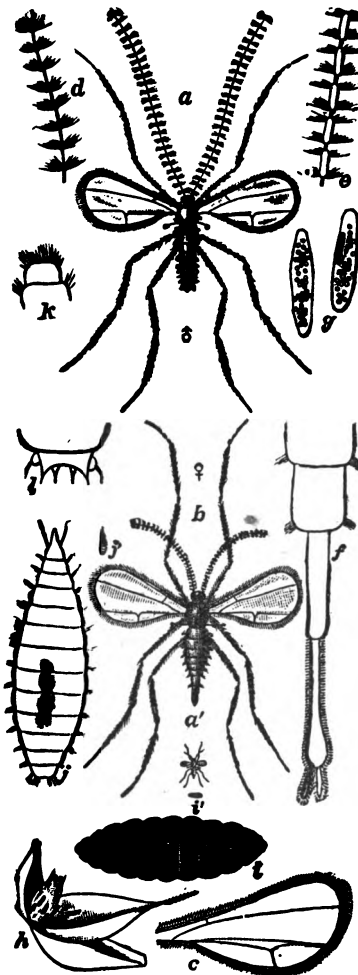


FIG. 2.—The Wheat Midge: *a*, male; *b*, female; *h*, flower of wheat showing larva on kernal. Other figures showing various parts of insect more highly magnified. [After Fitch.]

oblige the adult midges to travel from one field to another, during which change more or less are likely to be destroyed."

CRANE-FLY LARVÆ.

(*Tipulidæ*.)

We have, among other insects common to most localities in the United States, a number of species of two-winged flies that are known popularly as "Crane-flies," "Daddy Long-legs," "Giant mosquitoes," etc. These flies in their larval or maggot state are vegetable feeders, and live in the ground where they attack the roots of various plants. In European countries these insects have long been known as injurious to agriculture. Recently they have also been ascertained to injure small grains in portions of this country. In Indiana where they were studied

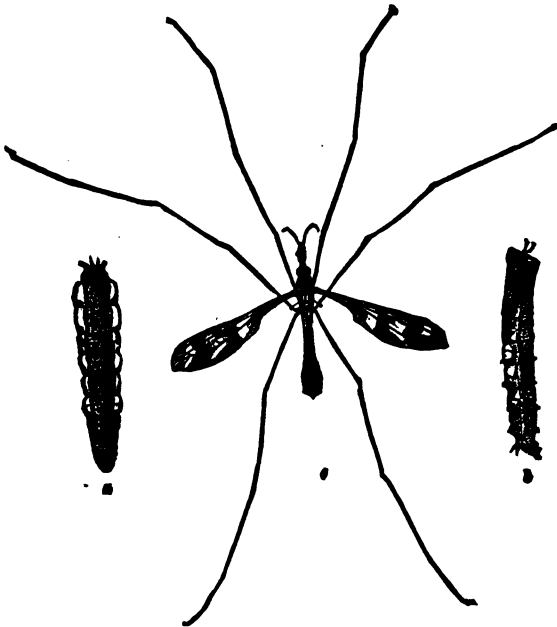


FIG. 3.—*Tipula hebes*; a, larva, b, pupa; c, imago. [After Weed.]

by Prof. F. M. Webster, they have been destroyed to a considerable degree by a fungus disease of some kind.

In a recent bulletin issued from the Ohio Experiment Station, Professor Webster has devoted considerable space to a discussion of these crane-flies. He mentions no less than four distinct species that have appeared as wheat and clover pests in this country. They are

THE TWO-HORNED CRANE-FLY (*Tipula bicornis* Loew.)

THE NARROW-WINGED CRANE-FLY (*Tipula angustipennis* Loew.)

THE BORDER-WINGED CRANE-FLY (*Tipula costalis* Say.)

THE THICK-NOSED CRANE-FLY (*Pachyrrhina*—sp?)

In his summary of the matter he says: * "With the increasing popularity of clover-growing, both for pasture, meadow, seed,

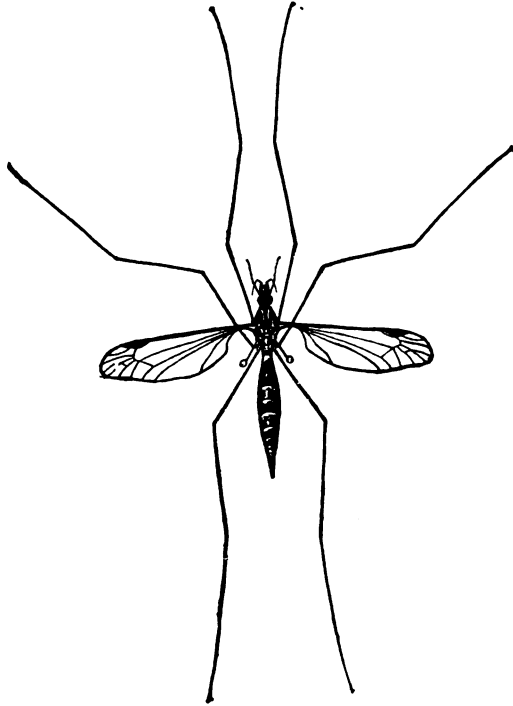


FIG. 4.—*Pachyrrhina* sp? [After Webster.]

and fertilizer, it would appear that we are on the verge of a new era with respect to the effects of these insects in our clover

* Bul. Ohio Agric. Exper. Station, Vol., V., p. 239.

fields; and even now one who watches them carefully and notes the numbers of adults which are often to be observed about our clover fields cannot help but suspect that they are working an injury which we either fail to observe, or, observing, attribute the loss occasioned thereby to other causes. So far as grain crops are concerned, the indications are that the American husbandman will have little trouble in preventing serious ravages in his fields. What the future of our clover lands is to be, especially if allowed to remain intact for a number of years, is yet to be seen. Of the species studied, there is not one the ravages of which cannot be almost entirely prevented in young wheat by plowing the ground during late August or early September, and there is every reason to believe that if the fall growth of clover is kept mowed or grazed off during September and October little trouble will likely follow from the depredations of the larvae the following spring." Figures 3 and 4 give the reader an idea of the appearance of these "Gallinippers," as they are also frequently called.

THE WHEAT STEM MAGGOT.

(*Meromyza americana* Fitch.)

Possibly the most widely distributed of all our wheat stem

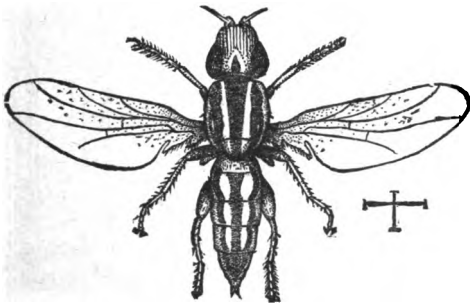


FIG. 5.—*Meromyza americana* imago.—
[After Forbes.]

worms, is the one herewith illustrated (Figs 5 to 7), and known by the name of Wheat Stem Maggot. It works in the stem. There are at least three broods of the flies each year in this part of the country. Possibly what Professor F. M. Webster, of the Ohio agricultural

experiment station has to say of it will be most to the point. He writes,* "In the ordinary course of things, then, it must be said

* Bul. Ohio Agric. Expr. Station, Vol. V., No. 5, p. 78.

that in Ohio there are three generations of the insect each year. Further south there may be more, as we have found all stages of the insect in central Texas late in February. With us, however,

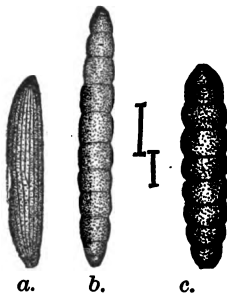


FIG. 6. — *Meromyza americana*; a, egg; b, larva; c, puparia—enlarged.—[After Forbes]



FIG. 7.—Young wheat plant; a, showing location of Stem Maggot and dead central leaf.—[Webster]

we may look for the flies in our wheat fields in September and October, where the eggs (Fig. 6, a) are deposited upon the plants, the young maggots making their way downward to a point indicated by a in Fig. 7, where they feed upon the central part of the stem, cutting it entirely off, causing it to discolor and die. Here the larvæ pass the winter, emerging as adults (see Fig. 5) in the spring. These flies deposit eggs in such a position that the young maggots will readily reach the succulent part of the straw just above the upper joint. The maggots remain here, feeding upon the stem, eventually killing it, thereby causing the upper portion of the straw and head to wither and die. From these straws the adults emerge in July and deposit eggs in volunteer wheat and grass, the maggots working now precisely as later in the fall, and developing in time to escape

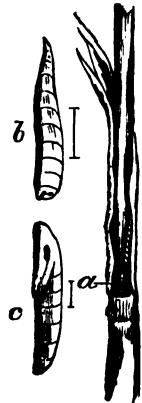


FIG. 7a. — The Wheat-stem Maggot; a, larva, natural size; b, same enlarged; c, pupa, enlarged. [After Fitch.]

again, as flies, and deposit on young wheat in the fields in the fall."

The insect occurs throughout the wheat belt of eastern North America, from Canada to Texas, where it appears to be quite common at most every locality where investigated.

Professor Webster further states that "the pest is not so destructive as the Hessian fly, yet sometimes works serious destruction, and probably in this respect ranks with the Joint-worm and Wheat Straw Worms. It is, however, vastly more difficult to destroy, and, feeding as it does in both grain and grasses, total destruction is impossible. As the adults emerge soon after harvest, it is clear that if the infested straw is left in the fields, they will soon escape to deposit their eggs; but if the grain is stacked or threshed and the straw stacked or burned, the number escaping would be greatly reduced, as it is not likely that those in the center of the stacks would be able to make their way out, and the threshing machine would likely destroy many. If plats of grain were sown immediately after the harvest in the vicinity of such stacks, many of the females could no doubt be induced to deposit their eggs therein and these could be destroyed by plowing under. How much could be accomplished by late sowing of grain is uncertain, as the females are known to occur abundantly up to October."

These flies are also attacked by a species of hymenopterous parasite and by a mite, both of which destroy the larvæ or maggots.

THE VARIABLE WHEAT FLY.

(*Oscinis variabilis*, Loew.)

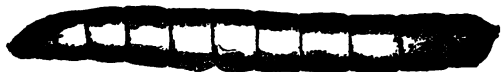


FIG. 8.—*Oscinis variabilis*, larva—enlarged.—[Garman.]



FIG. 9.—Do. Pupa—enlarged.—[Garman.]

An insect that is quite closely related to the Wheat Bulb

Worm described above, so far as its mode of attack is concerned at least, and one that will answer as a type for a number of allied species that have been mentioned as attacking small grains in



this country, is shown herewith in figures 8, 9, and 10. The figures will show the difference between these two little flies, so no description will be necessary:

REMEDIES.

FIG. 10.—*Oscinis variabilis*? Imago—enlarged.—[Garman.]

In case of the European frit-fly it has been suggested that the application of "stimulating dressing" to the soil would in some degree counteract the injuries of the insect by securing a stand of grain over and above that killed by its grubs. Whether or not such a remedy will have to be resorted to in this country remains to be seen. The "stimulating dressing" might not hurt the grain even if the frit-fly fails to appear in hurtful numbers.

Mr. Garman states * that "our insect has thus far proved most abundant on volunteer plants. The greater exemption from injury of late sown wheat seems to be due to the fact that many of the flies deposit their eggs on the volunteer plants, and disappear before the sown wheat appears above ground. Late planting may consequently be expected to enable farmers to avoid injury during the fall of the year.

"Another matter which I am satisfied is of importance in connection with injuries of insects such as this is the destruction in the fall or winter of volunteer wheat and oats with the pests they harbor. In getting specimens of the grain insects for examination I have always found these plants to yield the most. They accumulate on them in some cases in great numbers, the Wheat bulb worm, the Hessian fly, the Grain louse, and the American frit-fly sometimes occurring on the same plants. If such plants can be destroyed, they form a bait to attract pests from the sown grain. If they are permitted to grow during the winter, they are an encouragement to the insects and a menace to the wheat the next spring."

* Bul. Kentucky Agr. Expr. Station, No. 30, p. 19, Aug. 1890.

- THE SHANK-BANDED OSCINIS, *Oscinis tibialis* Fitch.
 THE YELLOW-HIPPED OSCINIS, *Oscinis coxendix* Fitch.
 THE THICK-LEGGED OSCINIS, *Oscinis crassifemoris* Fitch.
 THE COMMON CHLOROPS, *Chlorops vulgaris* Fitch.
 THE FEATHER-HORNED CHLOROPS, *Chlorops antennalis* Fitch.
 THE WHEAT CHLOROPS, *Chlorops proxima* Say.
 THE COMPANION WHEAT FLY, *Oscinis* — Sp.
 THE OBESE SIPHONELLA, *Siphonella abesa* Fitch.
 THE WHEAT MOW FLY, *Agromyza tritici* Fitch.
 THE DECEIVING WHEAT FLY, *Hylemyia deceptiva* Fitch.
 THE SIMILAR WHEAT FLY, *Hylemyia similis* Fitch.

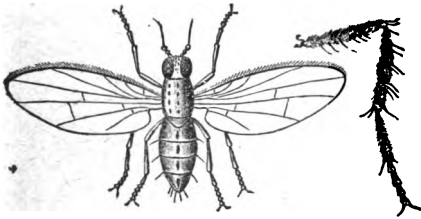


FIG. 11.—*Hylemyia deceptiva*—enlarged about four times, with a hind leg still more enlarged.—[After Fitch.]

The above named are some additional species of diptera recorded as wheat insects. They are all more or less closely related to the Wheat Bulb Worm and the Variable Wheat worm or American frit-fly.

WHEAT SAW-FLY.

(*Nematus marylandicus* Norton.)

The insect which is figured herewith (Fig. 12) has been ascertained to attack wheat in different parts of the country. It is also known as a grass insect in some localities.

The eggs are laid by the females in the edges of the blades as shown at *a, a*. These hatch in the course of two weeks to sixteen days. "The newly hatched larva (Fig. 12 *b*) is from 3 to 4 mm. long, rather slender and elongate and tapering gradually from the head to the last segment; head yellowish, eyes black. Full growth is attained in about five weeks." When full grown they measure from 17 to 20 mm. in length and are of a dirty greenish yellow color. They then enter the ground where they construct elongate cocoons of brownish silk mixed with dirt. Here they remain until the following spring when they transform to

the pupa, and later to the imago or perfect stage, about May 1st. The perfect insect (*e, f*, Fig. 12) varies greatly in color, the

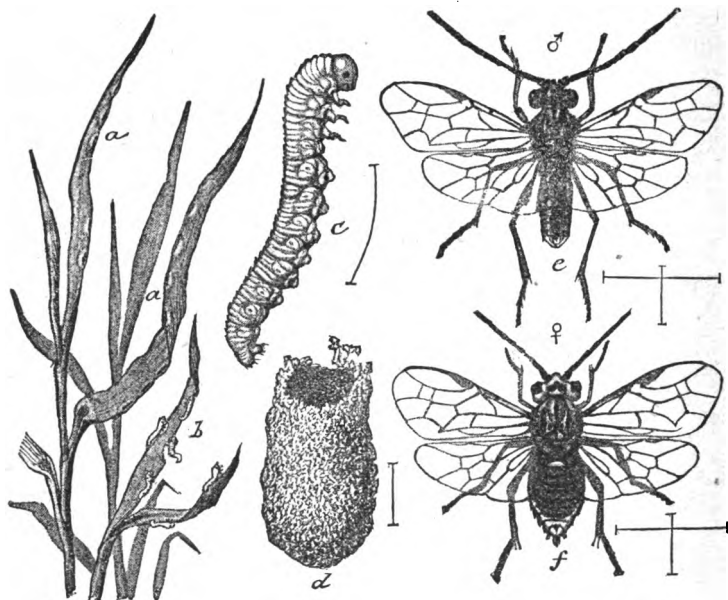


FIG. 12.—*Nematus marylandicus*: *a* *a*, eggs in wheat blades; *b*, young larvæ; *c*, full-grown larva; *d*, cocoon from which fly has escaped: *e* and *f*, adult insects—*e*, male; *f*, female; *a* and *b*, nat. size; *c* to *f*, enlarged. [Insect Life.]

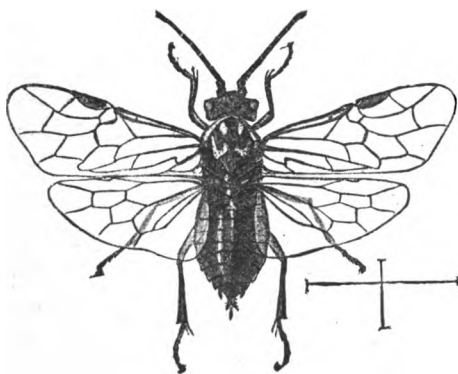


FIG. 13.—*Dolerus arvensis*, female. [Insect Life.]

male being almost black, and the female yellowish with dark markings.

Other species of sawflies that have been observed to attack small grains are—

DOLERUS AVENSIS Say,
and

DOLERUS COLLARIS Say,
both of which have been

reared, and at least three others that have not yet been reared to maturity. One of those bred (*Dolerus avensis*)

is figured herewith—Fig. 13. It is blue-black in color with the part between the wings more or less rufous or reddish-brown. The male is smaller, slenderer than the female, and is uniformly blue-black throughout.

THE WHEAT-STEM SAW-FLY.

(*Cephus pygmaeus* Linn.)

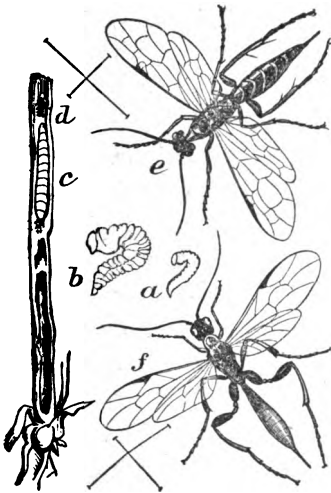


FIG. 14.—*Cephus pygmaeus*: *a*, outline of larva—nat. size; *b*, larva enlarged; *c*, larva in wheat stalk—nat. size; *d*, adult female; *e*, female parasite—enlarged. [After Curtis.]

The insect that has been known for years in European countries as the "Corn Saw-fly" has recently been introduced into the eastern portions of this country where it has been doing some injuries in grain fields. It has been quite carefully studied and reported upon by Prof. J. H. Comstock in the Bulletin of the Cornell University Experiment Station for November, 1889. Professor Webster, of the Ohio station, also gives us a full account of this insect in which he concludes about as follows: "Professor Comstock found that in the latitude of central New York the adults (Fig. 14 *e*) emerged from the stubble about or a little before

the middle of June, just as the heads of wheat were being put forth from the terminal sheath. The eggs were deposited almost anywhere in the stem, but chiefly in the upper portion. In whatever part of the straw the larva happened to hatch, it ultimately worked its way downward, and by the 19th of July all appeared to have reached the base, and nearly all had passed below the lower joint by the 15th. The larva, or worm (Fig. 14 *a*, *b*) does not pass out of the straw, but, at the extreme bottom, it constructs a cocoon, but before doing this it girdles the straw

from within, some distance above, in order to facilitate its exit after it has transformed to the adult."

PREVENTIVES OR REMEDIES.

From the above, it will be seen that this species is very similar to the other stem-infesting insects. It can, therefore, be gotten rid of by burning the stubble between harvest and next spring—the earlier the better so as to get the larvæ before they get too far down. Deep plowing might also be of value. The insect is also subject to the attacks of parasitic insects of several kinds. One of these, a European species, is shown in the figure at *f*.

A second species of the genus.

THE WESTERN STEM SAW-FLY. (*Cephus occidentalis* Riley) is illustrated herewith (Fig. 15). It has been reared from the stems of a hollow-stemmed grass, probably a wild rye. It is met with in California, Oregon, and Montana. A third species of this genus (not determined) has been taken upon wild rye here in Nebraska upon several occasions. At least fourteen distinct species of these insects have been described from various portions of North America.

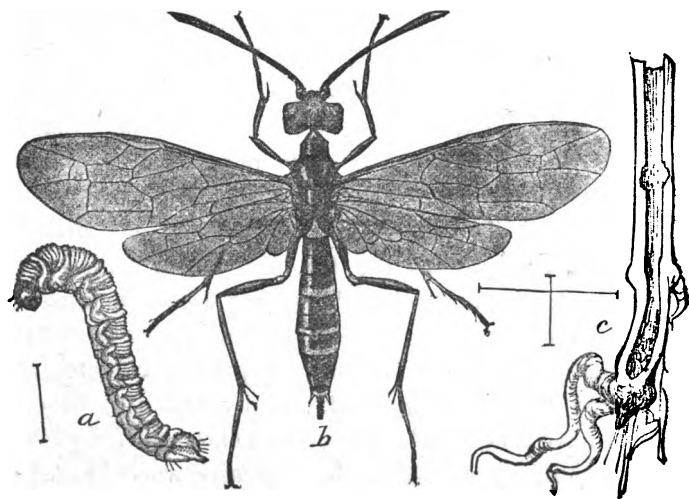


FIG. 15.—*Cephus occidentalis*: a, larva; b, imago, female; c, base of grass stalk showing excavation of larva—all enlarged. [Insect Life.]

THE WHEAT JOINT-WORM.

(Isosoma hordei Harr.)

By reference to figure 16 the reader will see illustrated a small

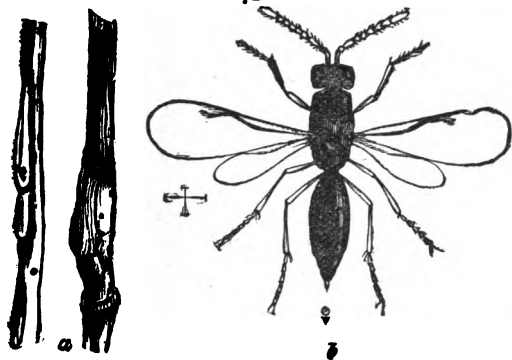


FIG. 16.—*Isosoma hordei*: a, wheat straws showing injury; b, female insect.—[After Riley.]

four-winged insect enemy of small grains together with its mode of attack. It is what entomologists know as the Wheat Joint-worm, originally described by Harris. It is quite destructive in some parts of the country.

The female lays her eggs in the wheat stem near the joints. These hatch into larva which are yellowish-white with brown-tipped jaws, similar in form to those of the next species, which are figured in 19 a, b. Then, by their presence in the plant, cause a more or less abnormal growth in the straw near the joints as shown in figure 16 a. So far as is known this insect is single brooded, the larva hibernating in the stubble and transforming the following spring. The mature insect which is quite small, the size being represented in figure 16 by hair lines at left of the figure of the insect, is black with the exception of a spot on the shoulders and the legs, which are black and yellowish, and the eyes which are reddish brown.

REMEDIES.

Since the insect winters in the stubble the remedy is simple. By burning the stubble at any time during fall, winter, or spring before the 1st of March, all the insects will be destroyed.

THE WHEAT STRAW WORM, *Isosoma tritici*, Riley.

A second species of these hymenopterous enemies of small grain is figured herewith. It differs somewhat from the preceding in its mode of attack, as well as in habits and life history.

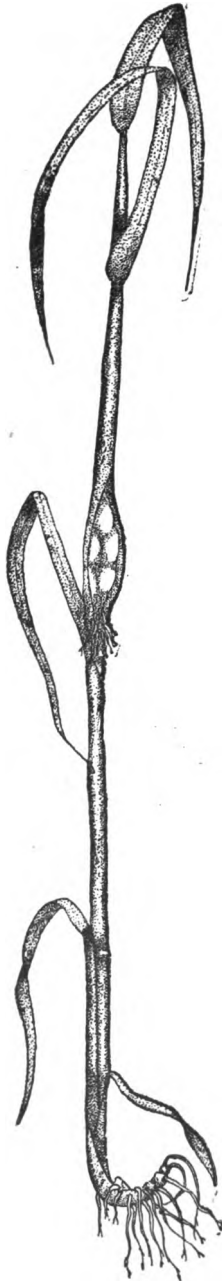


FIG. 17.—Wheat plant showing work of *Isosoma hordei*.— [After Webster.]



FIG. 18—Wheat plant showing work of *Isosoma hordei*. — [After Webster.]

Prof. F. M. Webster has recently studied these wheat-stem insects and sums up as follows when speaking of *tritici*: "It

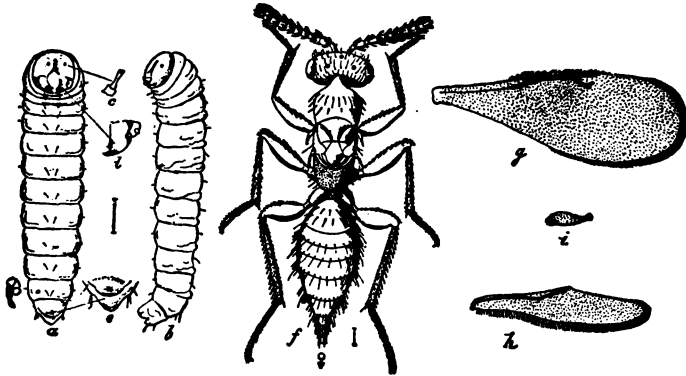


FIG. 19.—*Isosoma tritici*; a, b, larva; f, adult female; g, fore wing; h, hind wing.—[Riley.]

may be said that the Wheat Straw-worm is two brooded—an exceptional character with this group of insects—the adults of the second brood being small, almost wholly wingless, and therefore, non-migratory, composed almost exclusively of females. These appear in early spring and deposit their eggs in the growing wheat, placing them, usually, in or near the embryo head. These produce worms which, in June, develop a brood (the first) composed wholly of females (so far as known), which are robust, and provided with fully developed wings, and, therefore, compose the migratory brood, and through them the insect is diffused over the country. These deposit their eggs in or near the joints of the straw, more frequently the second below the head. The worms from these reach maturity and pass to the pupal stage in fall to emerge in early spring as adults."

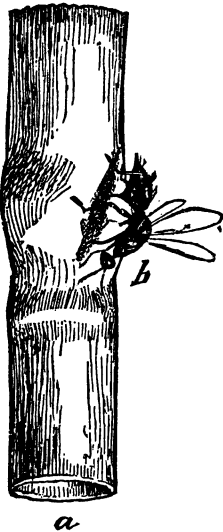


FIG. 20.—*Isosoma grande*.—[After Riley.]

REMEDIES.

As this insect hibernates in the stubble, burning will be a remedy. Then, too, by rotating crops the

wingless spring brood will be prevented from depositing their eggs.

The three following species, viz., the LARGER WHEAT STRAW WORM (*Isosoma grande* Riley), the RYE STRAW WORM (*Isosoma elymi* French), and the YELLOW-LEGGED JOINT WORM (*Eurytoma fulvipes* Fitch) are claimed by Professor Webster to be synonyms of the two species described above.

ANT. (*Formica shauffusii* Mayer.)

Occasionally ants are known to feed upon grain of different kinds. The present species has been observed by Professor Webster to eat kernels of seed wheat that had not been sufficiently covered in sowing. Other species could undoubtedly be added were their injuries of sufficient importance to warrant looking them up.

CUT WORMS.

(*Agrotis*, *Mamestra*, and *Hadena*.)

It is needless for me to tell the farmers of Nebraska that cut-worms are among our most dreaded insect pests, for everybody who has tried to raise corn, or garden crops of any description, for several years in succession, has had experience of his own concerning their powers of destruction. These insects are just as apt to attack small grains and grasses as they are to pay their attention to corn, garden products, etc. This being the case, we must include these insects here. The following account of these insects extracted from the report on "Corn Insects" will give a sort of generalization for the group:

The cut-worms are moderately large, fleshy worms tapering gently towards both ends. When full grown they average from one and one-fourth to one and one-half inches in length, are dull yellowish-white or gray, sometimes inclining to greenish, and clouded and striped or variously marked with dull black or smoky brown; sometimes, though rarely, with deep black and pure white. One of these (*Agrotis clandestina*) is figured herewith (Fig. 21), the illustration showing it has curled, a position taken by them when disturbed. This species is about an average in

size—some species being larger and others smaller than this.

The name "cut-worm" embraces the numerous species of caterpillars that have the habit of concealing themselves during day time, either beneath some object lying on the ground, or by



FIG. 21.—The W-marked Cut-Worm (*Agrotis clandestina*); larva.—[After Riley.]

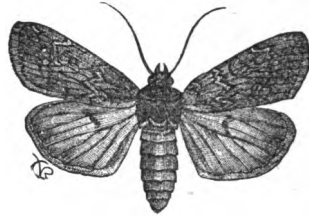


FIG. 22.—*Agrotis clandestina*; moth.—[After Riley.]

directly burying themselves just below the surface, and coming forth after night to feed upon various kinds of vegetation. Many of them confine their attacks to garden products and other low succulent plants, but others are known to climb up the trunks of trees, grape vines, and a variety of the taller kinds of vegetation belonging to garden, vineyard, and orchard, where they cause great havoc by eating the buds and tender leaves in early spring. Cut-worms are the young of a certain group of "Owlet" moths, which are also nocturnal in their habits. Both the larvæ and mature insects are, as a rule, inconspicuous in color, being usually dull gray, brown, or black, or have these colors combined.

There are upward of three hundred distinct species of cut-worms found within the limits of the United States; and perhaps fully one-third that number occur within our state. Of these the following species have been ascertained to work on the small grains:

THE DINGY CUT-WORM. (*Agrotis subgothica* Haw.)

THE GRANULATED CUT-WORM. (*Agrotis annexa* Treat.)

THE W-MARKED CUT-WORM. (*Agrotis clandestina* Harr.)

THE VARIEGATED CUT-WORM. (*Agrotis saucia* Hübner.)

THE CLAY-COLORED CUT-WORM. (*Agrotis Morrisoniana* Riley.)

THE BRONZY CUT-WORM. (*Nephelodes violans* Guenée.)

THE GLASSY CUT-WORM. (*Hadena devastatrix* Boisd.)

THE YELLOW-HEADED CUT-WORM. (*Hadena arctica* Boisd.)

THE WHEAT CUT-WORM. (*Prodenia commelinæ* Guen.)



FIG. 23.—*Nephelodes violans*: caterpillar. [After Lintner.]



FIG. 25.—*Nephelodes violans*: moth. [After Lintner.]

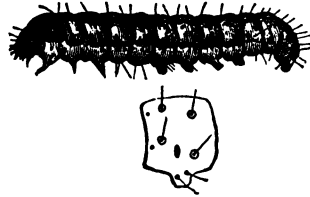


FIG. 24.—*Hadena devastatrix*: larva. [After Riley.]



FIG. 26.—*Hadena devastatrix*: moth. [After Riley.]

As my time and space are limited I shall not try to describe these different kinds separately, nor can I figure all of them now. The remarks—which are herewith presented—will, therefore, be general.

REMEDIES.

It is a rather difficult matter to name any single, or even two or three, remedies that will apply to all cut-worm depredations.

Before the various species had been separately studied, it was, and even now is, supposed by many that what is true of one is

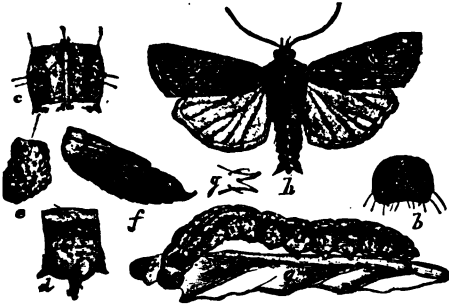


FIG. 27.—The Granulated Cut-worm (*Agrotis annexa*): a, larva; f, pupa; h, moth. [After Riley.]

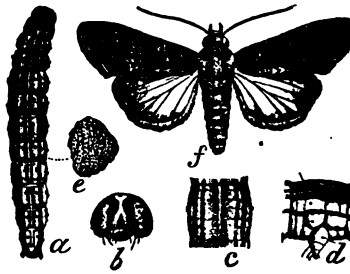


FIG. 28.—The Shagreened Cut-worm (*Agrotis malefida*): a, larva; f, pupa; h, moth. [After Riley.]

also true of all species of cut-worms. The different kinds appear at different seasons, and work in different ways, hence must be fought in various ways.

In the garden many of the worms can be taken by supplying artificial hiding places for them in the form of blocks, chips, or boards, which can be examined each morning, and the worms crushed. Digging about hills of corn, stalks of cabbage, and other plants showing recent disturbance, will usually result in the finding of the culprit. Cones of tar-paper set about plants will act as safeguards against their attacks, provided the paper

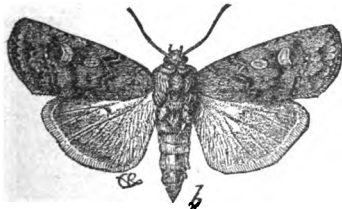


FIG. 29.—Dark-sided Cut-worm (*Agrotis messoria*): moth. [After Riley.]

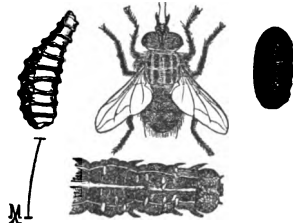


FIG. 30.—Army Worm Tachina fly: larva, pupa, imago, and front end of the Army Worm showing eggs. [After Riley.]

projects an inch above ground. Salt is also said to be repulsive to the worms. This latter mode of fighting injurious insects is

not to be too highly recommended, since salt is also more or less detrimental to the growth of many kinds of vegetation,

The very best remedy that has thus far been suggested and tried against cut-worms is the use of poisoned grasses, cabbage leaves, or clover. This is done by taking these substances and tying them into loose bunches, and then sprinkling them with a solution of Paris green, or London purple, say a tablespoonful to a bucket of water. Then in the evening scatter these



FIG. 31.—*Tachina*
or Flesh Fly.

poisoned baits over the field between the rows of beets, cabbage, etc. The worms will be attracted to them, eat, and die. These baits should be renewed several times, at intervals of two to four days, according to the state of the weather and the abundance of the worms.

All of these cut-worms are attacked by several kinds of parasites, both hymenopterous and dipterous. They are also devoured by a number of predaceous beetles, while birds of many kinds are especially fond of them. One of these dipterous parasites is shown in Fig. 30, and another at Fig. 31.

THE FALL ARMY WORM.

(*Laphygma frugiperda* Guen.)

Very closely related to the cut-worms, and resembling them much in general appearance and habits, is an insect that has received the popular name of Grass Worm or Fall Army Worm. This insect is shown in Fig. 32, where the mature insect is figured. This insect is frequently very numerous, and is accordingly very destructive. Although called the Grass Worm, it is by no means confined to grasses as its diet. Corn and other grain crops are just as eagerly attacked and devoured by it.

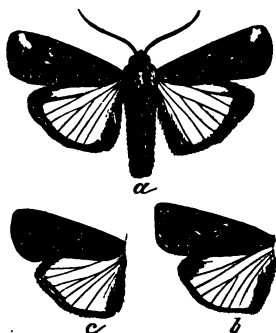


FIG. 32.—*Laphygma frugiperda*: moth, showing variations. [After Riley.]

Since this is such an important insect, and as I have not treated of it before in any of my reports to the Society, I will give a quite full description of it here. The following characterizations of the insect are copied from Prof. S. A. Forbes's account of the insect in the fourteenth report of the entomologist of Illinois:

Moth.—"Front wings narrow, apex broadly rounded. General color brownish-gray, varied with bluish white, dusky and fulvous. A bluish white patch at the apex of the wing, usually containing a few black points. Subterminal line arcuate, of the same color, continuous, with this patch in front, sometimes obsolete at the terminal point of the wing, but sometimes complete. Before the subterminal line, and within the apical patch, is a dark blotch upon the middle of the wing, which sometimes contains one or two triangular black points. Transverse anterior and transverse posterior lines sometimes obsolete, when present double, zigzag. Base of wing slightly paler, with a longitudinal black blotch in the middle. Orbicular spot obliquely oval, pale, testaceous, with an oblique mark of same color immediately without. Reniform spot obscure, distinguished in front and behind by small whitish blotches, the posterior linear, often shaped like the letter 'e', the anterior variable. Upon the costal margin, a series of whitish dashes, four of them between the reniform spot and the apex, and as many more, obsolete, between that and the base. Terminal line pale, subterminal space dark, divided into quadrate blotches by the nervures. Fringe paler gray, the scales tipped with black between the nervures. Under surface smoky but paler anteriorly and terminally, and fulvous along the costa. Posterior wings translucent, nearly white in some lights, roseate in others, dusky on anterior margin and on anterior half of outer margin. Head, thorax, and abdomen nearly uniform gray; thorax with a V-shaped black mark in front."

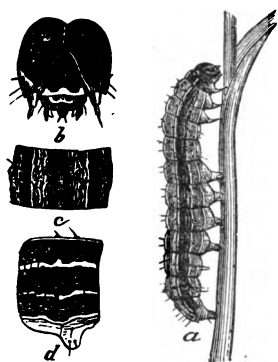


FIG. 33.—*Laphygma frugiperda*: a, larva; b, head of same. [After Riley.]

Caterpillar or larva.—"The larvæ are dark, the general effect being that of a nearly black insect with a broad buff band below the stigmata, and a narrow yellow subdorsal line. The dorsum is black or a very dark brown with a yellow median line, and irregular white lineations along the border of the dorsal space. The subdorsal band is also black, slightly mottled along the lower margin, bordered above by a yellow line which is itself bordered above and below by a shade of deeper black. The stigmatal band is drab, mottled with pale brown; the stigmata black, partly within the stigmatal band and partly within the subdorsal band. In one specimen the dorsum is pale chocolate brown with scarcely a trace of the median line. The heads in all are jet black except on the sides, behind the eyes, where they are somewhat mottled with whitish. The Y-shaped mark upon the front is white and deeply impressed. The cervical shield is black, with the median line and subdorsal yellow lines continued upon it. Upon the caudal shield the median line widens to a more or less triangular blotch. The labrum is brown, the basal joint of the antennæ is wholly white, the second joint white with a black ring at the base, and the third joint brown. The venter is greenish brown beneath the buff lateral band, becoming nearly yellow towards the bases of the prolegs. Each of the latter has a glossy black patch upon its outer surface. Between these legs the surface is a brownish green. The whole ventral area is finely mottled with yellow."

Judging from the notes that have been accumulated by different authors in reference to this insect, it would appear that there are at least two broods of the worms northward and three southward in the United States. The first brood northward often attacks the young corn, and by eating the leaves and burrowing into the heart of the plants kills them. Later in the summer the leaves and the tender ears are damaged.

REMEDIES.

As it is in the case of other cut-worms and the true Army Worm, so it is with reference to the present species. They are all usually held in check by their natural enemies, certain dipterous and hymenopterous parasites. Sometimes, however, these from some cause or other fail to do their work and the moth gains the ascendancy. When such is the case artificial means must be resorted to if we would protect our crops from their ravages. In writing on this feature of the subject Professor Forbes has the following to say:

"The female moths, when searching for a proper place of deposit for their eggs, are evidently attracted to the ground upon which the larvæ do their damage by the presence of an abundance of green food for the latter, a fact which immediately suggests early plowing of ground intended for winter wheat, as a preventive measure. Doubtless, except for the allurements of growing vegetation, the eggs of the imago would be planted elsewhere, or so widely scattered as to effect no appreciable damage.

"Certainly in that region where the grass worm prevailed last year it would be prudent to plow early after oats when it is intended to plant wheat.

"If, however, this precaution has been neglected and hordes of the larvæ appear in the wheat field, it will doubtless prove difficult to arrest their ravages. No opportunities for experiment have as yet offered, notice of the appearance of the larvæ in the wheat field having been received too late to permit trial of remedial measures; but it may be worth while to suggest heavy rolling as a measure likely to be practicable and efficient in some instances. This has occasionally been found useful for the destruction of the true Army Worm. One farmer in Mason county, who noticed that the grass worms were extending their ravages rapidly from the central area in which he first noticed them, believed that he had destroyed the brood and prevented further injury by plowing under the infested area and rolling it heavily immediately thereafter. If a disposition to migration, like that

of the Army Worm, is apparent, the march of the host may be arrested by measures which have been found more or less efficient in the case of the last named insect; that is, a furrow may be plowed across the line of their march, when the worms collecting therein may be destroyed by dragging a log along the furrow. If their appearance is easily detected while they are quite small, it might not be unprofitable to destroy them with Paris green or other form of insect poison, but in most instances it will doubtless be less expensive to resow the ground than to attempt the somewhat doubtful remedies here proposed."

THE STALK BORER.

(*Gortyna nitela* Guen.)



FIG. 34.—*Gortyna nitela*: 1, moth; 2, larva.
[After Riley.]

While the insect that is figured herewith (Fig. 34) is chiefly an infestor of the stems of pithy plants, it is also a feeder on other plants among which are the small grains. It is described

at some length as a corn insect in last year's report where remedies are given. The reader is therefore referred to that paper for an account of its habits, etc.

THE ARMY WORM.

(*Leucania unipuncta* Haw.)

The name "Army Worm" has been indiscriminately applied in this country to several species of widely separated insects that at times have appeared in great numbers, and moved apparently with a single impulse as of an army. Among these can be mentioned the Cotton Worm (*Aletia xylinia* Say.), which devastates the cotton crop of southern states; the Grass Worm (*Laphygma frugiperda* Sm. & Abb.), also a southern insect, mentioned on preceding pages of this paper; the Tent Caterpillar (*Clisiocampa*

sylvatica Harr.); the Fall Web Worm (*Hyphantria textor* Harr.); and one or two others.

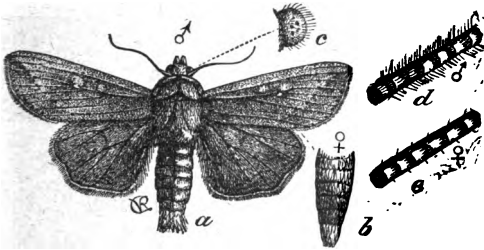


FIG. 35.—The Army Worm (*Leucania unipuncta*: a, male moth; b, abdomen of female, natural size; c, eye; d, antennal joints of male; e, do. of female, enlarged. [After Riley.]

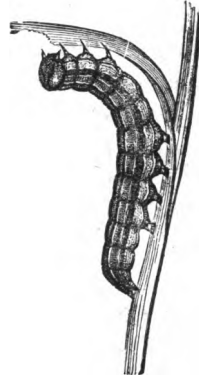


FIG. 36.—Army Worm, the full grown larva. [After Riley.]

Here in Nebraska the larva of a species of saw-fly is some-



FIG. 37.—Army Worm; the pupa. [After Riley.]

times "dubbed" with the name of Army Worm; one of the *Myaiapods* (a Polydesmid) is also called by that name. There is perhaps an excuse for this "many-foot" receiving the name because it frequently appears in veritable armies

upon low ground. Unlike the true Army Worm (*Leucania unipuncta*), of which this article treats, this "thousand-leg" does no particular damage to growing vegetation. It is an underground feeder, and only comes to the surface during excessively wet weather, and when mating.

The Army Worm is almost cosmopolitan in its distribution, but nowhere except in the United States does it appear to be a pest. Here, too, its ravages are confined chiefly to the middle and northern portions east of the Rocky mountain. In Nebraska it was first observed by me in injurious numbers during the summer of 1888, and then only over a limited area in our extreme northwestern counties. Of course it may have been present in hurtful numbers prior to this, and its ravages not have come to my notice. This is hardly probable, however, since I have been

carefully watching the coming and going of insect pests within the state for upward of fifteen years.

This insect can readily be recognized by a comparison with the above figures (35, 36, and 37). The moth is reddish-brown, more or less thickly sprinkled with minute black specks over the front wings; and it also has a small white spot near the center of each, from which it takes its specific name. The larva or "worm" is striped with light clay brown, which colors vary somewhat in different individuals.

REMEDIES AND NATURAL ENEMIES.

Chief among the remedies adopted for keeping in check the increase of this pest is the burning of old grass, stubble, and other like receptacles for the eggs and hibernating larvæ. Perhaps this accounts for the absence of the pest from our frontier settlements in this and other western states for the past twenty years and more, the customary fall and early spring prairie fires having destroyed such eggs and larvæ as would otherwise have entered upon the spring and summer campaigns. This is a pre-



FIG. 38.—*Colsonia colidum*; a, the beetle; b, the larva. [After Riley.]

ventive before the pest has "materialized." The burning should be postponed until spring has well advanced to be of most benefit. During late years the increase of area cultivated and the prevention of starting fires on the prairies, especially in the "cattle district" of the northwest, has perhaps been the direct cause for the presence of this insect in injurious numbers.

Now that it is with us, and liable to remain, we must be ready

to meet it face to face. Ditching, rolling, plowing, etc., are remedies that can be used advantageously. Ditching and fencing can be resorted to in preventing the worms from passing from one field to another. Fence boards set on edge and saturated with kerosene will effectually check an advancing column, after which they can be destroyed by crushing. Ditching, with



FIG. 39.—*Cicindela 6-guttata*. [After Riley.]



FIG. 40.—*Harpalus caliginosus*. [After Riley.]



FIG. 41.—*Exorista leucanica*. [After Walsh.]

the opposite side of the ditch from the advancing host "dug under," will "corral" the worms for the time being, when they can be destroyed by crushing, or by covering with hay or straw and setting fire to it. Poisoning with London purple and Paris green has also been resorted to with good results; but as long as other and less dangerous methods do not fail it is advisable not to resort to these. Grass or grain that has been sprayed with these poisons should never be fed to stock, as there is danger of poisoning animals so fed.

During ordinary years this, as well as most all other injurious insects, is kept in check by its natural enemies; but occasionally, from various cause these of themselves are not sufficient to do the work. Among the enemies of the Army Worm are to be mentioned the insectivorous birds, poultry, reptiles, and when hard pressed for food they even devour one another. Quite a number of the predaceous beetles and their larvæ destroy hundreds of the worms. Three of these beetles are figured here. Fig. 39 represents *Cicindela 6-guttata*; Fig. 40 is *Harpalus caliginosus* Fabr.; and Fig. 38, *a* and *b*, are larva and imago of

the Fiery Calosoma, *Calosomn calidum*. There are also a large number of true parasites that work upon this insect in one or the other of its stages. One of these (*Exorista leucaniæ*), a Tachina fly, is figured at Fig. 41. Besides the several species of two-winged flies that are parasitic upon *Leucania unipuncta*, there are certain Ichneumonids and other parasitic Hymenoptera that attack the worms by laying their eggs within their hosts' bodies, where their young eat away their vitals.

THE WHEAT-HEAD ARMY WORM.

(*Leucania albilinea* Guen.)

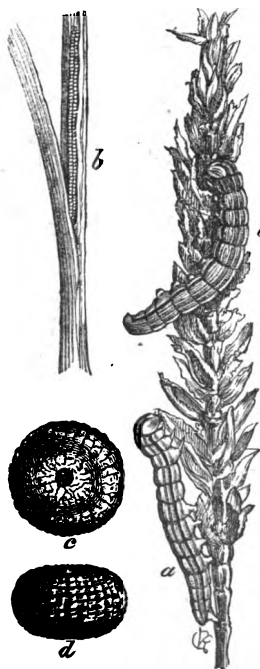


FIG. 42.—Wheat-head Army Worm: *a, a*, larva; *b*, eggs—nat. size; *c, d*, egg, top and side view—enlarged. [After Riley.]

The insect that is illustrated herewith, both as larva and imago, is known as the Wheat-head Army Worm. "Wheat-head," because of its feeding upon the heads of the grain, as shown in Fig. 44, *a, a*, and "Army Worm," because of its sometimes appearing in great numbers. Although it is not a constant species against which the grower of grains is obliged to wage war, it has on several occasions been known to do considerable injury in different parts of the country.

As will be noticed by reference to the scientific name, this insect is classed with



FIG. 43.—Wheat-head Army Worm; moth. [After Riley.]

the true "Army Worm" in the genus *Leucania*. Its appearance in armies is therefore not to be wondered at, since very often re-

lated forms have similar habits. The following description of the insect is copied from the 9th report of the state Entomologist of Missouri:

"*Mature larva*.—Average length rather more than an inch. Colors pale yellow and brown. The brighter marked specimens have the dorsum brown with a narrow medio-dorsal yellow line, obsolete posteriorly; then a sub-dorsal sulphur-yellow line one-half as wide and suffused in middle with carneous; then a still narrower brown line, ill-defined, beneath; then a yellow line of same width as preceding; then a somewhat broader brown-black stigmatal line; then a stigmatal sulphur-yellow line as broad as subdorsal and generally relieved below with pale brown—all the dark parts, except the black stigmatal line, speckled with yellowish. Venter dull white. Head large, wider than body, pale yellow—almost white, with brown-tipped jaws, mottlings on the cheeks, and two broad, brown marks (with a tendency to fade in the middle) on top, narrowing each side of V-shaped sutures. Stigmata white, with black annulus. (In *unipuncta* they are dark with a pale annulus.) Piliferous spots, though more conspicuous than in *unipuncta* [true Army Worm] in first stage, now less so. Varies considerably, some being quite dark and others greatly suffused with rosaceous; but the pale head, dark stigmatal line, and bright yellow lines are constant."

The imago, which is shown in Fig. 43, is dull straw color on front wings and marked with white and darker streaks as shown in the illustration. The hind wings are satiny-white with a faint dusky tint posteriorly.

In some parts of the country, especially southward, there are two broods of the larvæ or caterpillars; while northward the rule is but one brood.

REMEDIES AND ENEMIES.

The insect is quite subject to the attack of several species of parasitic diptera and hymenoptera. It is these that usually keep them within due bounds. Birds and other insectivorous verte-

brates also do much in the way of destroying both the caterpillars and moths.

Professor Riley states that "it cannot be successfully fought in the worm state, and the wheat grower who has been troubled with it should direct his attention to the destruction of the chrysalids by late plowing and harrowing and to the capture of the moths in spring by means of lights and sweetened and poisoned fluids."*

THE GARDEN WEB-WORM.

(*Loxostege similis* Guen.)

Although this insect has been quite well described in several of the other reports within the past two or three years, I consider it of sufficient importance even as a small grain pest to treat of it in this connection quite fully. I will therefore repeat what has been said of it as a corn insect. It is one of our more recent insect enemies and is an especially characteristic western species. From its already large food-plant list we need to watch it in the future.

It is known by the name of the Garden Web-Worm, from the fact that it spins a web while feeding; and "Garden," because it is a garden frequenter rather than a field inhabitant. Systematically, it belongs to the family of moths which bear the name of *Pyrallidæ*, the members of which are all more or less injurious. It has been quite thoroughly treated in Professor Riley's annual report to the Commissioner of Agriculture for the year 1885, pp. 265-270. I will therefore quote quite largely from that source. It might be well to state here that it is quite variable and has been several times described and has a large synonymy.

In referring to the distribution of this insect that author writes as follows: "*Eurycreon rantis*† is quite a widespread species, occurring all over the United States. It has been captured in South America, and the original description of the species was from a specimen from Montevideo."

*C. V. Riley, Ninth Missouri Rept., p. 55.

†This is one of the synonymic names that have been given to *Loxostege sticticalis*.—Bruner.

DESCRIPTIVE.

"The moth (Fig. 44, *f*) has an average expanse of 18 mm.

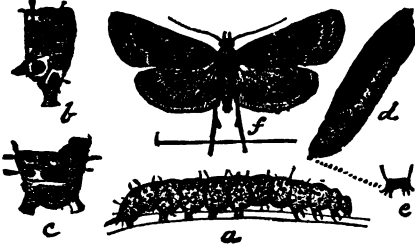


FIG. 44.—Garden Web-Worm (*Loxostege*): *a*, larva; *d*, pupa; *f*, moth—all slightly enlarged. [After Riley.]

The general color is either orange or reddish yellow, inclining to buff, or more commonly a lighter or darker shade of gray, having, in certain lights, either a copperish or greenish reflection very similar to that on the well known Cotton Worm Moth (*Aletia xyli*na). The char-

acteristic markings, as shown in the figure, are the darker reniform and obicular spots, with a paler shade between them; two irregular transverse pale lines, generally relieved by darker shade, most intense posteriorly on the anterior line and basally or interiorly on the posterior line. The terminal space may be either paler or darker than the ground color. The markings are very variable, however, dark specimens (*rantalis*) having them all well defined, paler specimens (*communis*) less so, while in others (*crinialis*) the anterior line and inner portion of posterior line may be lacking."

"The larva * * * is also somewhat variable in color, being either pale or dark-yellow, or even greenish-yellow. It is marked with rather distinct jet-black piliferous spots, as illustrated in the figure. The piliferous spots are also more or less distinctly relieved by a pale border.

"The pupa is of the normal brown color and characterized by the tip of the body having two prominences, each furnished with stout, short spines."

Although this insect is known to extend over a remarkably large area, its injuries have thus far been confined to the region between the Missouri river and the Rocky mountains; nor has it been observed here to any great extent—at least, north of the Platte river. This area is, however, quite liable to be increased with the general cultivation of the soil in the beet belt.

FOOD PLANTS.

Like many of our more injurious insect pests, the "Garden Web Worm" is quite a general feeder. It is especially one that will need our watchful care if we hope to keep it within bounds, for it is one of the very few species that is a genuine weed-feeder. In fact, it is more partial to some of the weeds than it is to cultivated plants. Professor Riley speaks of the food habits of this insect as follows in the report already referred to: "There is no question but that the preferred food of this species is the foliage of plants of the genus *Amarantus*, called in different parts of the country Amaranth, Pig-weed, and Careless weed. This was very noticeable in our observations in 1873, and its next preference seemed to be Purslane. Professor Snow also mentions Lamb's Quarter (also called "Pig-weed" *Chenopodium*) as a favorite food plant. Prof. C. E. Bessey, writing from Lincoln, Nebraska, August 11, mentioned an unusual abundance of these larvæ upon *Amarantus retroflexus* and *A. blitoides*. Another correspondent mentions finding them the present year (1885) upon the common Cocklebur (*Xanthium strumarium*), but this was probably due to their excessive abundance and want of proper food. This, also, is probably the case with the common Burdock (*Lappa*), which is mentioned by another correspondent. Professor Popenoe mentions, among the weeds injured, *Amarantus alba*, *Chenopodium album*, *Ambrosia trifida*, *Apocynum cannabinum*, and *Grindelia squarrosa*. He also mentions the fact that they injured a bed of scarlet verbenas."

The following are the cultivated plants that it has been observed to feed upon: Corn, cotton, cabbage, cucumber, castor beans, melon, squash, pea, beans, red clover, alsike, alfalfa, pumpkin, sweet potato, Irish potato, egg plant, tomato, orchard grass, timothy, meadow oat grass, millet, flax, tobacco, sugar cane, lettuce, onions, and beets, besides others. Thus it will be seen that the insect is a more general feeder than might be at first supposed. In fact it appears to be able to feed on almost anything.

HABITS AND NATURAL HISTORY.

Under this heading Professor Riley, whom I have already quoted largely, says: "The full natural history of the species has not yet been made out. The eggs have not yet been described, the method of hibernation is not positively known, and the number of annual generations has not been carefully determined."

The insect is evidently a many-brooded species, since indications point to at least three or four sets of the moths during the spring, summer, and fall. The larva is a web-maker, and always spins as it goes and constructs a sort of retreat in which it remains during the day time at rest. It is described by Professor Popenoe in the second quarterly report for 1880 of the Kansas State Board of Agriculture. He says: "The following points in its history are the partial result of my study of the insect. Although I made a careful search for the egg, I failed to discover it *in situ*, but it is without doubt deposited on the lower side of the leaf, or low down among the bases of a cluster of leaves, as newly hatched larvæ are found in both these situations, from which they soon wander to other parts of the plant. As soon as it (the larva) begins to move about it begins to spin the web, and this is increased in extent as the movements of the larva are

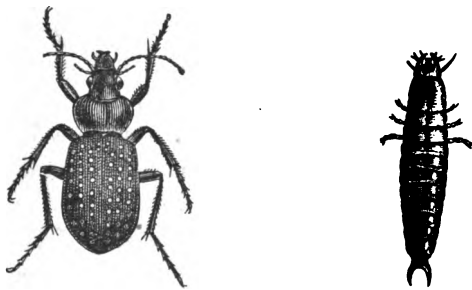


FIG. 45.—*Colsonia colidum*; a, the beetle; b, the larva. [After Riley.]

extended. It is very active in all stages of growth as a larva, and springs aside quickly when touched, sometimes throwing itself into a coil, but more often running rapidly away. At least in early life the larva, when thrown off a leaf, will hang by a

thread of silk. In case a single leaf is of sufficient size, as in the sweet potato, the well-grown larva is generally found on the upper side in a shelter formed by drawing partly together the edges of the leaf by the silk of its web. In this shelter it is



FIG. 46.—*Harpalus caliginosus*.
[After Riley.]



FIG. 47.—*Pasimachus elongatus*.
[After Riley.]

usually found at rest during the day, hanging by its feet, back downward, to the lower surface of the web. In other plants several leaves may be drawn together for a place of concealment. If, indeed, the larvæ are not partially gregarious, they are at least not disturbed with proximity to each other, as several may be found at times in a common web, although I believe this is exceptional. As they are forced to move to new parts of the plant for fresh food their webs are extended until finally the entire plant is covered. The young devour only the surface and substance of the leaf on the side where they are, leaving the veins and the opposite epidermis untouched, producing a "skeleton" leaf. As they grow older, however, they devour all portions of the leaf, and often eat also the petioles and tender stems. Opportunity has not been given to determine the exact length of the larval life of this insect, but judging from observations made, this cannot greatly exceed a week. Parties living in the region where the insect was present in great numbers give ten days as the length of time in which the chief destruction was accomplished."

Although I have never paid personal attention to this insect, it is learned from the records of others that, when full grown,

the larva spins for itself a delicate silken cocoon among the debris on the ground at the base of its food plant, and transforms to the pupa or chrysalis stage. It remains in this last from one to two weeks.

NATURAL ENEMIES.

Like all other injurious insects, this one is quite certain to have its insect enemies, both parasitic and predaceous. Some of the ground-beetles, like those illustrated in Figs. 45, 46, and 47, feed upon the larvæ, while a *Tachina* fly has been bred from them both here and in Kansas. A number of hymenopterous parasites have also been reared from the closely related *Loxostege sticticalis*.

THE MEAL SNOUT MOTH.

(*Pyralis farinalis* Linn.)

While this insect is not directly a grain pest, it can with propriety be included here on the grounds of its being a "flour feeder."

The moth is a member of the Deltoids or Paralidæ family—a name given to the group on account of the shape of these insects when at rest. This meal moth has the front pair of wings light brown, "crossed by two curved white lines, and with a dark chocolate-brown spot on the base and tip of each." These moths are often seen upon ceilings of rooms and out-buildings, and can easily be destroyed at such times. When they infest flour bins and barrels these can be ransacked and the larvæ and pupæ destroyed. It is one of the "household" pests that must be guarded against along with such others as the Clothes moths, Carpet beetle, etc.

THE SO-CALLED MEDITERRANEAN FLOUR MOTH.

(*Ephestia kuhniella* Zeller.)

The insect which is herewith figured in larva, pupa, and imago (Fig. 48) certainly deserves mention here, since it has

become a great pest in some parts of the country. The editors of *Insect Life* in an article on this insect, after giving some references to its probable origin, resume as follows:

"That the insect is with us now, however, in destructive numbers, and that it is a pest of no small magnitude cannot be doubted. The condition of affairs in Canada, as stated by Mr.

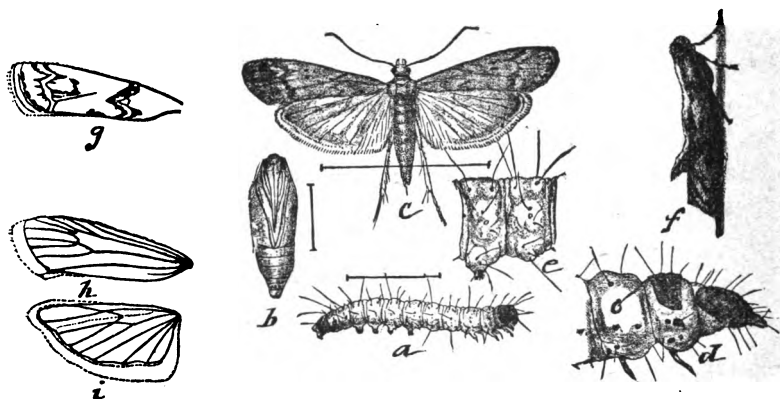


FIG. 48.—*Ephestia kuhniella*: a, larva; b, pupa; c, imago—enlarged; d, head and thoracic joints of larva; e, abdominal joints of same more enlarged; f, moth from side, resting; g, front wing, showing more important markings; h, venation of fore-wing; i, venation of hind-wing—somewhat enlarged.—[Ins. Life.]

Fletcher in his letter, is by no means exaggerated. Mr. Howard was in Canada the latter part of August and accompanied Mr. Fletcher on a tour of inspection to the worst infested establishment, and the entire building was completely overrun by these creatures. Hardly a crack or a nail hole was to be found without the cocoons (Fig. 49), and every bit of flour or grain remaining was spun together by their webs.

LIFE HISTORY.

The life history of this insect can be given briefly as follows:

The eggs are laid by the parent moth upon grain or flour bags, in crevices about mills, elevators, store houses, etc. These soon hatch and the young begin crawling about and feeding upon both the flour and grain, spinning a web as they go. There are two broods each year. The larvæ forsake the food and wander

about when full grown, crawling into cracks and crevices of all kinds preparatory to spinning up to enter the pupa stage. The

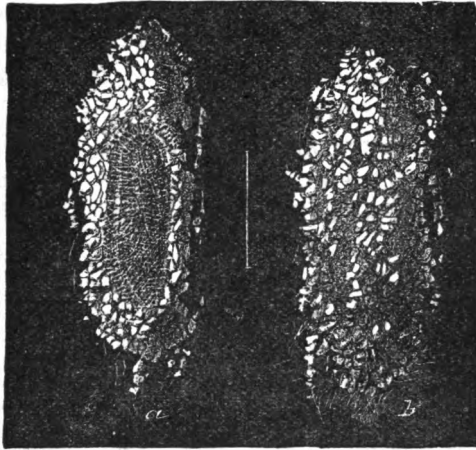


FIG. 49.—*Ephestia kuhniella*: a, cocoon from below, showing pupa through the thin silk attaching the cocoon to a beam; b, same from above—enlarged. [Insect Life.]

insect, besides being double-brooded, is also exceedingly prolific, there having been 678 eggs counted in a single female.

REMEDIES.

In the article referred to above it is stated that "The moths were still flying about in numbers, although great efforts had already been made to destroy them. The government of Ontario made strenuous efforts to stamp out the pest. * * * * * The machinery was taken down and steamed, the walls were scraped down, and the elevator spouts and loose wooden work, together with pipes, bags, and quantities of stock, were burned up; belts, cups, and cloth bags were boiled, and the whole place was subjected to sulphur fumes. Every inch of space about the machinery was subjected to the flames of a kerosene torch." White-washing the walls and subjecting them to steam heat did not effectually destroy the pest. Moving and airing the wheat is claimed to have little or no effect against it.

From the above statements it at once becomes apparent that we must be on the lookout for the insect in the mills. These should be thoroughly cleaned several times during the year, especially in spring and fall; and at all times the accumulating dust should be swept up and disposed of in such a manner as to destroy such insects as it may contain.

EPHESTIA INTERPUNCTELLA Huebn.

Very closely related to the preceding is a second species of *Ephesia* that is quite important as a small grain and flour pest. It is the one that sometimes goes by the name of "Indian Meal Moth," (*Ephestia interpunctella*), but is distinct from the insect that is known as the "Meal Snout Moth" which is mentioned on a preceding page.

While the present species has very similar habits with those of the Mediterranean Flour Moth, it is probably less to be dreaded than its ally. Still, the present species is capable of becoming an exceedingly dangerous pest in granaries and mills, and it should be carefully guarded against. The accompanying illustration (Fig. 50), when compared with that of the former, will show the differences between the two insects.

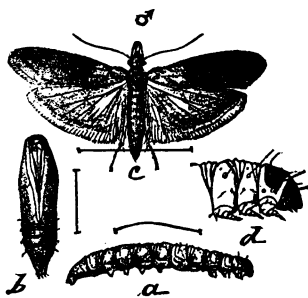


FIG. 50.—*Ephestia interpunctella*: a, larva; b, pupa; c, imago—enlarged; d, head and thoracic joints of larva still more enlarged.—[Insect Life.]

REMEDIES.

What is said under this head in reference to *kühniella* will apply equally well here. Whenever these insects are recognized they should immediately be attacked with energy. They can best be controlled by sprays of benzine or gasoline; but great care should be taken in the use of these highly inflammable and explosive liquids.

THE VAGABOND CRAMBUS.

(*Crambus vulgivagellus* Clem.)

The insect which is figured herewith, although normally a

grass-feeding species, is nevertheless at times quite an enemy of small grains. It is very well represented in the accompanying illustration in its different stages of growth, hence will not be described in detail. Like others of the "web-worms," this species conceals itself in a web when not feeding, and in which it retreats during daytime. This web is well illustrated in Fig. 51 at *b*. Dr. J. A. Lintner, in his first report as entomologist of the state of New York, in speaking of the family characteristics of this insect says (p. 139): "To those who are not familiar with that division of the pyralid moths to which this species belongs—the *Crambidae*—it may be of interest to state that they

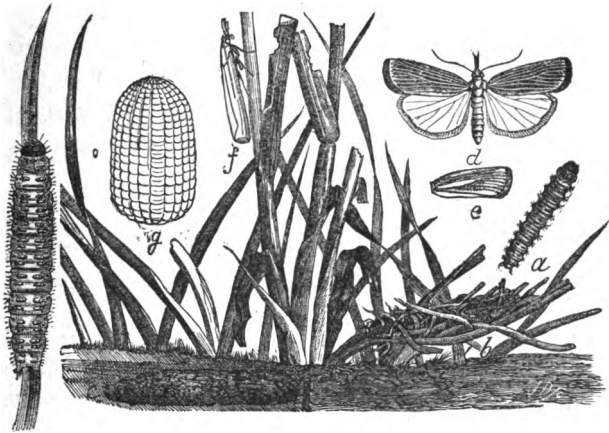


FIG. 51.—*Crambus vulgivagellus*: *a*, larva; *b*, web of same; *c*, cocoon; *d*, moth, wings expanded; *f*, same, wings closed; *g*, egg—greatly enlarged. [After Riley.] Larva more highly magnified at left. [After Lintner.]

are small moths, usually less than an inch in spread of wings, and presenting in general the following feature: The antennæ are thread-like; the palpi projecting like a beak for some distance in front of the head; body and legs long and slender; the front wings are narrow and long and are often ornamented with dots and lines in silver or gold; the hind wings are semi-circular and plain, and in repose are folded like a fan under the front wings; both pairs, when the insect is at rest, are wrapped tightly around the body in cylindrical form. They frequent meadows

and pastures during the latter part of summer, and when driven up by approaching footsteps, they fly for a short distance with a staccato flight, when they alight and hide beneath a leaf or upon a blade of grass, head downward, where, from their manner of folding their wings about them, they almost escape observation. This attitude, at rest, is the explanation of the name "Close-wings," sometimes applied to them in England.

NATURAL ENEMIES AND REMEDIES.

Several of the beetles that are figured in connection with the garden Web Worm are also known to destroy the caterpillars of this insect. Several parasitic insects of the orders Hymenoptera and Diptera have also been reared from it, so that ordinarily it will be held in check by these natural enemies and no special pains need be taken in the way of preventive remedies.

Rolling the infested fields will crush many of the caterpillars and numbers of the parent moths can be attracted by lights and destroyed.

THE BURROWING WEB-WORM.

(*Pseudonophara arcanelle* Clem.)

Another of the "Web-worms" that sometimes attacks the small grains is the species known as the "Burrowing Web-worm." While I am unable to give an illustration of it, I can at least say a few words about its method of living. Prof. S. A. Forbes who has studied this insect has published an account of the result of that study in the sixteenth report of the entomologist of the state of Illinois (pp. 98-100, Pl. VI, Figs. 2, 3, 5).

He writes of this insect as follows: "This larva constructs a silk-lined burrow in the earth, commonly terminating in a little chamber, and opening above in a webbed mass of earth or rubbish, into which its silken lining is extended. This web-worm is commonest in meadows, but most easily detected in cultivated lands the first year after grass. We have taken it from both corn and wheat following sod, and from gardens, hedge rows, and the like.

"This web-worm is described as a slender caterpillar from one and one-eighth to one and one-fourth inches in length. General color, a soft dusky-gray, with a peculiar silky look, darkening forward to the head and first thoracic segment, which are shining black. Distinguished especially by large, irregular, shining white or dusky areas on the thorax. The imago or parent insect is a thick-bodied, heavily-tufted, and wooly-looking moth of rather dark brownish-gray color, with distinct purple gloss, when fresh, on all the wings, the fore wings with lighter median shades, and indistinct spot and fine transverse lineations."

THE GRAIN MOTH.

(*Tinea granella*, Linn.)

Although this insect is principally a wheat pest it also feeds on shelled corn and other grains when stored for any length of time. When such is the case the outside of the kernels are attacked and fastened together with webs of silk. The insect has been described by a number of different American writers, most of whom

have given an account of its habits and mode of life. Briefly, this grain insect can be described as follows:

The moth, which is about one-third of an inch in length when its wings are folded, is creamy white, with six brown spots on the costa of each front wing, and with a long brown fringe at their ends. It is commonly found about old granaries during summer, and at such times should be killed.

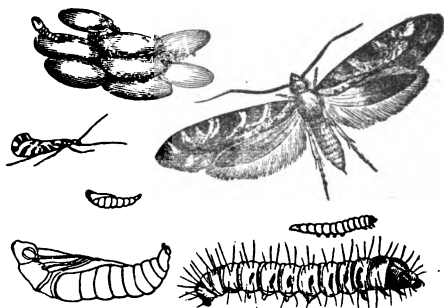


FIG. 52.—*Tinea granella*: larva, pupa, imago, natural size and enlarged; also grain fastened together by web of larva. [After Packard.]

REMEDIES.

While not the easiest among insects to get rid of, the grain

moth is not as difficult an enemy to control as is the preceding. Usually granaries are sufficiently tight to permit the use of some such a remedy as the bisulphide of carbon alluded to above. When this is the case it will be quite an easy matter to pour some of the liquid into a vessel and place in the bin containing the infested grain. Now cover this with some heavy sheet or blanket so as to retain all the fumes and allow them to penetrate the entire contents of the bin. Be very careful not to bring a lighted lamp, lantern, cigar, pipe, or any other fire in contact with the fumes, for they are very inflammable. Neither should this be used in places where any animal or person will be confined with it for any length of time, for it is quite as destructive to higher animals as it is to insects. After the fumes have penetrated the whole contents of the bin or granary for a considerable time, open and let it air. No poisonous effects are left behind, and grain thus treated does not appear to be materially injured for planting.

THE ANGOUMOIS GRAIN MOTH.

(*Gelechia cerealella*, Oliv.)

"A very important insect in the south to-day is the so-called Angoumois Grain Moth. It abounds in the southern corn fields and granaries to an alarming extent; but as we go north its numbers lessen and its injuries decrease. It is difficult to give its native home with certainty, but the probabilities are that it was originally a south European insect. It has been known in this country since 1728, and was probably introduced by the early settlers of Virginia and the Carolinas. No insect is more easily carried from one country to another, as it will breed for years without intermission in a bottle of grain kept as a sample, or will remain unsuspected in kernels in parcels of seed."

Professor Riley, in his report as United States entomologist for the year 1884, has devoted considerable space to this insect's injuries, habits, and history in this country; and in treating it here that paper will be largely quoted. He writes of its natural history and habits as follows: "The old state-

ment concerning eggs is: 'The female moth lays a cluster of from twenty to thirty eggs upon a single grain, in lines or little oblong masses in the longitudinal channel.' Our own experiments on the moth in confinement show that the eggs are preferably laid (in ears of corn) under the membrane which adheres to the basal portion of the seed, and although the membrane adheres very closely the moth manages to insert her ovipositor under it. They are also deposited in both the longitu-

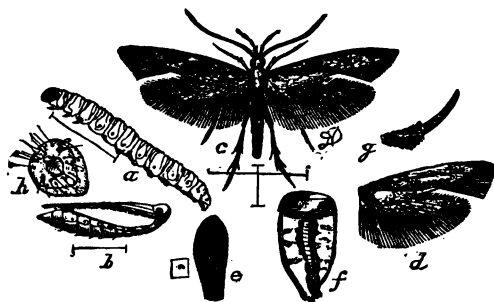


FIG. 53.—*Gelechia cerealella*; a, larva; b, pupa; c, moth; f, mode of attack. [After Riley.]

dinal and transverse grooves between the grains. Sometimes there is only a single egg, though usually they occur in batches of as many as twenty-five. The eggs are delicate, flat, and oval, and are pale red in color, with prismatic reflections (Fig. 53 e).

"The young larvæ are very active and crawl rapidly about, sustaining themselves by silken threads. They soon find tender places and bore into the kernels, leaving almost imperceptible openings. With wheat it is stated that a single grain has never more than one occupant, but with corn two or more are usually found. The larva is smooth and white, with a brownish head and prothoracic plate (Fig. 53 a). With the smaller grains, it has been inferred, from the fact that the quantity of excrement in the grain seems less with the full grown larvæ than with the younger ones, that the larvæ eat their own excrement once or twice. At full growth the larva cuts a circular hole in the cortex of the seed for the exit of the future moth, without, however, displacing the stopper thus formed. It then spins a delicate cocoon

within the grain, in which it transforms to pupa (Fig. 53 b). The moth issues through the previously prepared hole, and is of a very light grayish-brown color, more or less spotted with black, and with an expanse of wing of about half an inch."

REMEDIES.

This insect, along with several other species that attack stored grain, are readily killed by means of fumes of bisulphide of carbon, which remedy is more carefully described under the grain weevils. It also is infested by a small parasitic hymenoptera that is of some value in keeping it in check.

WHEAT LEAF-MINER.

(*Elachista præmaturella*, Clem.)

A little insect that has been discovered attacking wheat in some parts of the country is one of the Tineidæ or leaf-mining moths. While it probably never will become of sufficient importance as a wheat enemy to require special attention, it is an excellent example of the many insects that are known to work upon plants without becoming specially injurious. Of this kind, each plant has many distinct species that have been detected upon it.

Prof. F. M. Webster, of the Ohio Agricultural Experiment Station, writes of this insect as follows: "Early in November, in a small plat of wheat sown on the grounds of the Experiment Station, at Columbus, Ohio, on July 20, a single larva was observed mining in one of the largest leaves of one of the plants, near the upper extremity. The infected plant was transferred to the insectary, where the larva continued to feed, working its way downward near the edge of the leaf, toward the base. November 16 it abandoned the plant and was placed in a small glass tube. The length of the larva at this time was about 10 mm., the color yellowish, with dorsal transverse dark bands. After spinning a very thin white cocoon, through which its every movement could be clearly observed, it passed into the chrysalis stage on the 18th. The chrysalis was 4 mm. in length, and from it the imago emerged December 1."*

* INSECT LIFE, Vol. IV., Nos. 7 and 8, p. 290.—April, 1892.

THE LESSER GRAIN BEETLE.

(*Silvanus surinamensis* Linn.)



FIG. 54.—*Silvanus surinamensis*. [H. G. Barber.]

A very common insect that occurs in stored grain of various kinds is that herewith illustrated and known by the above name. It is a small brown beetle about one-eighth of an inch in length, and is characterized by having its thorax toothed along the sides, while the top is provided with grooves and intervening ridges. Both the mature insect and its larvæ feed upon the grain. This insect also attacks a large number of other substances. It is especially troublesome to dried fruits, seeds, grains, tobacco, and other similar substances. There are also two additional species of the genus which have been known to feed upon grain. They are

SILVANUS CASSIÆ Reich., and

SILVANUS ADVENA Waltl.

Both of these have similar habits with the *surinamensis*, hence need not be described separately. All three of them can be destroyed by the use of bisulphide of carbon in the manner described for several other stored grain pests.

LÆMOPHLEUS ALTERNANS Er. is another representative of the family Cucujidæ that has been found feeding in flour and grain. Like the preceding species it is a small brownish beetle, less than one-twelfth of an inch in length. If not very numerous, Dr. Linter suggests that they may be caused to leave by putting gum camphor or naphthalin crystals in cloth and placing it within the flour.

TENEBRIOIDES MAURITANICA Linn.

A reference to Fig. 55 will give the reader some idea of the general appearance of the members of a small group of insects that frequently infest granaries, where they feed upon stored grain to some extent at least.

These insects can be described briefly as "oblong, somewhat

depressed or flattened beetles, of a black or reddish-black color," which are usually found under the bark of dead trees. The one figured is of an average size. While feeding to some extent upon grain and grain products, most of the species are carnivorous in their food habits. Evidently these species found in granaries, corn cribs, and even on ears of corn while on the stalks, and on the ground in fields, also live to some extent upon the larvæ of other insects.

TENEUBRIOIDES DUBIA Mels.

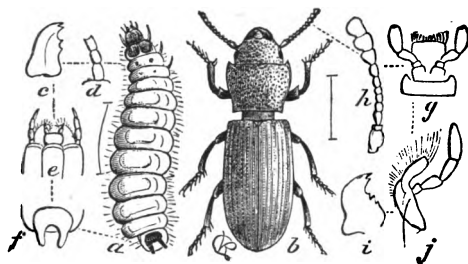


FIG. 55.—*Tenebrioides corticalis*: a, larva; b, beetle. [After Riley.]

WIRE WORMS.

The insects which bear the above name are so very prominent among the farm pests belonging to this class of



FIG. 56.—Wire Worm, Nat. Size.

animal life that, although quite thoroughly described in my last year's report, I will repeat what was said there. Professor J. H. Comstock, one of our best authorities on the subject of insect depredations, has the following to say of this group of insects:

"Wire worms occur in all parts of our country; there is hardly a cultivated plant that they do not infest; and, working as they do beneath the surface of the ground, they are extremely difficult to reach and destroy. Not only do they infest a great variety of plants, but they are very liable to attack them at the most susceptible period of their growth, before they have attained sufficient size and strength to withstand the attacks; and often seed is destroyed before it has germinated. Thus fields of corn or other grain are ruined at the outset."

Professor Comstock in another place writes of these insects: "In our studies of the life history of wire worms an interesting point was determined, which is of more practical importance, and will therefore be mentioned here. Wire worms live for several years in the worm or larval state. When the worms are grown they change to pupæ. This takes place in the species that commonly infests field crops during the summer. The pupa state lasts only a short time, the insect assuming the adult form in the latter part of the summer. But, strange to say, although the adult state is reached at this time, the insect remains in the cell in the ground in which it has undergone its transformation till the following spring, nearly an entire year. With most insects only a very short time is required, after the change from the pupa to the adult state, to allow the body to harden, and the insect to become fitted for active life. But in this case the quiescent period after the adult form is reached is not only of long duration, but appears to be necessary to the life of the insect; for in every case where the soil in the breeding cages was disturbed after the insects had transformed, the beetles perished in the soil. The only way in which we have been able to rear active adults has been to leave the soil in the breeding cages undisturbed from midsummer till the following spring.

"This experience clearly indicates that by fall plowing we can destroy the beetles in the soil, and thus prevent their maturing and depositing eggs the following spring."

These wire worms are quite numerous in Nebraska, as well as in other portions of the country. They are the young of the insects popularly known as "click beetles," "snapping beetles," and "skip-jacks," so common everywhere.

These wire worms are rather hard, smooth, cylindrical larvæ of a light brownish-yellow or straw-yellow color. They live, as a rule, in the ground, where they feed upon the roots of various plants. In the case of corn, they sometimes bore into the root, or they eat away the small fibrous rootlets, and in that manner cause the plant to shrivel up and die. They cannot bore into the roots of the small grains, but they eat away the entire root,

and in that manner kill the plants. Wire worms are said to be rather long-lived, some of them remaining in that stage for several years, as stated above.

AGRIOTES MANCUS Say.

Our commonest species in grain fields is the one known to entomologists by the above name. The beetle is a small, short, thick insect, measuring about three-tenths of an inch in length, and is of a dark brown color, covered with dirty yellowish-gray hairs, which are arranged in rows upon the wing covers.

AGRIOTES PUBESCENS Melsh., and several other species of the same genus, along with

DRASTERIUS DORSALIS Say, and

DRASTERIUS ELEGANS Fabr. are very common in fields. The species of *Drasterius* are pretty beetles. They are testaceous in color and marked along the middle of the thorax and across the wing covers with black.

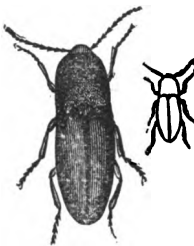


FIG. 57.—*Melanotus communis*.
Nat. size and
enlarged.

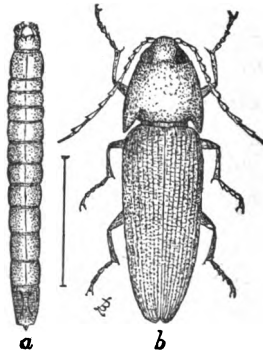


FIG. 58.—The common
Snapping-beetle (*Melanotus communis*): a, larva;
b, beetle. [Original.]

MELANOTUS COMMUNIS Gyll.

The insect which is figured herewith (Figs. 57 and 58, a, the larva, b, the beetle) is even more common than either of the preceding; but instead of working so much in corn fields is more of a grass and small grain insect. The line between the larva and beetle (Fig. 58) indicates the length of the latter, which is usually of a dull brown color. This is one of the few insects of

the family that are attracted by lights at night, and often enter houses.

REMEDIES.

MELANOTUS FISSILIS Say.

As remarked above, fall plowing will be beneficial by destroying the immature beetles in their cells. Another method which will undoubtedly prove of some value in checking the ravages of these insects is trapping the beetles in spring before they have deposited their eggs. This has been successfully accomplished in New York state by Professor Comstock, from whose writings I have already quoted considerably.

"The results of our efforts to trap wire-worms were very different from what we had expected. A few were taken in traps baited with sweetened dough, not enough, however, to be of much practical importance. But to our surprise, large numbers of click-beetles were taken. This at once opened a new line of investigation. If it is possible to trap and destroy the beetles before they have laid their eggs, we have at our command a much more effectual method of preventing the ravages of wire-worms than by destroying the larvæ after they are partially grown.
* * * Of the substances used as baits, clover attracted by far the larger number of beetles. It should be noted in this connection that a neighboring field, separated from the corn field only by a lane, is a clover-meadow. The average distance of our traps from the meadow was less than ten rods. It is a matter to be questioned whether the beetles spread from the clover field, or whether the proximity of this field lessened the number in the corn field on account of the greater attractions of the clover. The clover baits were small bunches, about one-quarter pound weight, of freshly cut clover."

That this method of trapping is feasible, can be judged from the fact that Professor Comstock took over 500 of the beetles in a single night in twenty-four traps—tin pie and cake dishes placed in the field above ground.

SITODREPA PANICEA Linn.

This is another of the small reddish-brown beetles that often

attack stored grain. It measures about one-eighth of an inch in length, and its larva is a bare, thick, "grub-worm-like" affair. It also is a somewhat general feeder—being found sometimes as a museum pest. It can be destroyed by the use of bisulphide of carbon as directed for several other species of similar habits.

THE ROSE-CHAFER.

(*Macrodactylus subspinosus* Fabr.)

The insect which bears the above name has become one of our most generally distributed injurious insects of the country. Like many of the others, it is also a very general feeder. As a corn insect it works mostly in the mature stage, but as a small grain enemy works also in the grub or larva state.

This species has been treated very fully by Prof. C. V. Riley in the April number of *Insect Life* (Vol. II., pp. 295–302, 1890); also by Prof. J. B. Smith, in a special bulletin issued from the

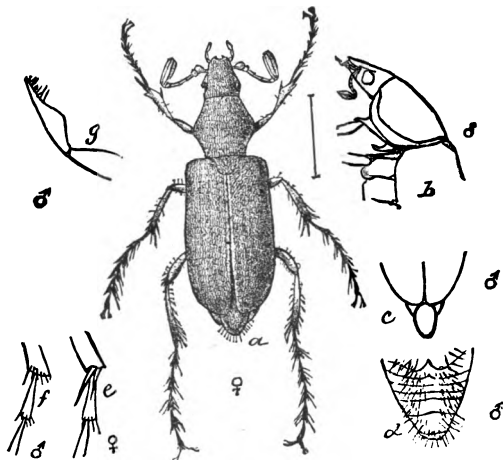


FIG. 59.—The Rose Beetle (*Macrodactylus subspinosus*): a, female beetle; b, c, d, e, f, and g, outline figures showing character of the sexes, etc.—all enlarged. [After Riley.]

New Jersey Agricultural Experiment Station, and in my report on "Corn Insects" issued last year as part of the annual report of this society. The following account of the insect is taken mostly from the article by Professor Riley:

NATURAL HISTORY.

The natural history of this insect can be briefly stated as follows: "According to Harris, the female beetle lays her eggs, to the number of about thirty, about the middle of July, at a depth of from one to two inches beneath the surface of the ground. He does not state the favorite place for oviposition, but in our experience the larvæ are especially abundant in low, open meadow land or in cultivated fields; particularly where the soil is light and sandy. Harris states that the eggs hatch in about twenty days, and, while the period will vary with the temperature, the larva is found fully grown during the autumn months. With the approach of cold weather it works deeper into the ground, but in the spring will frequently be found near the surface or under stones and other similar objects, where it forms a sort of cell in which to pupate. In confinement the pupa state has lasted from two to four weeks. The perfect beetle issues in the New England states about the second week of June, while in the

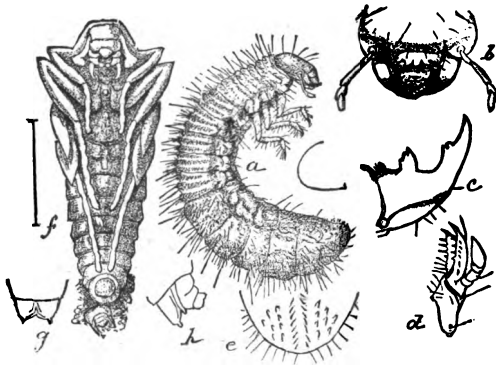


FIG. 60.—The Rose Beetle (*Macrodactylus subspinosus*): *a*, full grown larva, side view; *b*, head of larva, front view; *c*, left mandible of jaw of larva from below; *f*, pupa, below—all magnified. [After Riley.]

latitude of Washington it is seen about two weeks earlier. It appears suddenly in great numbers, as has often been observed and commented upon, but this is in conformity with the habits of other Lamellicorn beetles, *e. g.*, our common May beetles

(*Lachnosterna*), and this habit is still more marked in certain species of *Hoplia* and *Serica*. It remains active a little over a month, and then soon disappears. The species produces, therefore, but one annual generation, the time of the appearing of the beetle in greatest abundance being coincident with the flowering of the grape vine."

DISTRIBUTION.

This beetle occurs from the New England states westward to the eastern foot hills of the Rocky mountains, and is found from the Indian Territory northward to the British possessions. Its greatest numbers, however, are to be found near the Atlantic coast in Maryland, Delaware, and New Jersey, where horticulture and farming have been carried on for many more years than farther to the westward. It is also spreading to some extent into new regions.

ENEMIES AND REMEDIES.

Unless they appear in too great numbers the beetles can be destroyed to some extent by the use of London purple and Paris green. They can also be gathered by beating the plants upon which they have congregated, over an inverted umbrella and afterwards destroyed. The larvæ are more difficult to reach, but over small areas can be destroyed by drenching the surface with the kerosene emulsion and allowing it to soak in. Both the imago and the larva are eagerly devoured by a number of birds, and domestic fowls are remarkably expert in the art of getting away with the beetles. Reptiles and some of the smaller mammals are also very fond of them; while many an one is killed by Carabid beetles.

MAY BEETLES, WHITE GRUBS.

(Lachnosterna.)

The common May-beetles, *Lachnosterna fusca*, and allies, are

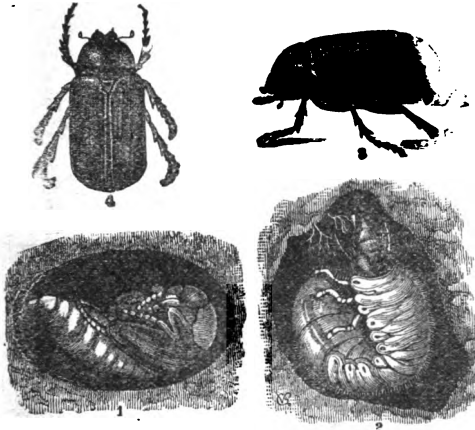


FIG. 61.—The Common May-beetle (*Lachnosterna fusca*): 1, the pupa; 2, the larva or white grub in its ground cell; 3 and 4, the beetle, side and dorsal views. [After Riley.]

among the most troublesome of all insect pests with which the agriculturist has to deal. They are accordingly to be added to a list of small grain pests. Here in the west these large and voracious insects are equally as numerous upon the prairies as they are in the vicinity of timber. In fact, they appear to be even more plentiful about new farms than old ones, because the tree-growth

on the newly cultivated grounds is so scant that a moderate number of the beetles will very quickly entirely strip off the leaves, while they would make but very little show if working on the foliage of trees of moderate or large size. All of these May-beetles are nocturnal in their habits and feed while we are asleep; and during day time lie hidden away in the ground, where they burrow during early morning, only to come forth again the following evening to continue their work of destruction among our fruit, shade, and forest trees.

One of these beetles (*Lachnosterna fusca*) is represented in Fig. 61, where the pupa, mature larva or grub, and the imago are all shown natural size.

These different species of May and June beetles are usually about the size of the one shown in the accompanying figure, though some are larger and others smaller. They are mahogany-brown or yellowish brown in color, and either smooth or slightly

roughened; and some of them have a covering of short hairs, among which are several longitudinal rows of longer ones upon the elytra, while a few are more or less pruinose—*i. e.*, covered with a bluish-white powdery-like substance similar to that covering ripe or nearly ripe plums.

So common and destructive are these insects (*fusca* and allied forms) throughout the country that, next to the Colorado Potato-beetle, Chinch-bug, Codling-moth, Rocky Mountain Locust, and a few others of our most injurious insects, they have received more attention than most of our insect pests. Their work as small grain enemies is done chiefly in the grub state, although much injury is also committed by the beetles themselves to these crops.

LIFE-HISTORY.

The life-history of these beetles has been given in the follow-

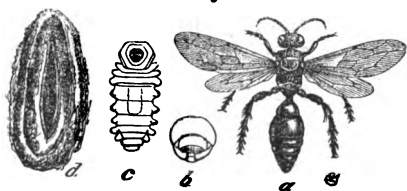


FIG. 62.—White Grub Parasite: *a*, imago; *b*, head of larva; *c*, larva; *d*, cocoon. [After Riley.]

ing summary by Professor Riley (First Report Insects of Missouri, p. 157): "Soon after pairing, the female beetle creeps into the earth, especially wherever the soil is loose and rough, and after depositing her eggs, to the number

of forty or fifty, dies. These hatch in the course of a month, and the grubs, growing slowly, do not attain full size until late summer of the second year, when they construct an ovoid chamber, lined with a gelatinous fluid, change into the pupa (see Fig. 62, 1), and soon after into beetles. These last are first white, and all the parts soft, as in the pupa, and they frequently remain in the earth for weeks at a time, until thoroughly hardened, and then on some favorable night in May they rise in swarms and fill the air. It is very probable that under favorable conditions some of the grubs become pupæ, and even beetles, the fall subsequent to their second spring; but growing torpid on approach of winter, remain in this state in the earth, and do not quit it any sooner than those transformed in the spring. On this hypothesis,

their being occasionally turned up in the fresh beetle state at fall plowing becomes intelligible."

From this summary then we are led to believe that the grub or larval state lasts more than a year—a long time when we take into consideration the comparatively short life of the beetle. The actual life of which, after it has once left the ground, is but a few days—not more than two weeks, and oftener less.

REMEDIES.

On account of their underground life the larvæ or grubs of the May-beetles are very difficult to reach and destroy. They are not without their natural enemies, both vertebrate and invertebrate, and the majority of them are thus destroyed between the time of hatching from the eggs and issuing as beetles. A large number of our birds are especially fond of the fat grubs, and can be seen industriously following the plow as it turns them up with the fresh, loose soil. All kinds of domestic fowls eat them greedily, while hogs industriously search for them by rooting over the ground where they occur in abundance. Mice, shrews, moles, ground squirrels, and skunks are also remarkably fond of both the grubs and beetles. Among their insect enemies the wasp known as *Tiphia inornata* Say, is the greatest. This insect is shown in it several stages in Fig. 62. The larva of this black or bluish-black wasp attacks and destroys the grubs, after which it spins a pale brown elongated silken cocoon of the kind so frequently dug up when working the ground, and transforms to the pupa state, and later to the perfect fly. During the spring of




FIG. 63—White Grub Fungus.
[After Riley.]

1889, here in the city of Lincoln, these May-beetles were attracted to the electric lights by thousands, as were also two large

black ground beetles, *Calosoma externum* and *C. lugubre*, in moderate numbers. These latter beetles would pounce upon a May-beetle as it lay floundering upon the walk under the lights, as a cat would upon a mouse, and very quickly kill and partly devour it.

The grubs are also frequently attacked and destroyed by a peculiar whitish fungus. This fungus issues near the head of the grubs and occasionally attains a length of three or four inches, when it has near the appearance of the accompanying illustration (Fig. 63).

Many of the beetles can be destroyed by jarring the trees over sheets and gathering them as they fall, after which they can be drowned in boiling water or thrown into the fire and burnt. Other methods can be devised by those who have the insects to fight—circumstances, of course, directing these forays against the enemy.

THE VARYING ANOMALA.

(*Anomala varians* Fabr.)

A beetle belonging in the same family with the May or June beetles, but a much smaller insect, has been reported as causing much injury to wheat in parts of Kansas. A Mr. Eugene F. Barnes, from whom specimens of this insect were received by the United States Department of Agriculture, said of its mode of attack that the insect appeared in his wheat field about June 15th, 1884, but on inquiry he found that it had been at work in the neighborhood for nearly two weeks previously, destroying some heads of wheat and leaving others amongst them uninjured. They began work as soon as the wheat was in the dough.

REMEDIES.

Possibly this insect may never become a serious pest, and therefore need not be fought. Should it continue to increase and normally become a wheat pest, by studying its life-history some remedy may be suggested by which it can be kept in check.

LEAF BEETLES.

(Chrysomelidæ.)

Aside from the few "Flea Beetles" mentioned below, but comparatively few species of the large family of "Leaf Beetles" known as the Chrysomelidæ to entomologists have been found to attack small grains. Of these the two following have been recorded:

THE COLORADO POTATO BEETLE. *Doryphora 10-lineata* Say.,
and

PORIA NIGROCYANEA Cr.

The first of these probably only accidental, and the latter not in great numbers. Unless we find them of more importance in the future than they have been in the past, no attention need be given them in the way of fighting them as small grain pests.

THE TWELVE-SPOTTED SQUASH BEETLE.

(Diabrotica 12-punctata O liv.)

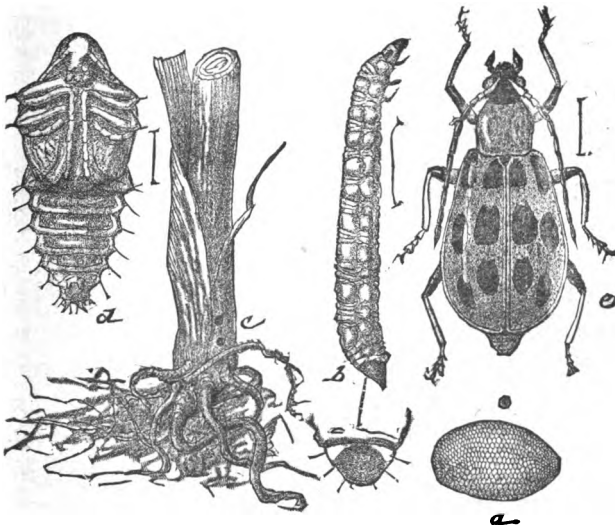


FIG. 64.—The 12-Spotted Diabrotica. [Insect Life.]

The insect that is herewith figured in all its stages of growth

(Fig. 64) was described quite fully in last year's report as a corn insect. I am sorry to be obliged to state that it also is to be included as a small grain enemy. It is one of our most common insects in all parts of middle and eastern United States, where it makes itself known, in the beetle state at least, as an enemy of a great variety of plants.

REMEDIES.

On account of its great range in food plants, and its being a double-brooded insect, the Twelve-spotted Diabrotica is a rather difficult pest to handle. (See last year's Report.)

FLEA BEETLES.

(*Chætocnemis* and *Psylliodes*.)

The insect which is shown in the accompanying illustration (Fig. 65), while not on record as an enemy to the small grains, will give the readers of this report an idea of the appearance of several species of "Flea Beetles" that have been taken while doing considerable injury to wheat. Most of these Flea Beetles are rather fastidious in their tastes and confine their attention to one, or at most, but few food-plants. A few of them are, however, less particular in this respect, and will eat almost anything. Among these latter we have

CHÆTOCNEMIS CONFINIS Lec.,

CHÆTOCNEMIS PULCARIA Mels, and

PSYLLIODES INTERSTITIALIS Cr.,

All of these attack the grain by eating the leaves full of small holes; and when very numerous, by almost completely devouring them. Of course the result is injury to the plants thus affected.

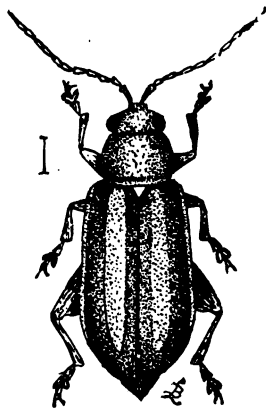


FIG. 65.—The Pale Flea-beetle (*Systema blanda*.) [Original.]

THE EUROPEAN MEAL WORM.

(Tenebrio molitor Linn.)

FIG. 66. — *Tenebrio obscurus*; a, larva; b, pupa; c, beetle, natural size. [After Riley.]

The ordinary meal worm is too well known to require a lengthy description here. Every housekeeper has seen both the parent beetle and its larvæ. Packard states of this insect in his Guide to the Study of Insects: "*Tenebrio molitor* Linn., the meal worm, is found in all its stages about corn and rye meal; it is sometimes swallowed with food. * * *

The larva is about an inch long, cylindrical, smooth, and glossy, with the terminal segment semicircular, slightly serrated on the edges, and terminated in a single point." These beetles also gather in large numbers in granaries and corn cribs, where they feed upon the stored grain; especially are they to be found in these places if they are not rain-tight and the grain becomes wet and rots. This species is also the most characteristic of mill-infesting insects both in this country and Europe.

The beetles have become thoroughly "domesticated" and are seldom found away from the habitations or storehouses of man. They are nocturnal and move about after nightfall, when they can often be seen flying and creeping about the walls of buildings which they enter whenever an opportunity is presented. In houses they soon seek out the pantry and attack all kinds of flour and meal.

THE AMERICAN MEAL WORM. (*Tenebrio obscurus* Fabr.)

Very similar to the above is a second species of meal worm. This latter, a native of America, is darker colored than the European insect and of the same size. Our insect is less numerous also than the foreigner, but its habits are the same. It is shown herewith (Fig. 66) in its different stages of development.

REMEDIES.

Meal worms are very retiring in their nature, and feed and breed only in dark retreats where they are seldom disturbed. To

prevent their increase about mills and such other places where their food occurs, these should be kept well lighted and cleaned. No heaps of rubbish should be left to lie about under which the beetles and larvæ could gather, while flour and meal bins should be made tight and kept closed during night-time when the insects are moving about.

THE FERRUGINEOUS FLOUR-BEETLE.

(*Tribolium Ferrugineum* Fabr.)

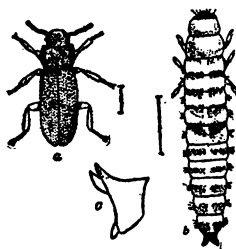


FIG. 67. — *Tribolium ferrugineum*: a, beetle; b, larva; c, tip of abdomen of larva—enlarged. [F. Clements.]

The little beetle that is illustrated here-with (Fig. 67) is a rather common pest about granaries and store houses, as well as in dwellings. It frequents meal chests, flour bins, and is also quite a general feeder, occurring as a museum pest, in many of the large museums of the country. In speaking of these insects Dr. J. A. Lintner says (2d Rept. New York State Entomologist, p. 187): "They were quite rapid in their movements, and could hardly be taken from the flour, from the facility they displayed in burying themselves and eluding capture. The beetles were far more active in the evening by gas-light, when they would come to the surface of the flour in the glass vessel in which they were confined, where for some reason, a marked tendency was shown to collect in clusters, clampering over the backs of one another for the purpose. During the several days that they were under my observation, not a single individual was seen to take wing for flight, or to climb up the outwardly sloping side of the glass vessel."

REMEDY.

When occurring as a house pest this insect can be destroyed by heat. In its role as a museum pest and also as a stored-grain pest it can be destroyed by using the bisulphide of carbon.

PHILETHUS BIFASCIATUS.

Another of these flour and grain pests that should be included

here is the small beetle known as *Philethus bifasciatus*. It is almost cosmopolitan in its distribution, and if allowed to increase unmolested might become a very troublesome pest.

SITODREPA PANICEA (Linn.)

Another of the cosmopolitan, omnivorous beetles that frequently makes attacks upon grain and grain products is known by the above name. It is less than one-tenth of an inch in length, rather robust and of a dark-brownish color, with short antennæ.

GNATHOCERUS CORNUTUS, Fabr. and

PALORUS DEPRESSUS, Fabr. are both insects of like nature with the above, that can be destroyed by artificial heat or by the use of fumes of bisulphide of carbon.

THE OAT WEEVIL.

(*Maycrops porcellus* Say.)

"A white, legless maggot, burrowing in the bases of the stems of oats, leaving the plant when full grown and penetrating into the ground a short distance to pupate, emerging three weeks later as a small, brown weevil with mottled wing covers."

In writing about the attack of this insect Mr. James Fletcher, the Dominion Entomologist, says in his report for 1891: "In walking through an oat field on the 10th of July I noticed that several of the stems had a faded and yellow central leaf, an attack similar to that of *Meromyza americana* upon many grasses. This latter insect is reported by Prof. Cook as injuring oats severely in the state of Michigan, so I was very curious to see if I had at last found it here, where, although it is a very active enemy of grasses, barley, wheat, and rye, I had never found it in oats. Upon taking up some of these stems I was much interested in finding an attack quite unknown to me. The base of the stem had been entirely eaten out by a footless, yellowish-white grub, one-fourth of an inch in length, with a chestnut-brown head and the posterior end of the body becoming rapidly smaller at the last two rings. On taking the grub from the oat stem it progressed quickly across a table, working itself along

by moving the rings of its body like a dipterous larva and at the same time making use of its slightly extensile tail to push itself along."

Mr. Fletcher does not consider the insect to be one that will ever become a destructive grain pest, as it seems to prefer to work upon the grass *Panicum crus-galli* instead.

THE GRAIN WEEVILS.

(*Calandra granaria* Linn. and others.)

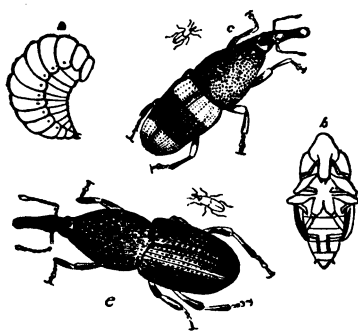


FIG. 68.—*Calandra oryzae*: a, larva; b, pupa; c, *Calandra granaria*—all enlarged. [After Packard.]

This is the true grain weevil, concerning which so much has been written, both in this and European countries. It is a blackish snout-beetle very similar in form to the different species of "bill-bugs" described or mentioned in my paper on "Corn Insects," but much smaller—being about one-fifth of an inch in length. It is well illustrated in the accompanying illustration (Fig. 68) at e, enlarged and natural size. In this

country the insect is less common than in Europe, and occurs chiefly in old granaries and corn cribs, where it feeds upon the stored grain. It attacks both corn and wheat, as well as some of the other grains. The mature beetles, as well as the larvæ, feed upon the grain. As a remedy, the use of bisulphide of carbon, as directed under several others of the species that attack stored grain, will be found very efficient.

THE RICE WEEVIL. (*Calandra oryzae* Linn.)

The insect which bears the name of "Rice Weevil," is naturally an enemy of that grain, but also attacks grains of various kinds. It is distinguishable from the *granaria* in having two large red spots on each elytron or wing cover. It is shown in the figure at c.

THE REMOTE PUNCTURED GRAIN WEEVIL. (*Calandra remote-punctata* Gyll.)

Still a third species of these grain weevils is occasionally to be met with in stored grain in this country. Its true home, however, appears to be farther south, or within the tropics, where it is very numerous and troublesome.

THE SMALL BILL-BUG.

(*Sphenophorus parvulus* Gyll.)

In my report to the Board last year I spoke of this and several other species of the same genus under the general title of "Corn Bill-Bugs." Although but a single one of the species

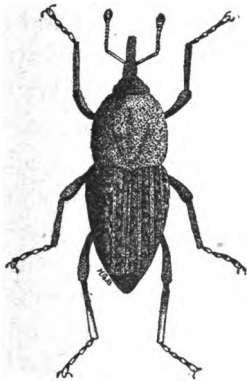


FIG. 69.—*Sphenophorus parvulus*; enlarged. [H. G. Barber.]



FIG. 70.—*Sphenophorus ochreus*: larva. [Insect Life.]

there mentioned has thus far been found to attack the small grains, it is a well known fact that nearly if not quite all of them are grass enemies.

Professor Forbes writes of the injuries to these "Bill-Bugs" as follows:* "As larvæ these species live and feed, as far as known, in the roots of grass-like plants, less commonly boring also the lower part of the stem. Grasses with bulbous roots, like timothy and the club rush, are probably their more normal breeding plants. In timothy meadows the hollowing out of the root bulb frequently kills the plant—if not outright, then the

* Sixteenth Rept. Ills. State Entomologist, p. 69.

following year. The larger club rush seems to endure better the attack of the clay-colored Bill-Bug, as several successive bulbs of a series are often found excavated, each having given origin to its plant notwithstanding the injury.

"The adults of all the species feed in substantially the same manner, as far as observed, and inflict a similar injury on the plants they infest. Standing with the head downward and the feet embracing the lower part of the stalk, they slowly sink the beak into the plant, using the jaws to make the necessary perforation. At intervals the head is slowly and regularly rolled from side to side as if to pry apart the several tissues, and when the soft interior substance of the plant is penetrated, a pause is made to enable the insect to devour the part thus brought within reach of its jaws. By moving forward and backward and twisting to the right and left, the beetle will often hollow out a cavity beneath the surface much larger than the superficial injury would indicate. *Ochreus* (and possibly several other species also) elongates the original slit by pulling the head strongly backward with the compressed beak inserted, thus using the latter to split the stem as a boy uses his knife to split a stick. In this way a slit an inch long may be made in the stalk of corn or head of cane beneath which the softer parts will be completely eaten out. Our imprisoned beetles, confined with rapidly growing corn, left the lower part of the stalk as it hardened and fed at the tip of the plant, or searching out the forming ears, penetrated the husk and gouged out the substance of the soft cob. The intestines of these beetles were well filled with the solid tissue of the plant, but I saw no evidence that they sucked the sap, although it is not, perhaps, impossible."

The species figured herewith (Fig. 68) is a very common blue-grass enemy here in the west, and needs to be combated more as an enemy of this grass than as a wheat pest. The larva of still another species is shown in Fig. 70.

REMEDIES.

No remedy can be given with our present knowledge of this insect that is at all satisfactory.

STORED GRAIN RHYNCHOPHORID.

(*Brachytarsus variegatus*, Say.)

The insect which bears the above scientific name has been taken in the act of feeding upon stored grain in the state of New York, and must, therefore, be mentioned, at least, in this connection. It is one of the snout-beetles, is scarcely more than one-tenth of an inch in length, of a dull ochreous color, varied with blackish. Its occurrence in grain and the injury done in this instance may have been accidental, as other species of the genus *Brachytarsus* are known to feed upon scale insects.

Should the beetle be found to habitually attack grain in the future, it could be destroyed by the use of bisulphide of carbon as directed in cases of injury by several other insects that infest stored grain. A very good way to apply this remedy is to take a piece of gas-pipe or other tube of sufficient length to reach the bottom of the bin containing the infested grain. Choose a stick of the proper size to fill the hollow, and with this in the pipe work the latter into the grain. Now draw out the stick and pour the bisulphide of carbon into the gas-pipe. In this manner you will reach the bottom and the fumes will kill all animal life in the bin. If the grain is covered with some heavy cloth so as to prevent the fumes from escaping the effect will be more perfect. After one or two hours the cover can be removed and the granary thrown open to air. Be very careful about fires of all kinds while using this remedy, as the fumes of the bisulphide of carbon are very inflammable.

CHINCH BUG.

(*Blissus cucopertus*, Say.)

Although this insect was discussed at length in my last year's report to the State Board, it is of sufficient importance to be mentioned again. Especially is this true in a report embracing the insect pests of small grains—the principal food of the insect.

The Chinch-bug, which has become one of our most destructive insect pests in the United States, was first noticed in the

state of North Carolina, where, like all of our injurious insects, it acquired its taste for cultivated crops, and began its attack upon these plants in preference to those growing wild, and upon which it had probably fed from time very remote. These new food plants being always at hand during the season when the bug lays its eggs and the young are growing and occurring in vastly greater quantity, of course gave the insect advantages for rapid increase. The loose soil about the roots of these cultivated plants, too, more nearly met the requirements necessary for the work of the young than was to be found upon uncultivated grounds.

The Chinch-bug was first scientifically described by Mr. Thomas Say, in the year 1831, from a single specimen captured in eastern Virginia. He called it *Lygæus leucopterus*. Soon after this, and within a few years, its range in injurious numbers began to widen, it having made its appearance in grain fields in different localities west of the Alleghany mountains.

From the year 1839 forward, its spread in the middle and western states has been quite regularly noted, until now it is known to occur very nearly from ocean to ocean. It is more of

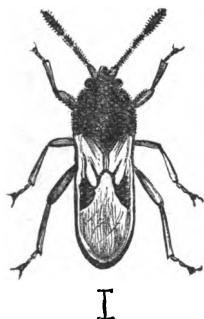


FIG. 72.—Chinch-bug. (*Blissus leucopterus*): imago. [After Riley.]

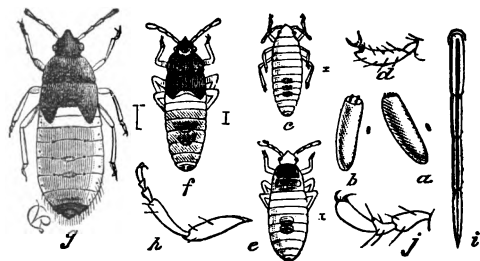


FIG. 73.—Chinch-bug: *a*, *b*, eggs; *c*, larva just hatched; *e*, and *f*, same, more advanced; *g*, pupa; *h*, *d*, and *j*, legs of bug—all enlarged. [After Riley.]

a southern insect than a northern one, although it is often met with north of our boundary line in Canadian territory. While it has been seen and is now known to be a regular resident along our northern border, its depredations have thus far been confined

chiefly south of the forty-fifth degree of latitude. In speaking of the geographical distribution of this insect, Mr. Howard says:* "East of the Rocky mountains the Chinch-bug seems to be indigenous, north and south, feeding naturally upon various species of wild grasses, and becoming multiplied wherever the cultivation of wheat has reached its original haunts." In the Rocky mountain region, and over the great interior basin, its presence does not appear to have been noted and recorded; but that it occurs on the Pacific slope, in the state of California, is now a well settled fact. It has been reported from Texas, Mexico, and the Island of Cuba.

LIFE-HISTORY AND HABITS.

The Chinch-bug hibernates in the mature or perfect state, tucked away in various nooks and crannies and underneath all sorts of vegetable *debris* as well as other things that offer retreats from the cold and snows of winter. When the warm days of spring appear, such of the bugs as have "pulled through" the long, cold winter, issue from their retreats and begin preparations for the summer's campaign. The mature insects are to be seen flying about during both spring and late fall on bright sunshiny days—in fall to seek shelter and in spring to seek suitable grounds for egg-laying. They also fly during the latter part of July and early August, when preparing for the second brood of young. The mating of the second or last brood sometimes occurs in fall, especially if the weather is pleasant; but usually takes place when the winter quarters are being forsaken. The eggs are then usually laid upon the roots of the plants chosen by the parent bug to be the food of the young, though sometimes upon the stalks of these just above ground. The average number of eggs laid by each female has been estimated at about 500. These are not all deposited at once, but are laid from time to time, during parts of May and June. Hence the reason for finding young of all sizes at the same time. The time required for the full development of the winged insect from the egg as laid is close to sixty days. This being the case, of course those bugs

* Bulletin No. 17 of the United States Dept. Agri., Div. Ent.

hatched from the first eggs will be the first to mature. When the grain has ripened and no longer affords food for the insects, they must necessarily seek it elsewhere; they must therefore migrate. These movements are made on foot, and by *all*, larvæ, pupæ, and imagoes, until they find some plant upon which to feed. This new food-plant usually proves to be corn, foxtail, Hungarian, or millet, though frequently various of the native or prairie grasses, sorghum, or broom-corn are the plants attacked. Even the weeds of fields are occasionally resorted to by them, as I have myself observed in this state, and have been told by others wild buckwheat being one of these. Upon these grasses and corn the eggs for the second brood are deposited—usually tucked in between the sheath and stalk.

FALSE OR BOGUS CHINCH-BUGS.

While this insect is only too common, and occurs generally throughout the regions mentioned, it not unfrequently happens that several other insects are sometimes mistaken for it, and unnecessary alarm caused. The first of these which I will mention is the False Chinch-bug (*Nysius angustatus* Uhl.), which



FIG. 74.—False Chinch-bug (*Nysius angustatus*): mature insect, enl'r'd. [After Riley.]

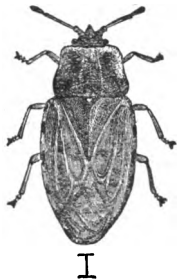


FIG. 75.—*Piesma cinerea*: greatly enlarged. [After Riley.]



FIG. 76.—Negro-bug (*Corimelaena pulicaria*): mature insect, enlarged. [After Riley.]

is shown in Fig. 74. Like the true Chinch-bug, it is widely distributed over the country, and sometimes does considerable injury to grape vines, strawberries, potatoes, young apple grafts, and all cruciferous plants. It is exceedingly fond of purslane

weed, and also occurs plentifully upon various species of smartweed. This bug also becomes quite numerous during certain years. Another of these false Chinch-bugs, which is also very widely spread, is the Ash-gray Leaf-bug (*Piesma cinerea* Say), which usually occurs upon the foliage of trees. Sometimes in spring it has been known to injure the blossoms of the grape. I have very frequently seen it upon the "tumble weeds" (*Amarantus*) in numbers sufficiently great to cover them from top to bottom. The Insidious Flower-bug (*Thriphleps insidiosus* Say) is another of the bugs frequently mistaken for the "true and only one." This particular insect, however, must be placed among our friends, as it is one of the few insects that destroys the species for which it is sometimes mistaken. A fourth one of these bugs that is a cause of "mistaken identity" is the Flea-like Negro-bug (*Corimelaena pulicaria* Germ.), of which Mr. Howard writes as follows:*

"Its appearance is more different from the Chinch-bug than any of the insects mentioned under this head, and is plainly shown by the figure. It feeds abundantly upon the fruit of the raspberry, and punctures also the stems of the strawberry, and the blossoms, leaves, and fruit stems of the cherry and quince. It is also injurious to certain garden flowers and to certain weeds. * * " This latter species is well represented in Fig. 76.

ENEMIES OF THE CHINCH-BUG.

The Cinch-bug appears to be one of the few of our insect pests that is comparatively free from the attacks of insects and other natural enemies. Among the species of predaceous insects known to feed upon insect life, only four of the lady bugs, one neuropterous, a single beetle, and several hemiptera, have been known to destroy it. Among the birds the quail stands at the head; while a few other birds follow closely. A few of the reptiles, as toads and frogs, also feed upon it, though rather sparingly.

Among the parasitic fungi there are at least two species known to attack the insect now under consideration. One of them is

* Bulletin U. S. Division Entomology, No. 17, p. 13.

very similar to that which is known to attack the silk worm. It is called the *Micrococcus insectorum*, and infests the alimentary canal. A second of these is the one figured herewith (Fig. 77), where a Chinch-bug is shown as he appears after having succumbed to this fungus (*Sporotrichum globuliferum*).

Professor Otto Lugger, entomologist and botanist for the Agricultural Experiment Station of Minnesota, in giving his experience with this fungus upon the Chinch-bug, writes as follows:*

"The warm weather continued, and the first generation of Chinch-bugs became quite numerous and destructive, and the second brood threatened a repetition of last year's disasters. Oats, rye, wheat, and some grasses were utterly destroyed by them, and the young and promising corn formed now a standing invitation to the hungry hordes. To prevent their inroads, all the infested fields and experimental plats were surrounded by a low board fence, six inches high, and snugly fitting to the ground so as to prevent insects from crossing under this fence. The upper edges of the boards were painted from time to time with tar, which prevented the bugs from crossing. The insects were at this time of all sizes and ages. Adults of the first brood, eggs, young hatched bugs, and pupæ of the second brood, were all mixed together, and all were decidedly hungry, as their intense activity and the swarming armies of famishing bugs plainly indicated. To gather in this crop of bugs, round holes about six inches in diameter were drilled in the ground close to the fence, and as one hole became filled with insects it was closed and another one was opened close by, for the reception of more victims. So matters worked to our satisfaction, when an unexpected assistant came to help us, making the structure of more fences unnecessary. The above-mentioned holes were quite deep, and consequently were always wet, a condition of things not at all suitable to starving Chinch-bugs, and they soon became unhealthy and weak, thus presenting the best condition for any disease to claim them as its victims. And such a disease, produced by a fungus, was not slow in making its appearance, as could be seen

* Bulletin No. 4, Minnesota Agricultural Experiment Station.

by the numerous dead bugs. The margins of all the holes, but chiefly those more densely crowded with captives, soon became whitened with dead bugs, enshrouded in white *mycelial* threads and dust-like spores. In fact, in a few days the upper rims of these holes looked as if recently whitewashed. Nor did the disease stop there. On the contrary, it spread very rapidly to adjoining fields of timothy, Hungarian grass, millet, etc. Even the course followed by it from the holes could be readily recognized for some time by the more or less numerous white spots left in its wake. The fields invaded by the disease afforded, upon closer examination, a truly edifying spectacle to those not interested in the welfare of the Chinch-bugs. They looked quite panic stricken, and moved about in a slow and dazed way, figuratively speaking, as if badly scared. And well they might be! The victims of the disease could be seen everywhere by the thousands. They had been slaughtered in all kinds of positions; but they were usually fastened to the blades and stems of the grass, or to the leaves of the young clover. All showed plainly that their last and strong determination in life had been to hold on as long as possible. Their legs were firmly planted upon the substances where the bug happened to be; others had only their beaks inserted, and were dangling by them free in the air. But all showed the characteristic white *mycelium* threads issuing from the spores of the disease. The illustration in Fig. 77 shows an enlarged Chinch-bug, with white threads issuing from its body, and numerous other specimens of natural size killed by the fungus. Although almost exclusively attacking Chinch-bugs, the disease was not slow in slaughtering such small flies as found the society of such malodorous companions to their taste. A story with a moral! * * *

"Most, if not all, the Chinch-bugs would have been killed at the experiment station, if the suitable conditions for this disease had lasted a few days longer. But the wet spell, prevailing part of the time the disease was playing such havoc among the bugs, soon passed, and was followed by warm and very dry days, which soon stopped any further spread of the disease. But by arti-

ficially producing such conditions, the disease was kept at work for some time, but only on a very limited scale. Nor could it be spread, because in nature such artificial conditions could neither be produced nor maintained on any extensive scale."

"As many parts of the southern portion of this state were overrun with Chinch-bugs, I thought that a good opportunity and an inviting field was presented to purposely spread a disease—an act not usually considered a very kind one to engage in, and one not to be recommended to physicians. This was exceedingly simple, as all that was necessary was to gather a number of the diseased bugs, put them into tight-fitting tin boxes, and mail them to regions infested by Chinch-bugs. Arrived at their destination, the contents of the boxes could simply be thrown into any field known to be infested by such bugs.

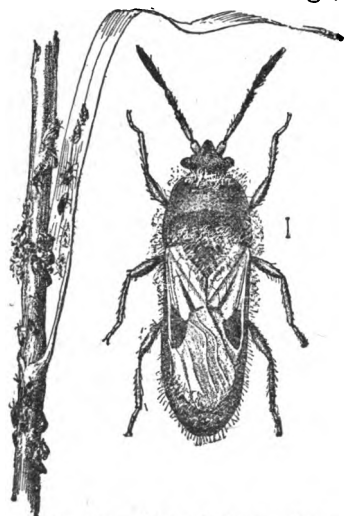


FIG. 77.—Chinch-bug, showing the insect as it appeared when killed by the fungoid disease; enlarged and natural size. [After Lugger.]

This was done with specimens of the diseased bugs collected at the Experiment Station, and eighteen different places in southern Minnesota were thus made centers of distribution for this disease, and, as it seems, with remarkably good results, as the disease has killed off the bugs to such an extent that careful search in a majority of places failed to produce a single living specimen, whilst the traces of the disease were found everywhere. The disease spread so rapidly that even corn fields growing near wheat fields crowded with Chinch-bugs were entirely protected, and no bugs had entered them in all the places visited by myself."

Professor Snow, of the State University of Kansas, has been very successful in killing off the Chinch-bug by means of these diseases which he succeeds in spreading over the country in infested regions. A number of reports that have been printed in

the various agricultural and other journals of the country will show how entirely successful his remedy has proved. A short extract from his first annual report on contagious diseases of the Chinch-bug * will give the reader of the present paper in brief the results of Professor Snow's experiments.

"THE WHITE-FUNGUS DISEASE.

"(*Sporotrichum globuliferum*).

"During the earlier part of the season, especially during the wet period, the larger percentage of the reports observed were obtained by the use of white-fungus infection. This, no doubt, is due to the conditions having been more favorable to this infection.

"As to the behavior of the infected bugs in the field, the following notes have been taken:

"(1) The disease begins to show that it has been communicated from the second to the fourth day after infection has been placed in the field.

"(2) The live bugs, leaving their food plant, show signs of uneasiness by moving rapidly and aimlessly about from spot to spot.

"(3) In the course of another day, the bugs become sluggish and seek protection from the sun's light and heat. The favorite place of shelter is beneath clods and corn stalks, or within some moist and shaded spot.

"(4) From the sixth to the eighth day, the first dead bugs are found, enveloped with fungus, looking when first dead, as some have put it, 'like little wads of cotton.' From the time the bugs first become sick, they cease to sap the growing stalk. Thus it will be seen that the ingress of the pest into the field may be quickly checked, if the experiment is properly attended to.

"In some fields, the bugs have been reported dead in bunches. Of the fields visited, no large bunches of white-fungus bugs have been found. In the corn field of Frank Shannon, at Augusta, Butler county, small bunches of dead bugs, perhaps a teaspoon-

* The University of Kansas Experiment Station, First Annual Report of the Director, for the year 1891, Contagious Diseases of the Chinch-bug, pp. 31-33.

ful in a bunch, were seen; but here it was observed that the bunched dead bugs were always found beneath a bunch of grass, where it was moist, or under a clod. In the oat field of John Kinsey, at Douglas, Butler county, the crop had lodged, shading the ground, which was necessarily moist. While the dead, fungus-covered bugs were present in countless numbers, no bunches were found. Each bug had died by himself.

"Under favorable conditions, it has been observed that the white-fungus infection spreads with considerable rapidity. Near Herington and Solomon City, Dickerson county, there are districts over which the disease became almost an epidemic. It is a fortunate fact that the more numerous live bugs are present in a field, the more rapidly the disease is communicated and the more malignant it becomes. In the wheat field of Noyes Barber, at Howard, Elk county, although a few dead bugs were placed along the extreme south line, the disease spread of its own accord a quarter of a mile in a little more than one week, killing the bugs before it as it went. So effective, also, was the same disease when placed in his corn field, that the ravages of the bugs were abruptly ended on the fourth day, when the whole brood was found upon the ground. Despite the fact that thirty or forty rows of corn had been visibly damaged before the infection was introduced, so that the blades were yellow, the hills 'braced up' and produced a good crop.

"THE BACTERIAL DISEASE.

"(*Micrococcus insectorum*.)

"While during the earlier part of the season the larger percentage of successful experiments observed were due to *Sporotrichum*, on the other hand during the latter part of the season the larger percentage was due to bacterial infection.

"Fortunately conditions unfavorable to the propagation of *Sporotrichum* are favorable to successful results with *Micrococcus*. The bacterial infection raged more strongly during the hot, dry weather, at the time when chinch-bugs operate most destructively. This infection is generally reported, by those seen by me, to have

spread under favoring circumstances even more rapidly and with greater destructiveness than does *Sporotrichum* when at its best. The abdomens of bugs sick with this disease appear greatly distended. It is this disease which causes the bugs to bunch. These bunches vary in size from that of a walnut to a teacupful, and, according to some few reports, still greater. However, it has never been my good fortune to see more than a teacupful of dead bugs and shells in a single heap. While the bugs were bunching in fields where infection had been placed, they did not bunch in uninfected fields. This fact was established by repeated examinations. In the fields of Thomas Nichol and of Samuel Garver, both of Abilene, Dickinson county, the extermination was complete, the piles of dead bugs and shells of dead bugs being distributed throughout their fields. The shells have belonged to bugs of all sizes and ages. Bugs and shells were taken by the bunch from the wheat fields of Hon. S. C. Wheeler, of Concordia, Cloud county, by Chris. Nelson of the same place, for the purpose of infecting his field, three miles distant, and a most satisfactory report was obtained."

THE GRAY-FUNGUS DISEASE.

(*Empusa aphidis*.)

"Previous to June 10th *Empusa* had not been found in the fields visited. However, on the date mentioned, a considerable number of *Empusa*-covered bugs were collected and sent to the station from the wheat field of Hon. Jacob Nixon, at Kellogg, Cowley county. No white fungus-covered bugs were seen in this field. Whether a part of the bugs had been destroyed by *Sporotrichum* or bacteria, it is impossible to say, since no correct memoranda had been kept, and the bugs had evidently been dead several days.

"The weather for a few days previous to the extermination of the bugs had been favorable to successful work with *Sporotrichum*.

"In all other fields in which *Empusa* has been seen, it has appeared along with white fungus and bacteria. When thus

found, about every tenth bug was covered with the *Empusa* 'mould.' Such bugs are easily detected in the field, from the fact that they are of a decidedly grayish color. They also present a moister and usually a larger appearance than those enshrouded with *Sporotrichum*. From about June 20th to August 1st, *Empusa* was seen in numerous fields, but in no field in great numbers. While *Empusa* without a doubt has proven itself to be a destructive agent in the extermination of Chinch-bugs, the great percentage of favorable results observed by me have been due to *Sporotrichum* and bacteria."

My report made to the United States entomologist upon this insect in October, 1887, will perhaps be of some interest here, as in that paper I have given a general outline of this entire subject. It is herewith given in full:

Great and widespread have been the depredations of this repulsive pest, which, next to the Rocky Mountain Locust, is our most injurious species of insect enemy. From its depredations alone throughout the drouth-stricken region of the Mississippi and Missouri valleys during the present season, millions of dollars' worth of grain have been destroyed, and in several localities actual privation is liable to follow.

The annexed crop reports, culled from various daily and weekly newspapers published throughout this region, will give a slight intimation of the true state of the subject under consideration. Still, each region always draws its own afflictions as mildly as possible, while in speaking of those of a neighboring district they are liable to be somewhat overdrawn or exaggerated.

About the beginning of the second week in July, rumors of Chinch-bug depredations at isolated localities throughout the drouth-stricken area were first circulating through the press. A week later these rumors had been substantiated, and it was definitely known that their distribution and depredations were more widespread and general than was at first supposed; not only in this state, but also in Kansas, Missouri, Iowa, portions of Illinois, Minnesota, and southeastern Dakota. But not until harvest arrived was the full extent of these depredations known.

Causes of increase.—When the matter is carefully studied and the causes of the undue increase of this insect are taken into consideration, the wonder is that the injury was not greater and more widespread than it actually has been. The long-continued drouth of last year, with large areas of Chinch-bug depredations, followed by a generally close and severe winter, after which came a warm, dry spring, and hot, scorching summer; all these favored in the greatest degree the most complete development of the bug in all its stages. But a comparatively few of its natural enemies were present, and most of these, too, were species that prefer preying upon other insects to feeding on the unsavory rebel under consideration, when insects of any other kind can be found. These predatory species had a plentiful host in the various species of aphides, leaf-beetles, and such-like other depredators that were also present in great numbers.

One of the most common and by far the chiefest of reasons for the large numbers of the pests that are always ready to take their place when the opportunity offers is the great carelessness prevalent among farmers in general to "clean up" during late fall and early spring. Especially is this true in portions of Nebraska, Iowa, and Kansas. The bugs winter among rubbish of all kinds, in meadows, along fences, in brush heaps, among fallen leaves, and among the *debris* collected by hedges, weed patches, and along the outskirts of groves among the underbrush. But there is no use of my going over these points that have been mentioned again and again by all writers upon the subject.

After the bugs have become a pest, the only effectual remedy is wet, cool weather. For some reason or other their constitution is not suited to a superfluity of moisture, nor can they adapt themselves to it. Humidity has the effect of bringing on disease and final dissolution with them, just as it does with various migratory locusts, the only difference being in favor of the locusts. A good, soaking rain, or at most two or three of such, following in the course of several days, generally ends effectually the most threatening Chinch-bug devastation; while on the other hand, a year, or even two, of such weather is sometimes required to entirely obliterate a locust plague.

The question, then, naturally comes up, can this insect not be materially kept in check by some other and natural means? My answer to this question is, yes. To a certain degree this is quite possible, and not nearly so difficult a task as one might suppose. A good cleaning up and burning of rubbish of all kinds in late fall, winter, or early spring, will answer the purpose, if the work be general, by reducing the number of hibernating insects. Osage orange and all other very brushy hedges are the most attractive retreats, and at the same time most formidable retreats to master. For my part, I would be in favor of removing these, and replacing them with some other kind not so difficult to keep free from the collecting *debris* carried by winds. Uncultivated prairie lands adjoining fields should also be burned early in the spring. The breaking down and burning of cornstalks in the spring following a Chinch-bug year will also destroy myriads of the insects that have hibernated between the leaves and stalks. At other times, however, the stalks had better be utilized as a fertilizer by plowing under. If covered deeply, this will be a remedy fully as effectual as if burned. Protect the birds, and above all the quails, for they destroy countless numbers of hibernating insects of various kinds that are to be picked up about hedges and such-like resorts frequented by these birds throughout the year. Although belonging to the granivorous birds, the quail is essentially insectivorous, except during inclement weather, when insects are not easily obtained. In my profession as taxidermist, I have dissected many different species of birds in the crops of which were contained injurious insects of various kinds, the Chinch-bug among the others. In no other instance do I remember of the presence of this insect in the crop of a bird in so great numbers as in that of the quail. As a rule, but few birds, mammals, reptiles, or rapacious insects seem to relish any of the odoriferous members of the order Hemiptera or true bugs. In winter, however, this repugnance is partially overcome, and now and then even a Chinch-bug seems a delicate morsel when "meat" is scarce.

Very few insects are known to prey upon the Chinch-bug;

while I myself have never observed any of the species which have been credited with the good work of thus attacking the enemy. True, I have frequently seen different species of Lady-bugs (*Coccinella*, *Hippodamia*, etc.), and the Lace-wing fly, upon the same corn stalk with the Chinch-bugs. Upon close observation it was also ascertained that the plant was more or less infested with some aphid or plant-louse which had attracted these, their natural enemies, before the bugs arrived. It must not be inferred from what I say here that I discredit the writings of such authorities as Thomas, Le Baron, and others. Such is far from my intentions.

Various remedies, as plowing, rolling, ditching, fencing, and the use of insecticides have been suggested and used with more or less favorable results, both in this and other states; deep plowing immediately after harvest having succeeded in a few instances by covering the bugs so deeply that they could not creep out. Rolling at a like season has crushed large numbers, while ditching and fencing have succeeded in "bunching" them and for a time checking their onward movement while migrating from small grain fields to corn fields. At such times the dragging forward and backward of a heavy weight of some sort has been the means of causing great slaughter among their continually increasing ranks. Ditches into which water could be turned have formed complete barriers to their creeping migrations, but not to the after movements of the winged insects as they were about to mate for the second brood.

This insect, like all depredators, has its likes, and dislikes, and chooses its food plants with considerable daintiness of taste.

The small grains are the first on the list, after which follow some of the grasses and corn. Among the grasses, millet, Hungarian, and fox-tail stand at the head, while a few others that usually grow as weeds follow closely. Wild buckwheat is also quite a delicacy with them, and I have noticed several examples where weedy fields were less injured than clean ones, notwithstanding the fact that the one contained equally as many bugs as the other. Several farmers in this state have also men-

tioned the same fact to me. As a rule, grain in a grassy field has the disadvantage alongside of that growing in a clean one. During the past summer I saw several examples in which the scale was turned. One of these in particular attracted my attention at the time. The crop was corn, growing just across the road from a field of wheat which had been so badly damaged as to render its harvest useless. The ground was covered with wild Hungarian or fox-tail grass, which at the time, August 6th, was dead and perfectly dry for a considerable distance in from the road. Upon examination it was found that our old acquaintance was at work here, attacking the fox-tail in preference to the corn. Referring to my notes made on the ground, I find the following:

"The Chinch-bug is still present in considerable numbers in a few corn fields, but absent from others where there are signs of its work. In these a large per cent of the grass (fox-tail) had been entirely killed before the corn was attacked. In no instance has the corn been greatly damaged, the only perceptible injury being in the drying up of a few of the lower leaves."

We had several heavy rains just prior to this, so the partial disappearance of the pest could very likely be attributed to that cause. Since that date but a few scattering specimens of the bugs have been noticed. Hence, I imagine our rains of August and September have been of great benefit in their diminution.

In conclusion, I would state that the only remedy that I know of is in clean farming—burning all rubbish in early spring that has not disappeared during fall and winter; also the protection of our winter birds.

In regions that depend entirely upon irrigation for moisture, or such as are easily flooded, there never need be any loss of crops from the depredations of this insect.

As to future possibilities of injury we can say nothing definite, as weather alone will decide the matter, a wet year preventing and a dry one favoring their increase in damaging numbers.

THE FALSE OR BOGUS CHINCH-BUG. *Nysius angustatus* Uhl.
FLEA-LIKE NEGRO BUG. *Corimelaena pulicaria* Germ.

See figures 74 and 76 on page 434, where these insects are

described. Both of these have been known to attack grain to some extent.

THE TARNISH PLANT BUG.

(*Lygus pratensis* Linn.)

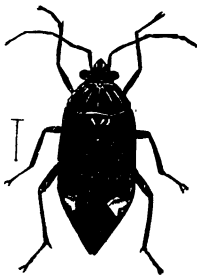


FIG. 78.—Tarnish Plant-bug (*Lygus pratensis*). [After Riley.]

Another of the insects that appears on almost every list of insect enemies is the one figured herewith (Fig. 78). It is known as the Tarnish Plant-bug, *Lygus pratensis*, and often is the cause of considerable damage during early spring by gathering in great numbers upon opening buds and blossoms from which it sucks the vitality by inserting its beak and extracting the sap. It hibernates in all kinds of sheltered places, and as soon as vegetation starts in the spring comes forth hungry and prepared for work.

REMEDIES.

As a small grain pest this bug is never very bad, but it should nevertheless be destroyed whenever and wherever this is possible. Since it breeds on weeds of various kinds in large numbers, clean culture is one of the best preventive measures to be recommended.

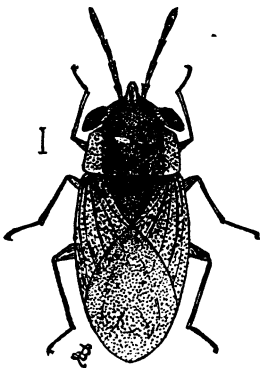


FIG. 79.—Large-eyed Ground-bug (*Geocoris bullata*), enlarged. [Original.]

LARGE-EYED GROUND-BUG. (*Geocoris bullata* Say) is another of the Chinch-bug-like insects that occasionally occurs quite plentifully in grain fields here in the west. It is shown in the illustration (Fig. 79). While it is more of a weed and grass insect than a grain pest, it

sometimes attacks the latter also.

EUCHISTUS FISSILIS, UHLER.

DRÆOCORIS RAPIDUS, SAY.

PODISUS—sp. ?

LEAF HOPPERS.

(Jassidæ.)

JASSUS INIMICUS Say.

There are a number of insects that go by the popular name of leaf-hoppers, which derive their nourishment by means of a beak, which they insert into the leaves and stems of various plants, and from which they extract the juices. Several of these have at different times been known to attack Indian corn in sufficient numbers to cause injury to that crop. One of these, the *Jassus inimicus* Say (Fig. 81), which is only about one-seventh of an inch in length, was first described in 1831 from specimens collected in Virginia. It is a moderately slender, greenish-yellow insect, dotted and marked by a few black points.

CICADULA NIGRIFRONS Forbes.

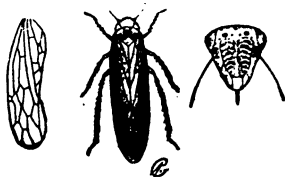


FIG. 80.—*Cicadula nigrifrons*—enlarged. [After Forbes.]

A reference to the accompanying illustration (Fig. 80) will aid the reader of this report in recognizing the insect which has received the above name. The insect which it represents is "a moderately slender, yellowish-green species, with four black points at the anterior margin of the vertex. The

head is sublunate, obtusely rounded in the middle, its antero-posterior diameter next the eyes being about three-fourths its median diameter. Its color is pale yellow, irregularly mottled with white, with an arc of four irregular black points at its anterior margin, the outer of these just above and within the ocelli. There is a slender impressed median line, black or dark brown, and a depressed spot upon each side appears midway between this and the eye. Total length, .14 inch."—(Forbes, 14th Ills. Rept., p. 67.) Found at Anna, Ill., July 14, very common on young corn. Also an enemy of small grains.

CICADULA QUADRILINEATUS Forbes.

A third species of these leaf-hoppers that is habitually a small grain enemy is "similar in general appearance to *Cicadula nig-*

rifrons, but differs in wing veins and color markings. Head with two round black spots upon either side of the middle of the base, about equidistant from the median impressed line and from the eyes. In front of these a transverse black line extending from eye to eye, but interrupted at the middle of the vertex, followed by a second heavier line sometimes interrupted and sometimes not, the two being nearly joined by a bar at the ends of the first."

As these leaf-hoppers occur upon small grains and grasses they can be best destroyed by the use of some form of the



FIG. 81.—*Jassus imicus*. [Osborn.]

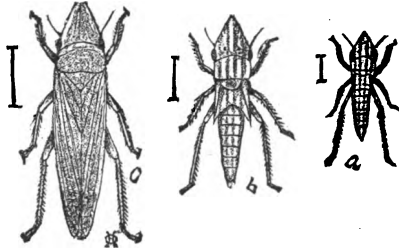


FIG. 82.—*Diedrocephala mollipes*. [After Osborn.]



FIG. 83.—*Cicadula exitosa*. [Osborn.]



FIG. 84.—*Cicadula exitosa*. [Marx.]



FIG. 85.—*Deltocephalus debilis*. [Osborn.]

"hopper dozer," which has proved so successful in capturing and destroying young grasshoppers or locusts.

DIEDROCEPHALA FLAVICEPS Riley.

TENDER-FOOT LEAF HOPPER (*Diedrocephala mollipes* Say.)

This insect is shown in Figure 82 in its different stages of growth.

STICTOCEPHALA LUTEA Walk.

STICTOCEPHALA INERMIS Fabr.

ATYNINA VIRIDIS Emmons.

LEAF-HOPPER—Undetermined.**THE DESTRUCTIVE LEAF-HOPPER (*Cicadula exitosa* Uhl.)**

Perhaps the most destructive of these "leaf-hoppers" that has thus far been observed to attack the small grains here in the United States is the one figured herewith. (Figs. 83 and 84). It is a rather small species, being but about one-fifth of an inch in length. In general color it is pale clay-brown, "polished above, but pale beneath." While enjoying a moderately wide distribution, it is most abundant southeastward, where most of its injuries have occurred to winter wheat.

THE WHEAT APHIS.**(*Siphonophora avenæ*.)**

Possibly the insect that is next in importance as a small grain enemy after the chinch-bug, is the one figured herewith (Figure 86). It is known as the Wheat Aphis, although it also attacks

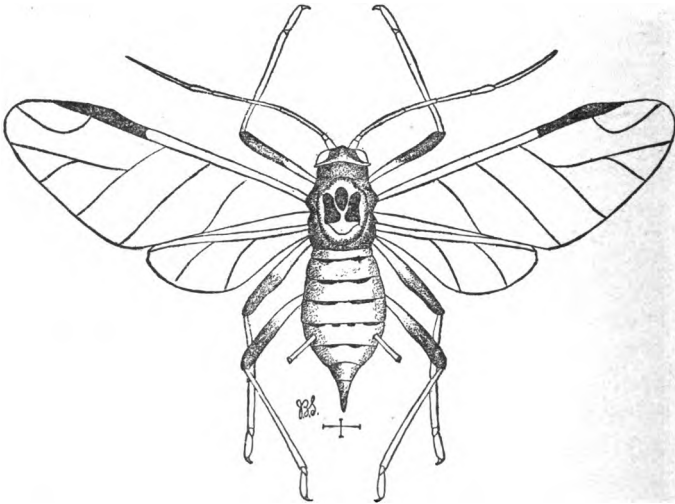


FIG. 86.—The Wheat or Grain Louse, winged viviparous female. [After Smith.]

other small grains, as well as some of the cultivated and native grasses. While this louse has never been the cause of any great amount of injury in the state, it has been observed to be present

in various localities for several years in considerable numbers. That it is on the increase there can be no question, and that it may do damage in the future is also possible. It, therefore, behooves us to acquaint ourselves with its appearance and mode of attack.

Winter wheat seems to be most favorable to the development of this grain louse, since it provides a means of carrying it through the winter. It can be described as follows:*

"The fully grown plant lice are rather less than a tenth of an inch long, with the body a little flattened from above downward (depressed), and widest behind. Each bears a pair of slender feelers (antennæ), a jointed beak which it holds close against the underside of the body when not in use, three pairs of jointed legs, and toward the hind end of the abdomen are two short tubes (cornicles) with open extremities. The general color is pale green, varying sometimes to pale brown. A series of small spots along each side of the abdomen, most of the antennæ, the tips of the thighs, the feet, and in winged examples the greater part of the thorax, are black. About the bases of the cornicles a rust-brown color is generally apparent."

LIFE HISTORY.

The life-history of this plant-louse does not appear to be very well understood. While a sort of general knowledge of the insect's life is known, there still remains much to be ascertained. That the insect infests all the small grains, corn, and several of the wild and cultivated grasses, is pretty well established. That it lives through the winter on the roots and down in the ground on the stem of winter wheat is settled; and that it also occurs through late summer and early fall on volunteer grain is quite evident from observations made by different investigators. Just where the true sexes—male and female—are matured and where the eggs are deposited that carry the insect through critical periods, is still a mystery. But that such a state exists at stated intervals I believe there is no doubt. All other, or more definitely, a large number of allied plant-lice have such a stage in

* Garman, in Bul. 21, Kentucky Agr. Expr. Sta., p. 22, Sept., 1889.

their life-cycle. The insect is to be met with both as winged and apterous forms, just as are other species with which entomologists are more or less better acquainted.

Wherever and in whatever manner the insect passes through winter, in spring it soon reappears upon the plants, where it develops quite rapidly by many generations and spreads over the field and neighboring fields. The winged individuals establishing new colonies in distant localities. The methods of reproduction among plant-lice have repeatedly been described by me in different reports, so will not be repeated here.

ENEMIES OF THE WHEAT APHIS.

Professor A. J. Cook, of the Michigan Agricultural College and Experiment Station, in speaking of these says: "The importance of parasitic and predaceous insects in overcoming our insect pests has long been recognized by the practical entomologist. He sees the destroyers swept off as by a flood; and sees in

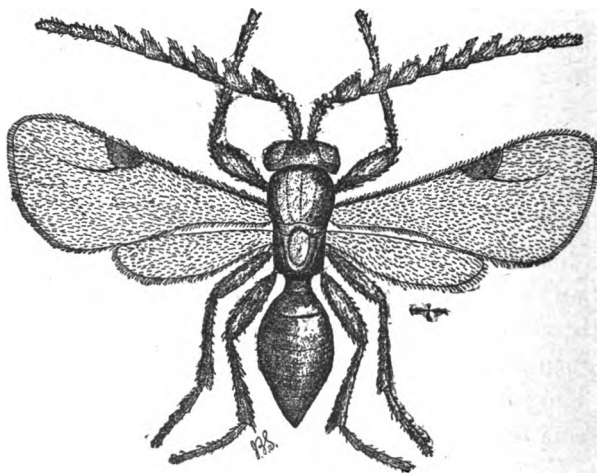


FIG. 87.—*Ceraphron triticum*. [After Smith.]

these prolific friends the easy solution of the problem of insect years. He knows that were it not for these friends the destroying hosts would make our earth a desert, and replace plenty with famine. He knows that adversity among these tiny helpers

means success to the swarms of insects that devour the crops, and is rejoiced when he sees these little helpers active and numerous."

Among the internal or parasitic enemies of this louse the small, four-winged hymenoptera are chief. Of these there are several. These small creatures attack the lice by laying their eggs in the bodies of the aphides, one in each louse attacked. These soon hatch and the grubs begin feeding upon the tissues of their unwilling hosts. Professor Cook, in his little bulletin above referred to, states that "the lice that are the victims of these eager parasites are easily distinguished. They are short, rounded, and gray in color. After the larva disembowels the louse it uses the dry, thick skin as a cocoon, in which it changes to a pupa. Very soon the mature insect comes forth from a small, round hole in the upper, hinder part of the abdomen, and very soon mates and commences to lay its many eggs in new victims. Of course, these parasitic larvæ fairly swim in the rich, nutritious blood of the lice, and so are rapidly developed. Thus we see how it is that the parasites are too much for the lice. Prolific as are the lice, and rapid as are they in development, yet the parasites are even more so, and thus it is that in ten days the parasites have so outnumbered the lice that the latter have been routed and driven from the field." In describing one of these parasitic flies he uses the following language: "The little flies are just about one-tenth of an inch in length. They are black above and yellowish-brown beneath. The antennæ are black, while the front, mouth parts, and legs are yellowish-brown. In some specimens the femora and tarsi are dusky and the underside of the abdomen quite dark. Occasionally we find specimens with the upper part of the abdomen brownish, except the pedicel and tip. There seems much variation in the color of abdomen and legs, though in most cases the dorsal surface is black and the ventral surface and legs brown. The antennæ are sixteen-jointed in the female and seventeen in the male. They are cylindrical, recurved, and thickly set with short, light-colored hairs. The first two joints are shorter and larger than

the others. The succeeding joints are nearly cylindrical, close together, and equal in length, except the last, which is longer and conical. The abdomen is lanceolate and all the segments are freely movable on each other, so it can be easily bent beneath the body. The venation of the wings is simple and the first discoidal cell is incomplete."

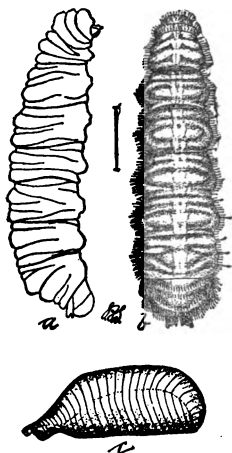


FIG. 88.—Larva of *Syrphus torvus*: a, b, larva; c, pupa. [After Smith.]

The parasitic fly shown in Fig. 87 is also one of the louse destroyers, but it belongs to a different genus from the one mentioned by Professor Cook, as the name will indicate.

Besides the parasitic insects mentioned above these and other lice are preyed upon by a large number of insects of a different nature. These latter are predaceous rather than parasitic, *i. e.* they seize and devour the lice bodily. Among these latter the larvæ or maggots of the *Syrphus*, or flower flies, stand first in rank. "These larvæ are generally overlooked, and they are better known by their deeds than their appearance."

"In shape they are slug-like, tapering toward the head. There are no distinct feet, and the larvæ stick rather close to the leaves or on wheat heads, and remain concealed among the spears and flowers. When they are hungry, which is generally the case, they lift the head and first segments of the body and extend them out in every direction, the larva nearly doubling in length when stretched out. Any unlucky aphid within reach is pounced upon, caught with the jaws of the larva and lifted high in the air, where it kicks and struggles until its juices are sucked dry. The empty skin is then thrown away, and the larva is ready for the next victim. In color this creature [which is shown in Fig. 88] is a very pale yellowish-green when young, darkening in color and becoming mottled with reddish purple as it matures. It is then about half an inch

or less in length, transversely wrinkled and with a very rough skin, set with minute, bristly-like hairs. When it is full grown it fastens itself to the leaf or spear of wheat upon which it has lived, and curls itself up, contracting into a curious hard case of a dark gray color, and rather more than one-quarter of an inch long. Fig. 88, c, gives the appearance of one of these pupæ. Not long does it stay in this form, but in about eight or ten days a pretty bronze and yellow fly emerges.

"This fly is nearly half an inch in length, the head entirely taken up by the large, brown-red eyes, the thorax shining bronze, but covered with a fine, velvety, soft hair, the little lunate scutellum at the tip of the thorax yellow. The abdomen is also bronze, but each segment being usually broken in the middle. The figure (No. 89) will give a very good view of the fly

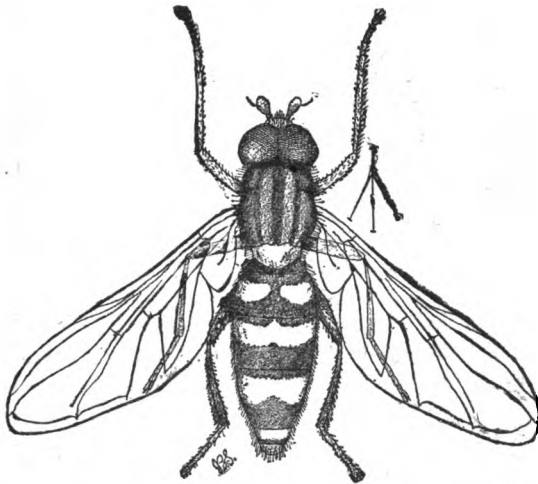


FIG. 89.—*Syrphus torvus*, imago enlarged. [After J. B. Smith.]

as it appears at rest. It hovers about the wheat in the bright sunshine, and the female lays its long, oval, pure-white egg wherever she spies a colony of lice large enough to support the young larva when hatched." *

A large number of other insects, such as are shown in figures

* Prof. J. B. Smith, in New Jersey Agric. Col. Expr. Sta. No. 72, pp. 12-14.

90 to 95 also do much towards keeping this and other plant-lice in check. Most of these latter have been described in various of my former reports, to which the reader is referred.

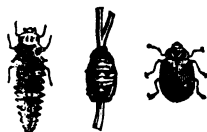


FIG. 90.—*Hippodamia convergens*. [After Riley.]



FIG. 91.—Larva of Ladybird. [After Riley.]



FIG. 92.—*Hippodamia 13-punctata*. [After Riley.]



FIG. 93.—*Coccinella 9-notata*. [After Riley.]



FIG. 94.—*Hippodamia maculata*. [After Riley.]



FIG. 95.—Lace-wing: a, eggs on leaf; b, larva; c, d, mature insect. [After Riley.]

Other species of Aphididæ that have been taken upon small grain are the following as nearly as they have been determined and reported:

SIPHONOPHORA GRANARIA Kirby.

APHIS MALI Linn.

APHIS—sp.

MYZUS—sp.

MEGOURA—sp.

TOXOPTERA GRAMINUM Rond.

CALLIPTERUS—sp.

RHOPALOSIPHUM—sp.

TOXARES—sp.

SCHIZONEURA—sp. .

THE WHEAT THRIPS.

(*Thrips tritici*, Fitch.)FIG. 96—*Thrips tritici*. [Original.]

The insect that is figured herewith is typical of a moderately numerous group of small insects that occur in myriads upon flowers of different kinds. They are also more or less common upon other kinds of vegetation which they injure to a greater or less degree. Our American species of the group (*Thysanoptera*—fring-wings) are mostly undescribed. There are, however, a few of them that have been known to injure crops to such an extent that entomologists have written about and published descriptions of the insects themselves. One of these is the insect figured herewith (Fig. 96). It is about one-twentieth of an inch in length, of a yellowish color, the thorax inclining to orange, with the legs and antennæ yellowish-white, the latter becoming darker at their tips.

THE THREE-BANDED THRIPS (*Coleothrips trifasciata* Fitch.)

This second species is nearly twice as long as the *tritici*, and is correspondingly more robust. Dr. Fitch describes it as being "of a black color, polished and shining, with the third joint of the antennæ white, and its wings black or dark smoky-brown, with three broad, white bands, whereof one is upon the base, another across the middle, and the the third, which is somewhat narrower, upon the tip."

These insects live upon the heads of wheat where they feed upon the juices of the forming kernels. Other species feed upon the tissues of the plants themselves, and some are carnivorous and feed upon mites and other microscopic forms of insect life.

ORTHOPTERA.

It is not my intention to mention all of the different species of orthopterous insects that attack small grains, for were I to do so most all of the different kinds known in the country would have

to be included in the list. The order as a whole is composed of vegetable feeding forms, and most of these feed upon grasses and allied plants in preference to bushes and trees or herbaceous ones. They nearly all attack cultivated crops in preference to wild or uncultivated plants when the former are at hand. In this paper, then, only such species will be mentioned as have been ascertained to injuriously attack these crops.

THE WESTERN CRICKET. (*Anabrus simplex* Hald.)

The insect figured herewith (Figure 97) is the famous Buffalo Cricket that has so frequently become sufficiently numerous in the great interior basin country to destroy crops. It has been

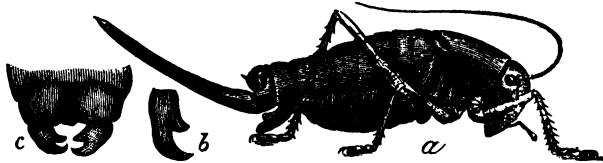


FIG. 97.—*Anabrus simplex*: a, female; b, clasper of male; c, tip of male abdomen, (Entom. Com.)

treated of in the reports of the United States Entomological Commission, and other government publications. As it is confined chiefly to the region lying to the west of the Rocky Mountains and east of the Coast Range, we never need fear its depredations in the Mississippi valley.

THE CONE-HEAD GRASSHOPPER. (*Conocephalus attenuatus*. Scudd.)

Sometimes found in grain fields in moderately large numbers. Especially is this the case during harvest in spring wheat and other spring sown small grain. Other species of the genus were taken by me in Texas several years ago, while running a "hopper dozer" on a wheat field.

THE RED-LEGGED LOCUST. (*Melanoplus femur-rubrum* De G.)



FIG. 98.—The Red-legged Locust (*Melanoplus femur-rubrum*); female. [After Riley.]

Of all our North American locusts or grasshoppers this one enjoys the widest range. It is the common species in all parts of the country from the Atlantic to the Pacific, and from the Arctic circle to Central

America. Its devastations, while perhaps not as great as those of some others of our destructive species, have been frequent and extensive at times.

THE LESSER MIGRATORY LOCUST. (*Melanoplus atlantis* Riley.)

This locust, which frequently becomes injurious on account of its excessive increase, is somewhat smaller than the Rocky Mountain species. It is also migratory in its habits, but to a much less degree than is *spretus*. In its distribution this insect is much more widely spread than *femur-rubrum*, being common in almost all parts of our country from the Mexican boundary to the fifty-third degree of north latitude, and even beyond in some parts of the country. It is the species which most frequently does the locust injury in the New England states, much of that in our northern states, and some in the extreme northwest. It has also been known to become injurious even in the middle and southern states. In its distribution *atlantis* appears to be more partial to hilly or mountainous country, and especially is this noticeable in reference to its appearance in destructive numbers. It also seems to prefer wooded or mixed country to the open prairie or plains.

As would naturally be expected from its wide distribution, this particular locust presents some variations in its size, color, and to some extent also, its structure. At any rate there appear to be three well-marked forms of the species to be met with

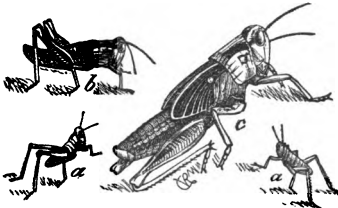


FIG. 99.—R. M. Locust: different stages of growth of young. [After Riley.]



FIG. 100.—Rocky Mountain Locust (*Melanoplus spretus*): male. [After Riley.]

within the confines of North America. It does not differ materially in general appearance from the *femur-rubrum* which is figured above.

ROCKY MOUNTAIN LOCUST. (*Melanoplus spretus* Thos.)

The Rocky Mountain or Migratory Locust is the insect which is generally referred to as *the* destructive locust of North America, and has caused more injury during the past twenty years than any dozen of the other species combined. It is this species which we most fear on account of its migratory habits. So marked is this trait that swarms hatching on the Saskatchewan have been traced to the Gulf of Mexico in one season. Its habits have been so frequently described that further mention is

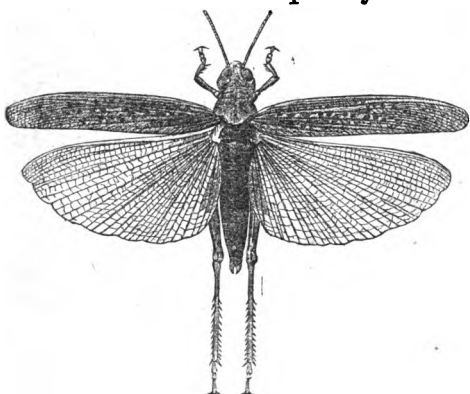


FIG. 101.—R. M. Locust; female. [After Emerson.]

unnecessary. It is shown in the accompanying illustrations (99, 100, and 101) which show the insect in its various stages of growth with spread wings and closed. The Rocky Mountain Locust has very probably been studied more than any other species of locust known to science; and the numerous remedies that have been suggested

and tried at different times and places have proved that it is possible to handle almost any injurious insect enemy if we go at it in the right manner, and continue our attacks after once having begun.

THE DEVASTATING LOCUST. (*Melanoplus devastator* Scudd.)

This is one of the destructive locusts of the Pacific slope, and is well represented in the accompanying figure 102. Its ravages have been confined to the small grains and grasses. Several other species of locusts that should be mentioned in this connection are

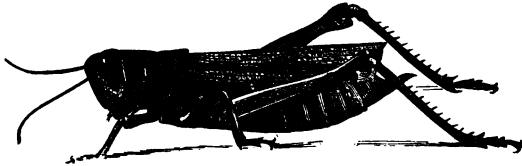


FIG. 102.—*M. devastator*.

THE ASH-COLORED LOCUST. (*Melanoplus cinereus* Scudd.)

THE DETESTIBLE LOCUST. (*Melanoplus foedus* Scudd.) and

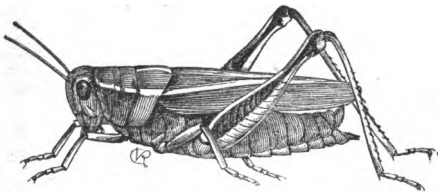
THE ROBUST LOCUST. (*Melanoplus robustus* Scudd.)

THE DIFFERENTIAL LOCUST. (*Melanoplus differentialis* Thos.)FIG. 103.—The Differential Locust. (*Melanoplus differentialis*): female. [After Riley.]

Here in the west we are frequently not a little bothered by a rather large, yellowish locust of which the accompanying illustration is a poor representation. This insect occurs along roadsides, the edges of groves, and at other localities where the vegetation is somewhat rank in growth. When more than commonly numerous it attacks and injures both garden and field crops. There are two forms of this differential locust here in the state, viz., the ordinary yellow one, and a black one. This latter form does not differ otherwise from the typical specimens.

THE TWO-LINED LOCUST. (*Melanoplus bivittatus* Say.)

The locust which is shown in Figs. 104 and 105 is too well

FIG. 104.—*Melanoplus bivittatus*: female. [After Riley.]FIG. 105.—*M. bivittatus*: male. [After Lugger.]

known to all of the readers of this report to require any special

description here. Like the preceding species it is a lover of rank vegetation, and is oftenest found in weed patches or low grounds. When it becomes more than ordinarily numerous these weed patches are forsaken and it enters grain fields and gardens, where occasionally much injury is done to growing crops. Unlike *differentialis*, which is confined to the central portion of the United States, *bivittatus* occurs from the Atlantic to the Pacific, and from the Gulf of Mexico to the Saskatchewan. Its increase in destructive numbers appears, however, to be confined chiefly to the regions lying between the Rocky Mountains and the Atlantic. This locust also varies somewhat in color, but can always be recognized by the two light-colored lines along the side of thorax and wing covers. Fig. 105 represents a male specimen that has been killed by a fungous disease that very frequently destroys numbers of these insects.

THE AMERICAN LOCUST (*Shistocerca americana* Drury.)

The locust which is shown herewith in figure 106 is known as the American Locust, to entomologists at least if not to the populace. It is truly a beautiful insect. In addition to its large size and attractive appearance this insect has become familiar to many of us on account of its ravages to crops. It is the species

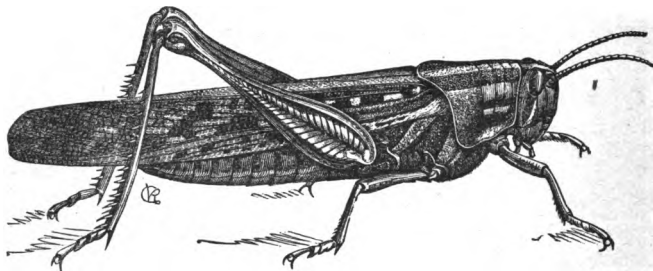


FIG. 106.—*Shistocerca americana*: female. [After Riley.]

which occasionally devastates Yucatan, Central America, and portions of Mexico, and which, on rare occasions, becomes sufficiently numerous along the Gulf coast to do injury to crops. It has also been known in dangerous numbers as far northward as the Ohio river, and occurs sparingly as far north as the northern states.

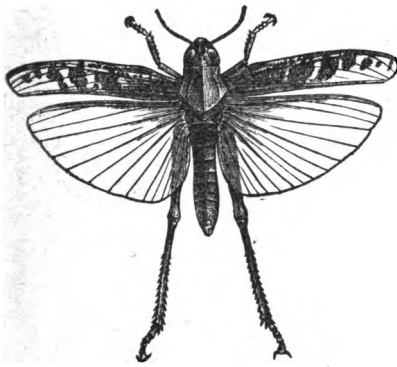
THE PELLUCID LOCUST (*Camnula pellucida* Scudd.)

FIG. 107.—*Camnula pellucida*.
[After Riley.]

The locust that is shown in Fig. 107 is a representative of a different subfamily from the above. It is one of the destructive species that has appeared at different times in California and Nevada.

Another locust that has recently increased to an alarming extent on the plains of Colorado, New Mexico and the extreme western portions of Nebraska and Kansas is

THE LONG-WINGED LOCUST (*Dissosteira longipennis* Thos.)

THE GREEN-STRIPED LOCUST (*Chimarocephala viridifasciata* De Geer.)

REMEDIES.

These grasshoppers or locusts are usually kept within bounds by their insect enemies, but when the weather has been such as to kill off these parasites the locusts become numerous. When this is the case some artificial measures must be resorted to if we wish to keep the 'hoppers within bounds and prevent their injury to crops. Such remedies have been numerous, but the ones that have proved the most efficient are plowing under deeply the eggs before they should have had time to hatch, and the capturing of the unfledged locusts by means of "hopper dozers." These latter are shallow sheet-iron pans in which are put coal tar or kerosene oil and drawn over the ground by horses in such a manner that the 'hoppers will hop into the pan and be killed by coming in contact with the oil.

THE FIELD CRICKET. (*Gryllus abbreviatus* Serv.)

The common field cricket has on several occasions been caught in the act of cutting off stems of grain in the field. It is also a noted fact that several species of these insects are guilty of much damage to shocked grain in the way of cutting the twine bands that hold the grain in sheaves and also by feeding upon the grain in itself. They also cut off young growing plants. Several species of these crickets are concerned in this mischief; and in addition to the above we might add

Gryllus PENNSYLVANICUS Burm. and

Gryllus LUCTUOSUS Serv.

THE GARDEN FLEA. (*Smynturus hortensis* Fitch.)

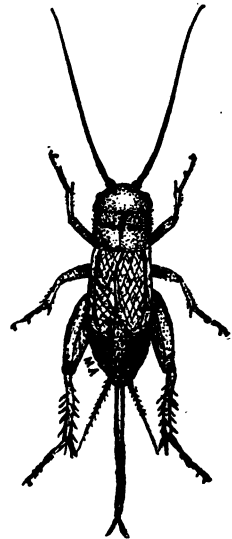
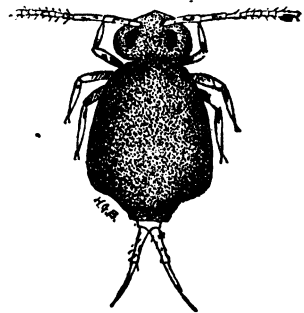


FIG. 108.—*Gryllus abbreviatus*. [Maysie Ames.]

In addition to the large list of insects described or mentioned on the preceding pages there are still others that occasionally are to be found in grain fields. Quite prominent among these are several species of small, soft-bodied, wingless insects of very very simple structure, belonging to the order Thysanura of naturalists. These are closely related to the "Snow Fleas" that are frequently met with in winter and early spring, jumping about on the snow. One of these "garden fleas" is shown in the accompanying illustration, greatly magnified. (See. Fig. 109.)



Dr. Fitch, in writing of this insect, says, "This insect is not limited to the garden, but occurs more or less common everywhere in arable land. In fields of young wheat and rye, in May and June, I have often noticed it as being more numerous than any other in-

FIG. 109.—*Smynturus hortensis*. [H. G. Barber.]

sect there." While these little creatures are vegetarians, they feed mostly upon such plants as are found upon the ground in a more or less decayed condition. They do not, therefore, figure among the very destructive forms. Their "jumping" is performed by means of tail-like attachments that are bent under their bodies and are used as springs, hence the name "Spring-tails" which is frequently applied to them.

THE PRETTY GROUND-FLEA. (*Smythurus elegans* Fitch.)

THE MARKED GROUND FLEA. (*Smythurus signifer* Fitch.)

ARACHNIDA.

(*Mites, Spiders, etc.*)

THE STORED-GRAIN MITE. (*Tyroglyphus longior* Gervais.)

This is probably one of the most disgusting creatures that we have to deal with as a grain pest. It does not confine its attacks entirely to grain, but is also known to attack stored drugs, cheese, flour, hams, and a variety of food products. As will be seen by reference to the figure of this creature and a second one (Figs. 110 and 111), they are eight-legged instead of six-legged as are the insects proper. They are all small, semi-transparent animals covered with long bristles or hairs.

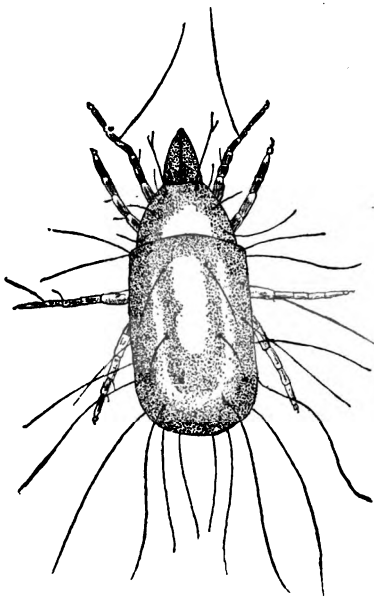


FIG. 110.—*Tyroglyphus longior*.
[After Murray's Fig.]

REMEDIES.

This and other mites of similar habits are subject to the attacks of several species of predaceous mites that destroy them.

The editors of *Insect Life*, in a reply to a letter in reference to this mite suggest as a remedy "the burning of sulphur all

through the building, especially where mites abound, and, where they are particularly thick, it might be well to let a little bi-sulphide of carbon evaporate, remembering that this vapor is heavier than air and that it is exceedingly inflammable."*

THE RED SPIDER (*Tetranychus telarius* Linn.)

The common "red spider" of greenhouses has been taken this past year on wheat plants in Brookings, S. Dak. It is figured in the accompanying illustration (Fig. 111.) It is not at all probable that this mite will ever be the occasion of any great amount of injury to grain, but it is mentioned here as an example of a certain group of Acarina or mites that naturally work upon growing vegetation. As a remedy against these kerosene emulsion is quite effective.

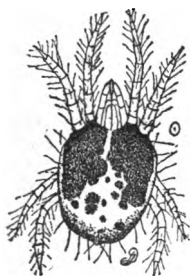


FIG. 111—*Tetranychus telarius*, enlarged. [Griffiths.]

* Insect Life, Vol. I., p. 51. Aug., 1888.

INDEX.

	PAGE
Entomologist's report.....	360
American locust.....	462
American meal worm.....	425
Angoumois grain moth.....	408
Arachnida.....	465
Army worm.....	390
Burrowing web worm.....	406
Chinch bug.....	431
Cut worms.....	382
Remedies for.....	384
Devastating locust.....	460
Differential locust.....	461
European meal worm.....	425
Fall army worm.....	386
Remedies for.....	389
Ferrugineous flour beetle.....	426
Field cricket.....	463
Flea beetle.....	424
Garden web-worm.....	396
Grain moth.....	407
Grain weevils.....	428
Gray fungus disease.....	441
Indian meal moth.....	404
Introduction.....	360
Leaf beetles.....	423
Leaf hoppers.....	448
Lesser grain beetle.....	411
List of insects treated.....	361
Acarina.....	365
Coleoptera.....	362
Crane fly larva.....	369
Diptera.....	361
Hessian fly.....	365
Hemiptera.....	363
Homoptera.....	364

INDEX.

	PAGE
Entomologist's report, List of insects treated— <i>Continued.</i>	
Hymenoptera.....	361
Orthoptera	364
Thysanoptera.....	364
Thysanera	365
Wheat midge.....	368
May beetles.....	419
Meal snout moth	401
Mediterranean flour moth	401
Oat weevil	427
Orthoptera	457
Pellucid locust	463
Red-legged locust.....	458
Rose chafer.....	416
Sitodrepa Panicea Linn.....	415
Small bill-bug	429
Snow flea	464
Stalk borer	390
Stored grain rhyncophorid.....	431
Tarnish plant bug	447
Twelve-spotted squash beetle	423
Two-lined locust.....	461
Vagabond crambus	404
Variable wheat fly	373
Varying anomala	422
Western cricket	458
Wheat aphid.....	450
Wheat-head army worm	394
Wheat joint-worm	379
Wheat leaf-miner.....	410
Wheat saw-fly	375
Wheat stem maggot.....	371
Wheat stem saw-fly	377
Wheat straw-worm	379
Wheat thrips	457
White fungus disease	439
Wire worms	412